MODERN WIRELESS

May

THE LARGEST BRITISH WIRELESS MAGAZINE

1/-

VOL. 1. No. 4. Edited by JOHN SCOTT-TAGGART, F.Inst.P., Member I.R.E. May, 1923.

No. 4

The First-Prize Armstrong Receiver

BY A. D. COWPER, M.Sc.

THE COLD VALVE OF THE FUTURE, by J. H. T. ROBERTS, D.Sc.

ASSEMBLING SETS FROM BOUGHT COMPONENTS

NOTES ON REACTION, by JOHN SCOTT-TAGGART, F.Inst.P., M.I.R.E. LOUD-SPEAKER HORNS, by G. P. KENDALL, B.Sc.

A Simple Tuner. Making Variable Condensers. A Novel Crystal Detector. Multi-layer Coils, etc

Western Electric

Loud Speaking Equipment

A Loud Speaker and a Loud-Speaking Power Amplifier combine to form that Loud-Speaking Equipment which has set a standard of efficiency unequalled by any other outfit. It can be used in conjunction with any good type of Valve Detector Set for amplifying radio telephone speech or music.
Western Electric Quality throughout.

MAKERS OF OVER HALF THE WORLD'S TELEPHONES

OTHER SPECIALITIES—

Low Frequency Amplifier
High Frequency Amplifier
Valve Detector & Tuner
Crystal Sets
Head Receivers
Etc., etc.

Western Electric Company Limited.

(WHOLESALE ONLY)

CONNAUGHT HOUSE, ALDWYCH, LONDON, W.C.

Telephone: Central 7345 (9 *lines*).

BRANCHES: BIRMINGHAM, LEEDS, CARDIFF, MANCHESTER, NEWCASTLE, GLASGOW.

CONTENTS

"MODERN WIRELESS," MAY, 1923

MODERN WIRELESS is published on the 1st of the month.

All correspondence relating to contributions should be addressed to Editorial Offices, Devereux Buildings, Devereux Court, Strand, W.C.2.

Contributions, illustrated whenever possible by photographs and rough pencil sketches, will be considered for publication.

PUBLISHING OFFICE: 3, Bolt Court, Fleet Street, London, E.C.4.

TELEGRAPHIC ADDRESS: "Radbooks, Estrand."

TELEPHONE NO.: Central 4393.

ADVERTISEMENT OFFICES: Scheff Publicity Organisation, Ltd., 125, Pall Mall, London, S.W.1.

TELEPHONE NO.: Regent 2440.

SUBSCRIPTION RATES

15/– per annum, post free. 7/6 six months, post free. 1/3 single copy, post free.
Registered at the G.P.O. for transmission by Magazine Post to Canada and Newfoundland.

Nothing in this journal is to be considered as a permission or encouragement to infringe any patent rights covering apparatus described.

MODERN WIRELESS

RADIO PRESS

Editor :
JOHN SCOTT-TAGGART, F. Inst. P.
Associate Editors :
J. H. T. ROBERTS, D.Sc. — E. REDPATH.
Scientific Adviser :
Prof. G. W. O. HOWE, D.Sc., M.I.E.E.

VOL. I MAY, 1923 No. 4

EDITORIAL

THE POSSIBILITIES OF WIRELESS DEVELOPMENT

EVERY day one hears that "wireless is only in its infancy." This platitude, voiced as it is in most cases by those who because wireless has only just been brought to their notice imagine that it is only a recent invention, has always appeared to me to be a remark, not only childish, but inaccurate.

When it is possible to send messages half-way round the world; when it is possible to listen to exquisite or mediocre music—according to one's mood—in one's own home; when it is possible to send a message to reach, within a few hours, any vessel on the surface of the Oceans—how can it be said that wireless is only in its infancy?

Real progress in wireless commenced in 1896 when Marconi landed on these shores and, by his practical vision and his enthusiastic activity, led the way for a multitude of investigators to probe what was practically a new science.

Many have tried since then to take away from Marconi what is unquestionably his right. It is a significant fact that there is no invention used to-day which is not claimed by several independent workers.

Professional jealousy exists as much in the art of wireless telegraphy as in any other science or industry. The natural instinct of an investigator to say that he accomplished a result earlier than someone else has resulted in much litigation, and not a little bitterness, in the world of wireless. Only when a patent for an invention becomes void does the true inventor obtain full recognition.

This, however, is by the way. The great fact which remains is that we are to-day using inventions which were conceived in the eighteenth century and which we nowadays take for granted.

The year 1907 marked two new very important developments in radio communication. One was the invention of the heterodyne method of reception—perhaps the most ingenious invention in connection with this art. The other was the De Forest valve, although De Forest himself probably did not appreciate at the time the full value of the instrument he had given to the world.

The year 1913 marked the advent of many new developments in the use of three-electrode valves, and much of this work was carried out in America. Since 1913, it is very doubtful whether the progress of wireless has been as rapid as one might have hoped. Many problems remain unsolved, and many, no doubt, will remain unsolved for many years. Broadcasting, no doubt, will result in many improvements in apparatus, and it is to be hoped that the impetus given to the wireless industry will result in many new inventions. By "inventions" I do not mean the absurd sorts of patents which are nowadays being applied for in connection with minor details of construction, but novel developments in the way of circuits and general systems.

It is not possible to calculate beforehand the actual influence of any given invention, but to those who are endeavouring to perfect apparatus for radio communication, I would say that the greatest and most far-reaching type of invention is the one which will facilitate long-distance signalling. There are such fundamental difficulties in the way of long-distance wireless communication that the intellects of this country should be brought to bear on problems of reliable long-distance reception and transmission.

It will be a great pity if, on account of broadcasting, the best engineers in this country have their attention diverted from the more important problems which face us to-day. It is to be hoped that real research and invention will not be neglected in favour of what, after all, is largely design work.

NOTES

WIRELESS without a wireless set: this sounds like the latest invention from the States, but it actually refers to the fact that one of our staff, who has recently been staying at an hotel in the Strand, found that Marconi House, which is only 200 yards away, could be clearly heard on all the house telephones, although not on the main telephone line to the Post Office exchange. Many interesting freaks of this nature have been reported. For example, in Manchester there is a single-valve set about a quarter of a mile from 2 ZY which brings in that broadcasting station quite audibly when the valve is pulled from its socket.

We have received from the Coventry Public Library's Committee a copy of their bi-monthly Readers' Bulletin, which we find forms a useful bibliography of recent wireless publications. The Wireless Telegraphy and Telephony section has a foreword by Sir William Noble, M.I.E.E., formerly the Engineer-in-Chief to the Post Office, and now a director of the British Broadcasting Company.

AS OTHERS SEE US!

The above caricature of the Editor of MODERN WIRELESS *and "Wireless Weekly" appeared recently in the "Westminster Gazette," accompanied by a very complimentary review of our new weekly periodical.*

We note that certain sections of the daily Press which devote themselves to the interests of the broadcast receiver, are beginning to take a good deal of interest in the question of the location and suppression of the offenders against the reaction regulations. Of all the schemes which we have seen suggested the most practical seems to be one which we know has been tried in certain northern centres. The method consists in equipping one or two closed motor-cars with frame-aerial receiving sets and making systematic eavesdropping visits to all the known stations in the district. The scheme, which can only be worked by local wireless societies, is difficult to carry out, but it has met with some success, and invariably has a most excellent moral effect.

THE COLD VALVE OF THE FUTURE

By J. H. T. ROBERTS, D.Sc., Associate Editor of MODERN WIRELESS

It is evident that future valve developments must tend towards the production of an appliance which does not make such exorbitant demands upon its supply batteries as the present type. Dr. Roberts indicates in a most interesting manner the lines upon which the desired ideal may be approached.

THE recharging of the low-tension accumulators which are employed for heating the valve filaments constitutes, perhaps, the principal item of expenditure in the maintenance of a valve receiving set. It is natural, therefore, that many attempts should have been made to produce a valve which should be altogether independent of heating batteries—in other words, a " cold valve."

This desirable appliance has been approached, but has not, up to the present, been reached. Valves have recently been introduced with special filaments, which require only about one-tenth of the heating current consumed by those with the ordinary metallic filament. Such valves are known as " dull emitters," because they give the necessary electronic emission when their filaments are raised merely to a dull red heat. They have proved very successful in operation, and mark an important step forward in the simplification of wireless apparatus.

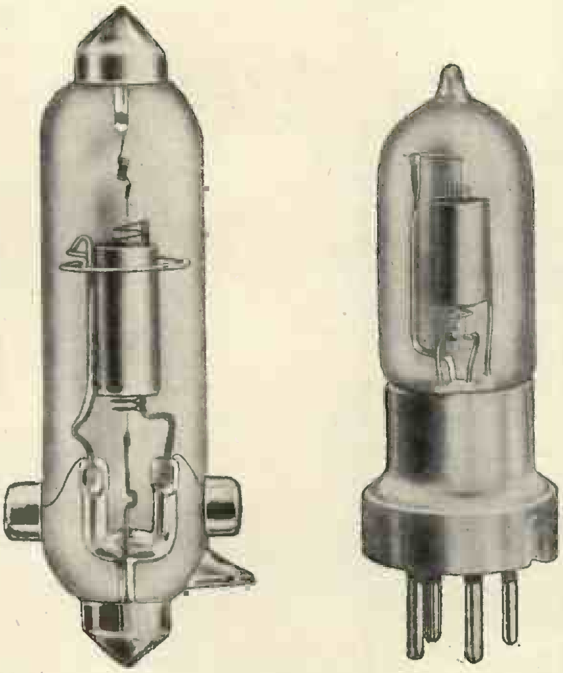


Fig. 1. Examples of present types of dull-emitter valves.

The ideal cold valve, however, still remains a dream of the future, and as its development constitutes one of the fascinating problems of wireless, the reader may be interested in a short description of the *modus operandi* of the present-day valve filaments, followed by a simple account of the phenomena of radioactivity, which will enable him to indulge in speculation as to the form which the cold valve of the future may possibly take.

Emission of Electrons from Heated Substances

It is well known that the electric current which passes in the anode circuit is carried through the valve by a stream of electrons which are emitted from the heated filament. Let us consider for a moment why it is necessary to have a heated filament to provide these electronic carriers in the valve.

The theory of the conduction of electricity through a metal conductor supposes that the atoms of the metal readily part with electrons which, under the influence of the electromotive force, pass from one atom to the next, and so on; there is thus an average " drift " of electrons in one direction, and it is this electronic drift which constitutes the current. But in so drifting an electron is never very much out of the sphere of attraction of one atom before it is within the sphere of attraction of another, and so the electromotive force required to maintain the drift is comparatively small. If an electron wished to leave the metal altogether and escape entirely from the attraction of the atoms, it would need a large force to enable it to do so. Under ordinary circumstances, therefore, the electrons are unable to leave the metal, and they can only be enabled to do so by special influences. If, for example, the metal is sufficiently heated the vibrations of the atoms may become so great that some of their electrons are thrown out far enough to escape from the ordinary atomic attraction. This is what happens in the heated filament of the valve.

It must not be supposed that a substance must be *electrically* heated to make it emit electrons. The valve filament is electrically heated merely for convenience, and it is true that the heating in this case is supposed to be caused by the agitation of the molecules of the metal by the rapid drift of the " free " electrons. But a substance heated in any other way (*e.g.*, a metal ball heated in a flame) will similarly emit electrons.

Waste of Energy

The heating of a filament is a wasteful method of causing it to emit electrons, for only a very small portion of the energy employed in heating the filament is used in detaching the emitted electrons—most of the energy is conducted and radiated away as heat. We are obliged to put up with this wastage, however, as we do not at present know of any other convenient way of producing our valve-electrons. In the ideal " cold valve " the electrons will be emitted spontaneously, or the energy absorbed by the valve will be only that which is necessary for the emission.

Cold Light

There are many other cases of this incidental waste. In order to obtain light from an incandescent gas mantle we have to raise the mantle to a high temperature, and only a very small percentage of the total energy reappears in the required form of light, by far the greatest part being lost as heat. All practical lighting devices are extremely inefficient in this sense.

The cold emission of light has, however, been more nearly approached (in a practical way) than has the cold emission of electrons. For the phenomenon of phosphorescence apparently represents the production of light with only a small incidental loss of energy in the form of heat. It is thought by some that the glow-worm and certain fishes and insects hold the secret of cold light—light without heat.

Much experimental work has been done on the discharge of electricity through glass tubes containing certain gases at fairly low pressures, and cases are known where the incidental waste of energy in the production of light energy has, in this way, been very considerably reduced. This problem is a very important one and about as difficult as the production of cold electronic emission.

Evaporation of Electrons

The emission of electrons from a heated filament has been usefully compared with the evaporation of molecules from a heated liquid (in fact there are points of definite relationship between these two phenomena). In evaporating a liquid we have to supply an amount of heat which is greater than that employed in detaching the molecules from the surface as vapour (latent heat of vaporisation) in order to make up the loss of heat by conduction, convection, and radiation.

Dull Emitters

The analogy of the evaporating liquid helps us to understand the action of dull emitters. It has been found that the admixture of thoria with the metal of the filament, or the coating of thorium oxide on its surface, increases the emissivity of the filament enormously, with the result that a required amount of electronic emission can be obtained at a much lower filament temperature. This corresponds, in a general way, to the evaporation of a liquid of low boiling point (*e.g.*, alcohol), where the same rate of evaporation may be obtained at a lower temperature. Owing to the lower temperature the incidental losses are reduced.

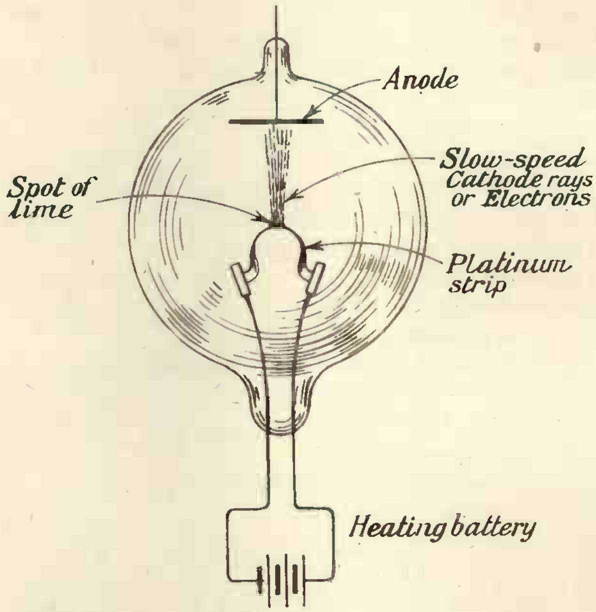


Fig. 2. A Wehnelt cathode (spot of lime on heated platinum strip), showing principle of dull emitter. A copious supply of electrons comes from the lime at a dull red heat, when the emission from the naked part of the strip is practically nil.

There are many types of dull emitter suitable for use by amateurs, one of them being a substitute for the popular " R " valve: this takes 0·4 ampere at 1·75 volts and the anode voltage is 30—50. Other types may take 0·2 ampere at 2·75 volts and have an anode voltage of 30. Owing to their low current-consumption they may be operated by dry batteries of suitable design.

The enormous emissive power of these coated filaments may be judged from the fact that a valve has recently been made fitted with such a filament, capable of transmitting over a thousand horse-power.

Dull emitters, then, represent the most important practical step in the direction of the cold valve.

Point-Discharge Emission

An ingenious attempt of quite a different kind has recently been made to produce a cold valve which is based upon a very familiar electrostatic phenomenon. It is well known that the surface density of electrification upon a solid conductor is greater in the region of protuberances or projections. If a projection takes the form of a sharp point, the surface density of electrification may become so great that a silent discharge of electricity takes place from the point and may be maintained by a comparatively low potential.

It will easily be seen how this principle may be embodied in the design of a valve, the cathode being sharply pointed. The high-tension battery alone would be necessary, the low-tension battery being dispensed with.

A valve of this kind is said to be in the experimental stages and it will be interesting to see if it can be applied to practical purposes.

Radioactivity

We have seen what efforts are being made to produce filaments which will emit at moderate temperatures ; these consume less energy, but they are different only in degree, not in kind. What, then, are the possibilities of a filament generating its electrons spontaneously ? In this connection we naturally think of radioactive substances, and they have, indeed, been proposed and tried for this purpose.

There are many radioactive substances, of which radium is probably the most popularly known. Their characteristic property is that they *spontaneously* emit certain rays known as alpha rays, beta rays, and gamma rays. Some, but not all, radioactive substances emit all three kinds of rays. The alpha rays consist of positively charged atoms of helium gas ; the beta rays are electrons, and the gamma rays are ether waves of very short wavelength.

At first sight the problem appears to be solved —why not substitute for the filament a radium-tipped wire ?

If we consider the mechanism of radioactivity and compare it with that of thermionic emission (*i.e.*, the emission of charged particles from

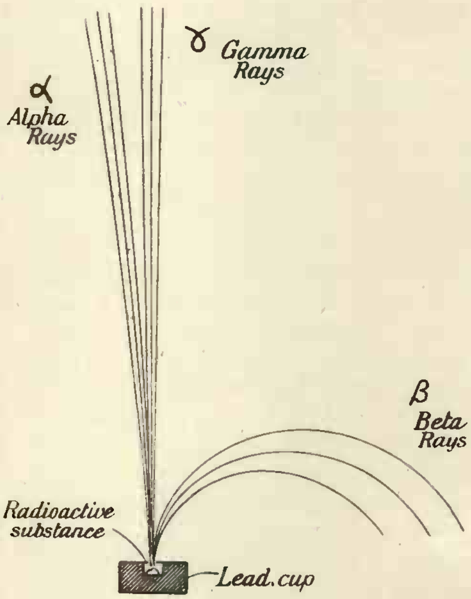


Fig. 3. Radioactive substance emitting alpha, beta, and gamma rays. A magnetic field at right angles to plane of paper deflects alpha and beta in opposite directions and to different extents, but does not affect gamma rays, since these are not electrical particles, but waves.

heated bodies) we shall see why, unfortunately, the matter is not so simple.

The Atom

An atom of any substance is supposed to consist of a nucleus and a number of surrounding electrons. The nucleus is a compact group of electrons and protons, the electrons negatively charged, the protons positively charged, the charge of the proton being equal in amount to that of an electron. The mass of a proton is approximately equal to that of the hydrogen atom, the mass of the electron being by comparison negligible. In the atomic nucleus there are more protons than electrons, so that the nucleus has a positive charge ; this is ordinarily neutralised by a certain number of surrounding electrons. The electrons in the nucleus are called nuclear electrons, and the surrounding ones are called planetary electrons, since they revolve round the nucleus after the manner of the planets round the sun. Now the first important point for our present purpose is that the planetary electrons are comparatively loosely held. There are many methods by which we may detach one or more of these electrons from an atom, or " ionise " the atom as the process is called. One simple method is to heat the substance, when many of the atoms will part with planetary electrons. These are the electrons which we make use of in the valve; being easily detached they may be made to leave the parent substance with a small velocity, which makes them easy to control. Furthermore, under the conditions in the valve, practically no other rays but the electrons are emitted, and we are not troubled with a mixture of rays requiring different controls.

On the other hand, the protons and the nuclear electrons are very tenaciously held, and they must develop large amounts of energy before they can escape from the atom. These are the particles which form the alpha and beta rays from radioactive substances. Their velocities are very large compared with the velocities of thermions from hot filaments; for example, the velocity of emission of electrons from a heated filament may be about 15 cm. per second, whereas that of the beta rays may be 100,000 miles per second.

Thus our first difficulty in attempting to make use of a radioactive substance as a source of electrons is that the electrons issue forth with such a high velocity that they cannot conveniently be controlled. And there are many other difficulties. The emission may consist of a mixture of negative and positive charges the positive being even more unmanageable than the negative. The gamma rays complicate matters, and secondary rays are produced by the impact of the primary rays upon surrounding objects. The total emission from a convenient amount of radioactive substance may be too small to be of practical use, and there are still further difficulties—the production of gas, the cost, and so on—into which we cannot at present enter.

But our knowledge of radioactivity is rapidly progressing. New radioactive substances may be discovered; induced or indirect activity may prove available, or methods for the control of the activity be found. Again, development may come along the lines of the cold light experiments, or it may come in some hitherto untried direction.

To some these may seem fantastic speculations. But how many times, particularly of recent years, have we learned the wisdom of reserving judgment in scientific matters. It is as unsafe to dogmatise in the negative sense as in the positive, and the tapping of the intra-atomic energy may yet be added to the list of the greatest achievements of science.

THE NEW "MODERN WIRELESS"

PURSUING our policy of not merely maintaining the high standard of excellence of this journal, but of constantly striving to raise it yet higher, we shall inaugurate in No. 5 a series of radical changes in its constitution. These changes will include the provision of many new and attractive regular features, an increase in the size of the magazine, valuable series of articles by eminent authorities and other good things, details of which we cannot yet disclose.

The most important article in our next issue, which will, by the way, have a different coloured cover, will be a very full description of a special two-valve circuit.

Full constructional details will be given of this important development which marks a new stage in experimental reception.

It is possible with this apparatus to receive broadcasting at 15 miles on a loud-speaker (100 yards away) on two valves. Excellent results on a loud-speaker are obtained with an aerial 9 ft. long and only 4 ft. high and on no account should readers miss this article. Tens of thousands of these sets will be made as a result of personal recommendations of this simple but exceedingly efficient apparatus.

A NOVEL CRYSTAL DETECTOR

By RAYMOND W. EDWARDS

Theory

I PROPOSE in this article to describe a novel crystal detector, the use of which in an ordinary wireless receiver will be found, in the majority of cases, probably to increase signal strength to a considerable extent.

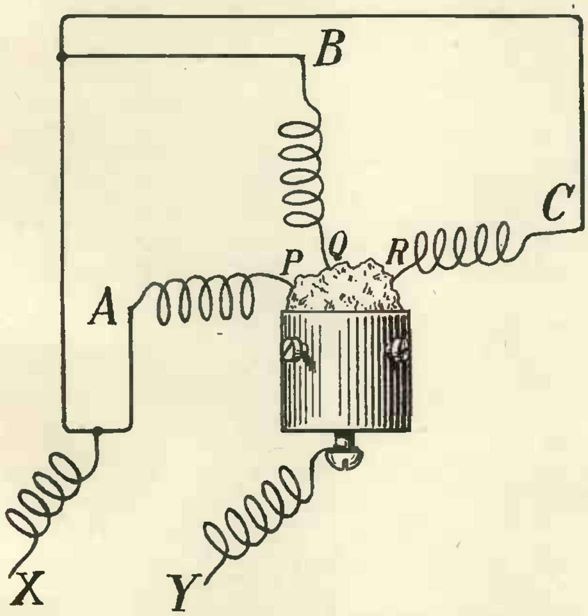


Fig. 1. Illustrating the theory of the detector. X and Y are simply connecting wires.

Fig. 1 shows diagrammatically the arrangement to be described. A, B, and C are three

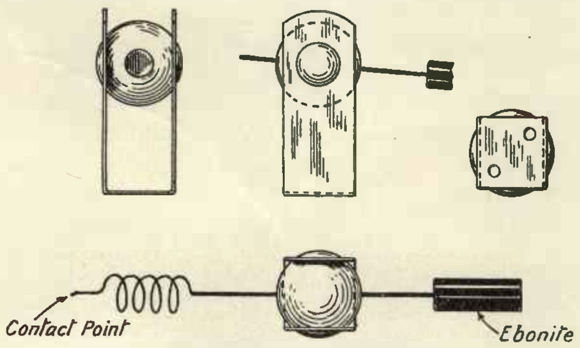


Fig. 2. Details of the spring contacts.

" cat-whisker " (fine wire) contacts which touch at the points P, Q, R upon a crystal of the type in common use, X and Y being the connections of the detector to the receiving circuit. The crystal, it should be explained at this point, must be very firmly held in the cup, and it is better not to rely entirely upon the three screws with which cups are usually furnished, since in tightening these screws sufficiently to get a good grip the crystal may be crushed. Although it is a more troublesome method, it is usually well worth while to mount the crystal by means of Wood's metal.

When three separate contacts are employed, connected in parallel as shown in Fig. 1, it is possible to maintain uninterrupted reception by adjusting one " cat-whisker " at a time and

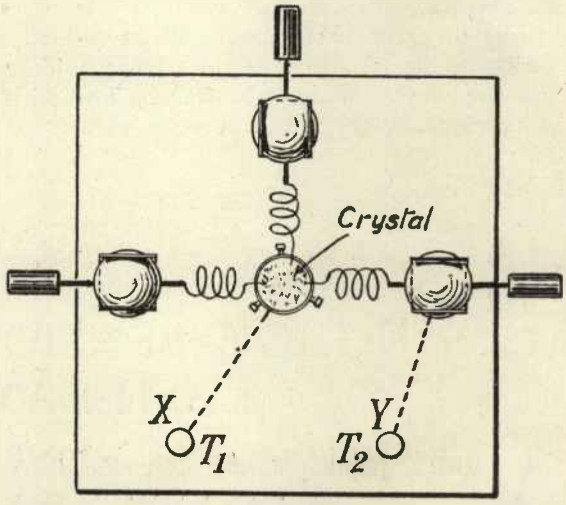


Fig. 3. The assembly of the detector. The three contact-holders are to be connected together beneath the panel.

taking care that they are never all out of adjustment at once. Moreover, some increase in the output of rectified current may be expected if all the contact points can be kept in adjustment together, which is quite easy when one has had a little practice with this detector.

Construction

To construct this type of detector a piece of ½-in. ebonite about 4 in. square will be required. This should be made perfectly smooth, and if polished should be rubbed down to obtain a matt surface.

Three contact spring-holders of type shown in Fig. 2 will also be required. The construction of these is quite simple and may easily be followed from the diagrams. The uprights for the ball joints should be of fairly thick springy brass or copper.

The detector may then be connected into the wireless circuit or, if desired, the ebonite baseboard may be dispensed with, and the complete detector parts mounted on to the wireless receiving panel.

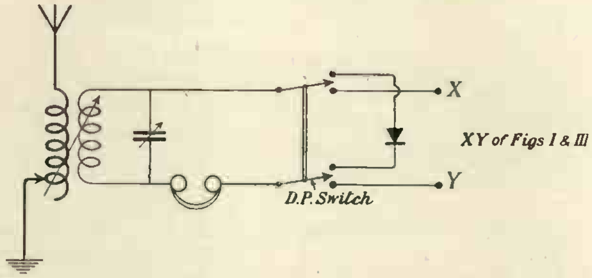


Fig. 4. Circuit for comparison of detectors.

No dimensions are given, as each experimenter can make his of the most convenient size. It should also be noted that the diagrams are not drawn to scale.

The different parts should be assembled as shown in Fig. 3, all connections being soldered, and the wiring being subsurface. The wiring is indicated by the dotted lines in Fig. 3.

In conclusion, it is a good plan while experimenting with this detector to use the circuit of Fig. 4, the double-pole switch allowing of an ordinary crystal detector being compared with the detector which I have just described in this article.

HIGH-TENSION SUPPLY FROM FLASH-LAMP BATTERIES

A VERY popular form of anode battery is one composed of a number of $4\frac{1}{2}$-volt flash-lamp batteries, connected in series. This is very convenient, as tappings can be taken to a switch or plug-board, by means of which the voltage is varied. Little need be said with regard to this method, except perhaps in connection with insulation and soldered joints. One method of connecting the batteries is to bend the long brass strip until it touches the short strip of the next, to which it is attached by soldering. It is preferable to use a non-acid flux when making electrical joints, as if this precaution is not taken, electrolytic action sometimes sets up corrosion. Good insulation of the battery is essential, not only to other parts of the apparatus, or earth, but between each component.

Flash-lamp batteries frequently break down, and some of the paste with which they are filled is forced out through the vents. This paste is highly corrosive, and very soon attacks the brass connecting strips. It is therefore advisable to place a sheet of waxed paper between each battery, which not only insulates it from the next, but should a breakdown occur it usually confines the trouble to the particular cell affected.

Damp and heat are both detrimental to the maintenance of an anode battery. Heat tends to dry up the paste which keeps the cells in an active state, while damp produces leakage. A leaky anode battery will give rise to terrible noises in the telephones, especially when used with multi-valve receivers. When mounting batteries composed of flash-lamp batteries, it is a very good plan to place them in a wooden box which has been painted inside with melted wax.

P. D. T.

WIRELESS OPERATORS AND THEIR CAREERS—III.

The Junior Operator

By "TRAFFIC MANAGER"

An article containing some sound advice for newly fledged operators.

THERE are at the present time a number of youths who have completed their training and who are awaiting their turn for appointment to the operating staffs of wireless companies.

If at all possible, these men should carry on with their studies at their training colleges, concentrating on the particular work which will form the main part of their duties after appointment. If this cannot be done, they are advised to devote several hours a day to study and telegraphy practice, going through their notebooks carefully and systematically, and reading up text-books dealing with the more advanced application of wireless to the needs of navigation, such as direction-finding.

Each student, as soon as he receives his P.M.G. certificate (usually a few days after he has passed the examination), should procure from the college a copy of the standard form of application for operator employment issued by the company whose staff he wishes to join. Particulars called for must be filled in carefully and neatly, after which the form should be forwarded, under cover of a brief but carefully worded letter, to the traffic manager of the company.

It must be borne in mind that this is the operator's first introduction to his future employers, and much in his early career will depend upon the impression made.

Imagine, for instance, that six students with equally good school records are under consideration for several appointments—some for cargo boats, some for intermediate boats, and one for a fairly busy liner. The primary selection will be made from the style of the applications—the man with a neat and easy style of handwriting will probably be selected for the best ship. An untidy and besmirched application would find its way to the bottom of the list or, in all probability, would be deferred.

The application form usually calls for the names and addresses of two or more persons of standing who can vouch for the good character of the applicant. It is always advisable to communicate with the persons indicated, so that no possible hitch will occur when the company takes up the references.

The next step forward is generally a personal interview with the traffic manager or official responsible for operator appointments and movements. At this interview the operator will, in all probability, receive instructions for signing-on or joining his first ship. By signing-on is meant the signing of Ships' Articles, an important procedure which takes place between two and four days prior to sailing date. In the case of some ships there is a medical inspection either immediately before or directly after signing-on.

Too much stress cannot be laid on the importance of timely attendance at these functions. They are both such slow and tedious affairs and generally so far behind programme that many operators become lax and make a point of being late. This should never be done. If all operators are not in the room when their names are called a great deal of unnecessary inconvenience and irritation is caused which frequently culminates in a letter of complaint written to the wireless company by one of the Shipping or Board of Trade officials.

The phrase "Late for Articles" appears on the otherwise good confidential record sheet of many operators, and is looked upon as one of many minor indications of carelessness or indifference. When signing Articles an operator should always have with him his P.M.G. certificate and, after his first trip, his discharge book.

Once on Articles the operator is, to all intents and purposes, a member of the crew directly under the authority of the operator-in-charge.

Usually after signing Articles the operators repair to their cabin to see that everything is in order for the coming voyage. At this stage the junior should seek his senior's instructions in the matter of work to be done prior to sailing, and the time of joining ship.

Nothing is more likely to create a bad impression in the mind of the senior than an apparent eagerness on the part of his junior to spend every minute he can off the ship between signing-on and sailing. The new man should make up his mind that the voyage begins as soon as he signs Articles, and must be prepared to remain on board afterwards if, in the opinion of his senior, this is necessary.

It will be remembered that in our first article it was stated that a very complete confidential record of every individual operator is kept by the wireless companies in which all details of merit and demerit are recorded for future reference.

The record of a junior operator is compiled mainly from the reports of his senior at the end of each voyage. It may be mentioned here that the operator-in-charge is held entirely responsible for the working of his station and the conduct of his staff. Any mistake occurring in the handling of traffic or accounts, any breach of traffic regulations or discipline, must be accounted for by him. For this reason it is extremely important, from his point of view, that his assistants can be relied upon.

If at the end of a voyage, the operator-in-charge puts in an adverse report on one of his juniors, with a request for his removal, this request is always acceded to. If it is thought that the junior may prove satisfactory on a less busy ship, or with a different senior, he is given another chance ; but it is important that junior men should realise that their future depends entirely on the manner in which they support and assist their seniors.

Operators-in-charge are frequently reminded of the importance attached to their reports on juniors, particularly in the case of new men. The Wireless Service is one in which those responsible for the working of stations have to carry on for long periods without any kind of supervision. It is therefore essential that no man be allowed to remain in the service who, during his first few voyages, does not show marked signs of improvement, or who cannot conduct himself in a responsible manner.

One of the main duties of a senior operator towards a new junior is to instruct him in his practical work. It will generally be found that senior men are only too anxious to assist their juniors in every way possible, particularly in the matter of their clerical work

One of the greatest difficulties experienced by juniors, particularly during their first trip, is to

Up-to-date transmitting and receiving gear on board ship.

receive press news accurately when signals are fairly weak. It is frequently necessary for the senior or second operator to take over the junior's watch when press news is to be received. If the junior is anxious and willing to become proficient in this work, it is necessary for him to obtain as much practice as possible in press reception, and a wise course for him to pursue is to wear the phones and copy bulletins whilst either of his seniors is taking them down. A junior, after two or three trips at sea, should be thoroughly competent of taking over a complete watch, which includes the reception of long-distance press news.

The junior operator's duties on board ship during his first voyage may be summarised as follows:

(1) Keeping watch, particularly during slack traffic periods.

(2) Checking the charges on all messages and entering both accepted and received traffic on their relative abstract sheets.

(3) Cleaning the apparatus.

Close attention to the smallest detail concerned with routine work should be the key-note of his policy. He should carefully observe the instructions given to him by his senior, and should use his own intelligence in the matter of keeping the radio apparatus in a tidy and clean condition.

(To be continued.)

A GLOSSARY OF TECHNICAL TERMS USED IN WIRELESS TELEGRAPHY AND TELEPHONY

(*Continued from page* 208.)

Chirp

The singular and quite unmistakable noise made when, in tuning-in by heterodyne for C.W., one tunes past a station sending. Begins as a high note, which descends the scale, vanishes, is heard again as a low note, and rises to a very high one.

Choke

A colloquial word, usually defining a coil whose main purpose is to keep down, by its inductance, the alternating current in a circuit.

Choke Control

An important method of modulation (*q.v.*) in telephony transmission, consisting in supplying the anode circuits of both power and control valves from the same source through a coil of high inductance.

Coherer

A detector (now obsolete) depending on the peculiar action of metal filings when an oscillating voltage is applied to them.

Coil

Usually, in wireless work, a spiral or helix of wire inserted in a circuit to provide a certain amount of inductance. The following are various types.

Coil, Basket

A disc-shaped coil, wound in and out of the spokes of a former shaped like a rimless wheel.

Coil, Duo-lateral

Very similar to the honeycomb coil (*see* below), but differs in the fact that the coils in one layer are not directly above corresponding wires two layers below, but half-way between them.

Coil, Honeycomb

A coil of many layers, usually short in proportion to its diameter. Its distinguishing feature is that the wire is wound on in a zigzag fashion.

Coil, Induction

A special type of transformer, utilising direct current which is made and broken alternatively, instead of the usual alternating current.

Coil, Loading

An extra coil inserted in the aerial circuit to increase its wavelength.

Coil, Pancake

A general term for disc-shaped coils of one layer.

Coil, Pile-wound

A cylindrical coil of a few layers, all the layers being wound simultaneously.

Coil, Slab

Used to describe multi-layer coils of disc shape which are not wave-wound.

Coil, Wave-wound

A general term including honeycomb and duo-lateral coils.

(*Continued on page* 236.)

THE USES OF WIRELESS

By MICHAEL EGAN

An interesting description of the present powers of wireless which should prove very suggestive of its future possibilities.

THE idea of dispatching messages from one place to another without the use of wires was entertained in bygone days by numerous observers who were familiar with the moving magnetic needle. Reports of elaborate systems are on record whereby one fluctuating magnetic needle *might, under certain conditions*, be used to actuate a distant needle in a manner which would permit of intelligible signals being transmitted. It was not until many years later, however, that the discovery was made which led to the development of wireless as we know it to-day.

In 1888 Hertz demonstrated for the first time that it was possible to produce electromagnetic waves which obeyed the same general laws as heat waves and light waves. This momentous discovery gave rise to numerous attempts to transmit messages over short distances. At first it was a question of a few yards. Later on it became possible to signal over a distance of a few miles. To-day we can carry on a wireless telephonic conversation over thousands of miles. The wireless telephone is, of course, a comparatively recent product; long before it became possible to reproduce the human voice by wireless the great value of the wireless telegraph had been repeatedly demonstrated in many fields of commercial and industrial activity.

One of the earliest applications of wireless telegraphy was made in the British Mercantile Marine. Throughout the last century there was no means of communicating between ships at sea other than by visual signalling, whilst the same applied with reference to ship and shore authorities. One result of this was that shipowners were frequently without news of their ships for months at a time. A sailing-ship, for instance, might leave an Australian port sometime in January and not be heard of again until, after weathering many storms in different parts of the world, she was sighted in the Channel towards the end of April. There are cases on record, in fact, of ships which were reported as "missing" for the best part of a year, and which eventually staggered up under the grey cliffs of Dover one foggy morning when they were least expected.

The most familiar and the most important aspect of wireless at sea is, of course, in connection with the saving of life in moments of distress. Everyone will remember the tragic fate of the famous s.s. *Titanic*, and the part that wireless played in summoning a dozen ships to the rescue of her passengers and crew on that cold winter's night when she slipped quickly to the bottom of the Atlantic. Never was the value of this new branch of science more staggeringly and poignantly illustrated than on that tragic occasion, although history holds many other similar records of the triumph of wireless over the perils that beset those who go down to the sea in ships.

Apart from its supreme importance in saving life at sea, however, there are many other useful applications of wireless to the needs of seafaring folk. It is often a matter of extreme urgency for a captain of a ship to acquaint the shore authorities with his time of arrival at a certain port some days before his vessel actually makes that port. This gives the shore authorities ample time to prepare a berth for the ship, and also to arrange for the necessary labour to unload and reload her cargo. By means of wireless the shore supervisors are thus constantly informed with reference to the movements of ships, and the risks of delay and confusion consequent upon a number of ships arriving at a port together are considerably minimised.

Wireless has also been of great service on many occasions in saving the lives of people who became dangerously ill on board ship. It is only on the larger passenger-ships that a qualified doctor is carried, and it has often been necessary to dispatch medical advice by wireless to a passenger who suddenly developed some serious illness on board a ship which carried no doctor. First aid treatment has been applied before now over a distance of some hundreds of miles! In some cases the patient was treated daily for a number of weeks. Each morning the shore medical authorities were given an account of the symptoms by wireless, from which a diagnosis was made. Instructions for treatment during the ensuing day were then wirelessed back to the ship.

There is something strangely fascinating about this idea of curing from a distance. Somehow or other it seems to epitomise the gradual triumph of man's ingenuity over the obstacles of the material world. The same suggestion is made to the imagination—although from a somewhat different angle!—by the records of the many instances in which wireless has extended the already elongated arm of the law by some thousands of miles. The famous Crippen case will not be forgotten in this connection for many years to come. The captain of the ship on which this clever criminal endeavoured to escape to America noticed that an eyebrow of one of his passengers assumed rather too rakish an angle at times!

Investigation satisfied the worthy captain that the eyebrow in question was a false one, whilst further observation left little doubt as to the identity of the amiable passenger who wore it. Within a comparatively short time after this important discovery had been made, the police authorities on both sides of the Atlantic were aware of the facts, and, when the ship arrived at New York, the first people to mount the gangway were a couple of plain clothes detectives.

For no commercial purpose has wireless been more useful than for the navigation of ships at sea. Previously mariners had to find their way across the oceans of the world by bearings taken from the sun and the stars. On a cloudy day, or a starless night, the only means of ascertaining the position of a ship was by calculating the distance it had gone in a particular direction since its position was last found by solar or astronomical readings. This was by no means an accurate process, and very often entailed a considerable loss of time in the ship's passage. By means of wireless beacon stations it is possible to-day to navigate a ship at any time of the day or night, irrespective of weather conditions.

There are two general methods of navigating a ship by wireless. By one system the ship's operator takes a bearing on two or more shore transmitting stations with the position of which he is acquainted. The point of intersection of these bearings represents the position of the ship. With the other method the direction-finding instruments are situated ashore and the shore operators take individual bearings on the ship when the latter transmits a prearranged signal. The shore direction-finding stations are in communication with each other, and the operator at the chief station of the group ascertains the resultant position and communicates it by wireless to the ship.

Wireless is also successfully employed to-day for the navigation of aircraft. With certain technical alterations, the two systems outlined above are in daily use. Dozens of machines are flying daily between this country and the continent, and the high standard of efficiency maintained by the various aerial services during the past year is in no small measure due to the practical assistance rendered by wireless. Needless to say, in certain circumstances wireless can be of supreme importance to commercial aircraft, of far more importance, in fact, than to any other form of transport vehicle. A ship, for instance, can remain afloat on the sea in a dense fog and, by using her siren vigorously, remain safe from collision with neighbouring ships. With aircraft, however, it is quite different. An aeroplane must keep on the move in order to remain "afloat" in the air, and for this reason would be in a particular danger when surrounded by a fog in traffic areas if it were not for the valuable assistance which wireless affords. An aeroplane can be guided through the thickest fog to a safe landing-place by means of modern wireless instruments.

Practically all of the machines flying on the continental air transport services from England are equipped with wireless telephony. These instruments are remarkably efficient and are in constant use; they are invaluable for enabling the pilot to keep in touch with the authorities at either of the terminal aerodromes. If "engine trouble," for instance, occurs *en route*, involving delay or even a "forced landing," the ground authorities are informed at once and considerable saving in time and money is thereby effected.

Apart from these more or less special uses of wireless there is practically unlimited scope for the application of different systems of wireless telegraphy and telephony to the needs of modern commercial and social life. In the commercial world hundreds of thousands of messages are being flashed across the earth by wireless each day, whilst "broadcasting" bids fair to become one of the most popular forms of entertainment in the home of to-morrow.

In the very near future it is probable that great things will be achieved with wireless photography. Already certain governments have sanctioned the transmission of signatures by this method. What a world it will be when one can write a letter in New York whilst sitting in a London office! And if wireless photography, why not wireless cinematography?

"DIRECTIONAL WIRELESS"

By J. ROBINSON, M.B.E., Ph.D., M.Sc., F.Inst.P.

(Continued from page 133 of MODERN WIRELESS)

TWO typical examples of simple loops are shown in Figs. 11 and 12, the actual form used in each case depending on the purpose for which the loop is required, the space available, and the necessity for obtaining as large a value for the area turns as possible.

This brings us directly to the design of loop aerials, and in this connection it should be noted that, although the factors involved have received a good deal of attention of late, the fact still remains that only experiment can finally fix the best loop to be used for a given amplifier and wavelength.

1. Design of Simple Loop

The importance of area turns on the electromotive force induced in a loop has already been pointed out, and it is not going far from the truth if the assumption is made that electromotive force is directly proportional to area turns. This factor in the design can naturally be increased in two ways: either the area of the loop itself is made larger, or else more turns are added to the winding. This process cannot be carried out indefinitely however, a very definite limit being imposed, as will now be shown. Consider the receiving circuit shown in Fig. 7 (No. 2, p. 131). What is the part played by the loop? Primarily it is the aerial for absorbing energy from the waves, but, at the same time, it is essentially the inductance coil of the tuned receiving circuit, and as such is strictly limited in value, depending on the wavelengths to be received and the permissible variation in capacity of the parallel tuning condenser. But the inductance of a loop is also a function of the area turns, and we now see that the designing of a loop resolves itself into the design of an inductance coil of given value, so proportioned, however, between area and turns, that for the area turns available the greatest possible electromotive force is induced by the passage of a wave.

The above statement is made entirely from the point of view of maximum energy absorbtion, and if this was the only consideration, would obviously result in a loop of such a size that the inductance value required was obtained with a single turn of wire. As a direction-finder, convenience in handling is of vital importance, and, except for the shorter wavelengths, it has been found that where the space is available a loop having sides of from three to four feet in length is most generally useful. The inductance is now obtained by additional turns, and for the determination of the number of turns required two approximate rules will be given.

Fig. 11. A loop or frame aerial used for direction-finding purposes.

The first of these rules shows the relationship existing between the linear dimensions of a square loop and the inductance for one turn of wire. The expression "square loop" has been used, and it is to such loops only that the rule strictly applies, but it may be used for cases of rectangular or other forms of loop, provided a square having an area equal to that of the proposed form is used as a basis for the calculations.

The rule states that the inductance of a loop of one turn is directly proportional to the linear dimensions of the sides, a loop with sides one

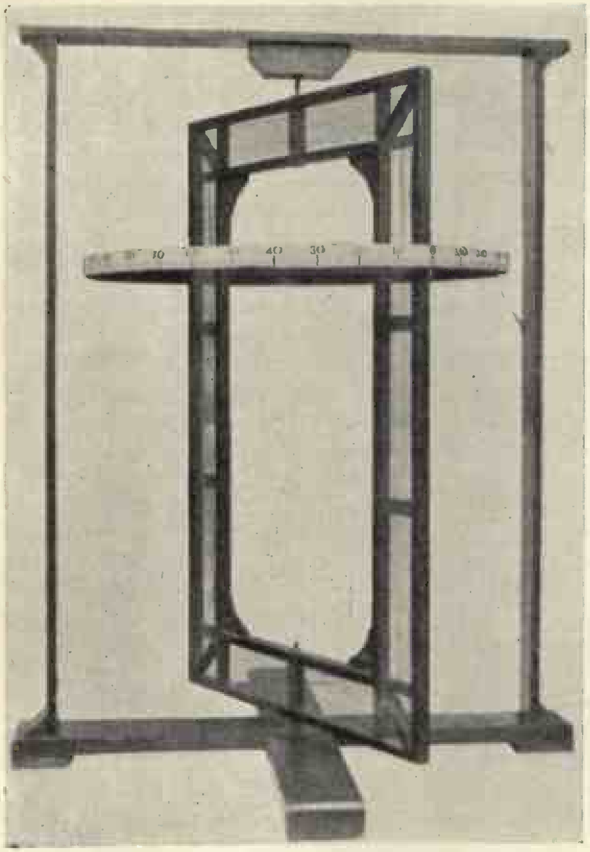


Fig. 12. Another type of frame aerial.

metre long having an inductance of 5 microhenries, or

$1 = 5$ microhenries for 100 cm. of side . . . . (1)

The second rule, which is based on the assumption that the turns are wound close together, being modified by spacing, as will be shown later, states that the total inductance of a coil varies as the square of the number of turns,

$$L = ln^2 \quad \ldots \quad (2)$$

where L is the total inductance of the loop, l is the inductance per turn, and n is the total number of turns.

The question of the spacing of the turns must now be raised, and this leads us at once to the self-capacity of a loop. This self-capacity is due to the capacity existing between adjacent turns of the winding, owing to the differences in potential set up between them while a current is flowing. The self-capacity is roughly equivalent to connecting a condenser across the ends of the winding and is, therefore, a capacity in parallel with the tuning condenser already referred to. The effect of this additional capacity is to give the loop a definite wavelength even with the tuning condenser disconnected, but, also, unless reduced to the minimum by means of spacing, it forms an additional factor limiting the number of turns that can be employed for a given wavelength besides seriously affecting the efficiency of the loop as a receiver. The self-capacity of a loop with only a few turns is considerable, the value growing rapidly as the number of turns is increased. This capacity, however, as just stated, can be reduced to a large extent by allowing a space between adjacent turns. The actual spacing to be adopted for efficiency should not, in general, be less than 0·75 cm. for small loops, and must, of course, be greater for large loops where the potential differences are bigger. Spacing the turns while reducing the self-capacity has a similar effect on the inductance, and in practice it is usual to allow for a reduction of about 12 per cent. on the calculated inductance. If this is done, the rule $L = ln^2$ can still be used for relating the total inductance to the number of turns required.

Various accurate formulæ exist for calculating the inductance of a single turn of a square, rectangle or circle, but, bearing in mind the fact that experiment is always required in order to design an efficient loop for any given conditions, the approximate rules already given will provide sufficiently accurate information at any rate for the preliminary work.

Let us consider the design of a loop for receiving a minimum wavelength of 600 metres. It will be assumed that a rectangular framework 3 ft. by 4 ft. is to be employed, and that a tuning condenser having a minimum capacity of 0·0001 μF. is available.

The inductance and capacity product corresponding to 600 metres is obtained from the formula :

$$\text{Wavelength } (\lambda) = 1885\sqrt{\text{Inductance (L)} \times \text{Capacity (K)}}$$

in which wavelength is in metres, inductance in microhenries, and capacity in microfarads. The product KL for 600 metres is, therefore, 0·1, and on dividing this value by 0·0001, the minimum value of tuning capacity or K, we obtain a value for the total inductance of L = 1,000 microhenries.

A square loop having an area equal to the area of the rectangle to be used has a side of $\sqrt{12}$ ft., or approximately $0 \cdot 3\sqrt{12}$ metres, and from (1) we obtain the inductance value for one turn as $l = 5 \times 0 \cdot 3 \sqrt{12}$, or $5 \cdot 2$ microhenries.

The total inductance L must now be increased in value by 12 per cent. to allow for spacing, and from (2) in the form :

$$n = \sqrt{\frac{L}{l}}$$

the number of turns will be found, which, when wound on a rectangular framework of the given dimensions, will have the total inductance required. In the above example $n = 15$ turns to the nearest complete turn. For a loop of these dimensions the spacing between each of the 15 turns should be about $0 \cdot 75$ cm., and under these conditions efficient reception will take place up to a maximum tuning capacity of about $0 \cdot 001$ μF., which, with the above inductance, corresponds to a wavelength of 1,885 metres.

The efficient wavelength range of a loop can of course be increased if the inductance is also made variable, but in order that efficiency and accuracy shall not suffer, it is necessary that this shall be accomplished in such a manner that dead-end turns are not introduced. The method usually adopted is a system of switching whereby varying numbers of the turns can be connected either in series or in parallel, the former increasing and the latter decreasing the effective inductance of the loop.

It is not proposed to go into the details of the construction of frame aerials as these must vary so much for the different uses to which an aerial is put. The frame should preferably be made of wood, although metal frames have been employed for special purposes with good results, and great care must be taken with the insulation of the turns, all terminals being well bushed and ebonite slips used wherever bare wire might touch the wood. The actual size of wire used is of no importance, provided no wire smaller than, say, No. 22 S.W.G. is employed, and for spaced turns this wire may be insulated or bare.

(To be continued.)

A GLOSSARY OF TECHNICAL TERMS USED IN WIRELESS TELEGRAPHY AND TELEPHONY

(Continued from page 231.)

Condenser

A component of wireless (and other) circuits specially designed to possess definite capacity with, as nearly as possible, no inductance, no conductive resistance, and infinite insulation resistance. Consists essentially of a series of metal plates, connected alternately to the two sides of the circuit, but insulated from one another. Favourite materials are : tin-foil or copper-foil and mica or waxed paper, for receiving ; aluminium, air insulated, for variable condensers ; zinc or copper sheet and glass and/or oil, for transmission.

Continuous Current. *See* Current.

Continuous Wave (C.W.)

That method of wireless transmission in which, so long as the key is pressed, a steady oscillatory current flows in the aerial. In damped wave and tonic train transmission the oscillatory current varies in amplitude.

Converter, Rotary

A machine combining the functions of motor and generator, which uses direct current and supplies alternating current or *vice versa*, or which is used to give current at a different voltage from that supplied to it.

Copper Pyrites

See Bornite or Chalcopyrite.

Counterpoise

A capacity used in some cases as a substitute for an earth connection. When properly designed is more efficient than " earthing." Consists of wires under the aerial, near to but insulated from the ground.

Coupler

A slang term for certain types of transformer (*q.v.*).

Coupling

The means by which electrical effects in one circuit are completely or in part transferred to another.

Coupling, Capacity

Electrostatic ; *see* below.

Coupling, Coefficient of

In most wireless work the influence of one circuit on another is variable. It is expressed as a percentage of the maximum possible (direct connection) or as the ratio (coefficient of coupling) between the existing coupling and the maximum. A small coefficient gives loose coupling and *vice versa.*

(Continued on page 254.)

AN EASILY CONSTRUCTED CRYSTAL DETECTOR

A CRYSTAL detector employs special minerals which, when put into contact with each other, or with a piece of metal, will only allow the passage of electricity in one direction. These crystal detectors do not, as a rule, require any batteries, and they will last almost indefinitely, without much attention. The only attention they require is an occasional readjustment. Crystal detectors are not as sensitive or as reliable as valves, but, on the other hand, they may be much more easily installed and do not need replacing.

Instead of using a crystal and a metal point, excellent results may be obtained by using in combination two crystals which are made to press on each other. Two crystals are used, each of which is secured in some kind of a holder, such as a crystal cup. The two crystals are now pressed together, some means being provided for varying the pressure between the crystals, and, if possible, one crystal should be capable of movement so that the point of contact between the crystals may be varied. It is found that with nearly all crystal detectors there are certain points on the crystal or crystals which give the loudest signals in the telephone receivers. To find these particularly sensitive spots, it is necessary in the case of the crystal detector using a crystal and metal wire, to move the point of the wire above on the surface of the crystal, until the loudest signals are obtained. It is similarly often necessary that this should be done in the case of a crystal detector using two different kinds of crystals pressed together.

The degree of pressure between the metal point and the crystal, or between the two crystals, is frequently very important, and there should be some arrangement provided for varying this pressure. The sketch shows a kind of crystal detector in which two cups are used, each containing a crystal. As will be seen, the two crystals are pressed together, means being provided for varying the degree of the pressure. It is also possible to vary the nature of the contact between the two crystals, and therefore to adjust the detector to its most sensitive condition.

When using two crystals, they must be of different character. Probably the best two crystals to use are what are known as zincite and bornite. Other pairs of crystals which have been found to give excellent results are zincite and tellurium, and zincite and copper pyrites. I would suggest that as a start you try the zincite-pyrites combination. These crystals may be purchased from any wireless dealer in small or fairly large lumps. The actual size of the crystal does not matter very much. The size of the crystal should preferably not be less than about $\frac{3}{16}$th in. in diameter. The shape of the crystal is not of particular importance. In certain kinds of cups, such as those fitted with screws, it is possible to turn the crystal round inside the cup and so present different faces to the other crystal. The advantage of the double crystal type of detector is that once it has been adjusted it is not so likely to get out of adjustment as the type which employs a fine wire resting on the surface of a crystal. When two crystals are employed it is possible to apply greater pressure to them, and consequently the arrangement is not so easily upset by vibration or accidental jars.

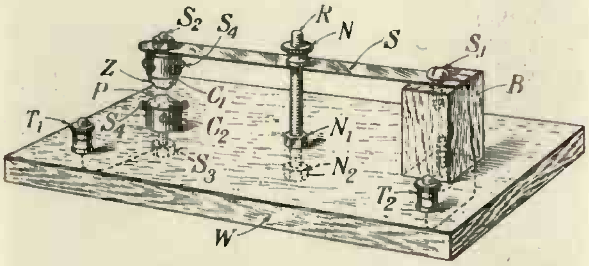


Fig. 1. A "Perikon" detector. Z and P, zincite and pyrites crystals; S, brass strip; R, threaded brass rod; N, adjusting nut; W, wooden base; B, wooden support for brass strip; C_1 and C_2, crystal cups.

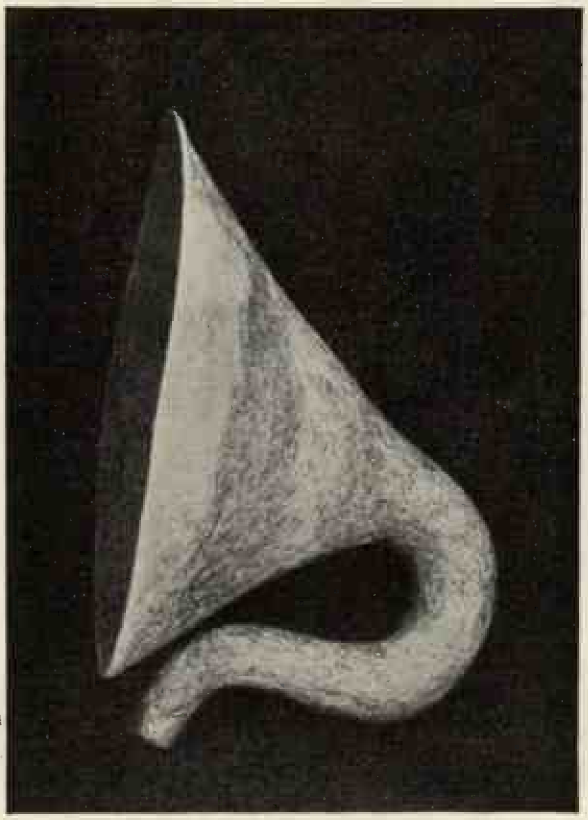
LOUD-SPEAKER HORNS

By G. P. KENDALL, B.Sc., Associate Editor, MODERN WIRELESS

An article containing a suggestion for a fascinating line of investigation for the experimenter, and instructions for making a cheap but effective loud-speaker.

A SERIES of experiments which I have recently carried out would seem to show that the exact shape and method of construction of a loud-speaker horn has a greater bearing upon the quality of the speech and music given by the instrument than is generally supposed. I am much inclined to believe that a very considerable part of the muffled "tinny" sound heard from some loud-speakers can be traced to imperfections in the design of the horn. The diaphragm, with its well-known defects, is, no doubt, the main source of distortion, but it is surprising how much worse matters can be made by a bad horn.

The loud-speaking receiver used in all the experiments to be described herein was one of those made by the Western Electric Company during the war, which I find gives good reproduction of telephony, although it was not, I believe, intended for this purpose. It has a large composition diaphragm with circular corrugations, which is actuated by a separate reed mechanism. Its resistance is 195 ohms, which I find suitable for working from a five to one ratio telephone transformer. (To prevent misunderstandings I should explain that this instrument is *not* one of the so-called ex-Army loud-speakers of 200 ohms resistance which have recently been upon the market.) The quality of the reproduction is considerably improved by shunting a large condenser (0·25 μF. is a good value) across the loud-speaker terminals. This, by the way, applies to certain other makes of loud-speakers, and is always worth trying.



A specimen of the papier mâché type of horn. This illustration shows the horn in a rough state before sand-papering.

When I obtained the instrument it did not possess a horn, and the first one which I made for it was intended rather for Morse signals than for telephony, since there was not much of the latter to be heard at that time. It was made of 24-gauge sheet brass, and had the shape indicated in Fig. 1. Its length was 20 in., and the diameter of the opening was 7 in., and it certainly did make big noises with Morse signals, so that I found it extremely useful for impressing the laiety. But alas, when I came to try that horn on telephony! Being made of a highly resonant metal like brass it responded strongly in sympathy with quite a number of notes and their harmonics, so that many a pianoforte solo suggested someone playing tunes upon a tin can. For speech and most vocal music it was tolerable, though certain voices did not appear to suit it.

I tolerated this horn for some time, and then started to seek a better material than brass. Metals in general, it seemed, were not very desirable, partly because of their tendency to resonate, and partly because one cannot produce *curved* metal horns in the average amateur workshop. Some plastic medium is required, and to use such a material successfully it is necessary to have some sort of former, model, or mould, upon which to work it. For this purpose I have found paraffin wax very convenient, since it is easy to remove by melting out from the finished horn. The method now

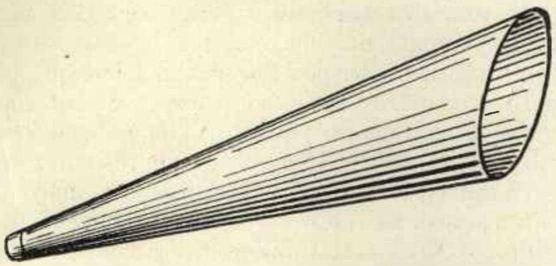


Fig. 1. An example of bad design. This horn was made of brass, and resonated strongly on certain notes.

used is to make an exact model of the *inside* of the required horn in wax and cardboard, as shown in section in Fig. 2. This is easily done by employing wax of low melting point (paraffin candles are quite good), immersing it in moderately hot water until soft, and then working it to shape with the fingers in a warm room. Start at the apex of the cardboard cone, and build up the wax towards the thin end of the horn. When about a third of the wax part is finished, stop and allow it to cool somewhat, since if the whole model is made at one start, great difficulty will be experienced in preventing it from drooping out of shape before it hardens. It is a convenience to have at hand during the modelling process a pot of melted wax and a good-sized paint-brush, because the application of liquid wax enables one to make the plastic wax adhere strongly to the cardboard, and to fill up any cracks and irregularities. When the model has hardened it can be smoothed and reduced to the exact

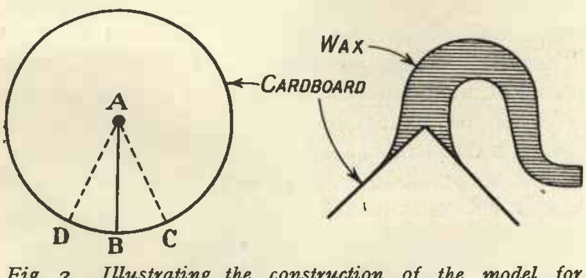


Fig. 2. Illustrating the construction of the model for making a papier mâché horn.

contour desired by scraping with a knife. To prevent the material of the horn from sticking the cardboard cone should be painted over with liquid wax. The cardboard cone, it should perhaps be explained, is made by cutting out a circular disc of perhaps 18 in. diameter, making in this a radial cut, as indicated by AB in Fig. 2, bringing the two cut edges past each other, and sticking them in the positions marked AC and AD in the figure.

For the construction of the horn some choice of material offers; for example, it can be built up by pasting sheet after sheet of tissue paper upon the model with starch. This method is not very satisfactory, on account of its slowness, each layer of paper having to be dried before the next one is pasted on. One of the most successful horns which I possess is made of papier mâché, which was prepared by pounding up a quantity of tissue paper in a mortar with starch paste. The resulting sloppy mass was plastered over the model to a thickness of about a quarter of an inch, smoothed down with the fingers, and kept for some days in a

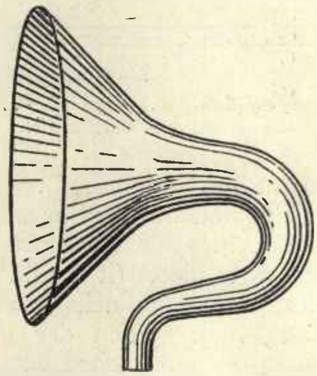


Fig. 3. Showing the shape of the first papier mâché horn made by the writer.

warm place to dry and harden. When dry, it was placed in the oven and the wax melted out, the cardboard cone being removed at the same time. This horn is very light and strong, and remarkably free from resonance effects, erring, if at all, on the side of dullness and flatness of tone. Its shape is shown in Fig. 3.

After making one or two specimens I came to the conclusion that even given a good non-resonant material, such as papier mâché, a great deal of experiment would be necessary to find the best shape and dimensions, and I therefore looked about for a material which would be quicker to use than those mentioned, in order to be able to make a good number of shapes for comparison. The material ultimately adopted for this purpose was Plaster of Paris, which besides being very speedy in use, has good acoustic properties. The method employed is to place the wax model in a wooden box so that its mouth is closed by one side of the box and its smaller end projects slightly from the top, and then to pour in the mixed Plaster of Paris (having previously greased the inside of the box with linseed oil to prevent the

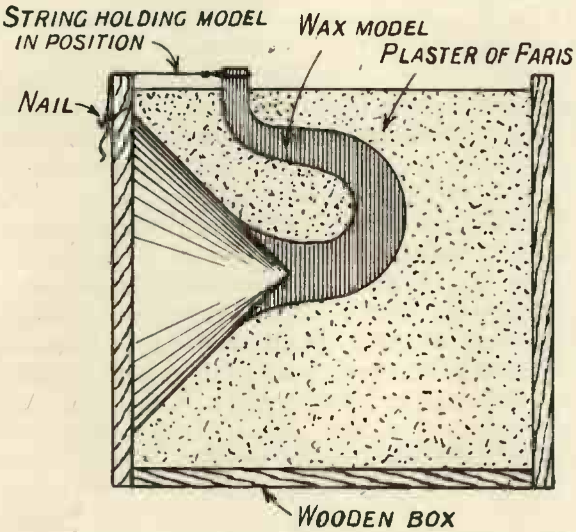


Fig. 4. Method of taking a Plaster of Paris cast of the wax and cardboard model.

plaster from sticking to the wood). The manner of arranging the model in the box will be understood from Fig. 4. When the plaster has set, the box is taken to pieces (it should be fastened together with screws, not nails), and the block removed and dried. When dry it is placed in an oven and the wax melted out: the result is a block of plaster in which the " horn " is represented by a cavity, as shown in section

Fig. 5. Section of a Plaster of Paris " horn."

in Figs. 5 and 6. These blocks are very quickly made, once the box has been constructed in which to cast them, and though they consume rather large quantities of plaster, they enable one to test all sorts of complicated shapes without difficulty.

My experiments on these lines have now been suspended, and may not be resumed for some time to come, and it is my hope that some of my readers may be inspired by this outline to go on from the point at which I left off, and perhaps achieve some notable improvement upon the known types of horns. The general conclusions at which I arrived as a result of the preliminary experiments carried out may be summarised as follows: It would appear that different shapes suit different instruments and different voices, and it seems difficult to find a form giving anything like uniform efficiency for all classes of sounds. For example, wood-wind instruments seem to be the best heard

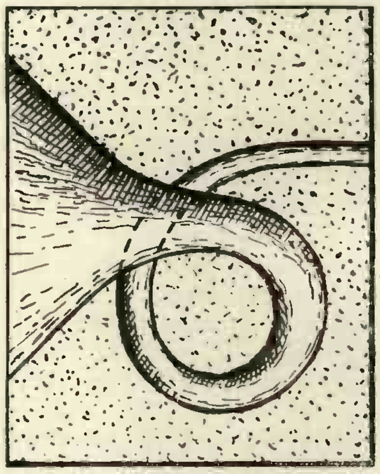


Fig. 6. Section of a spiral Plaster of Paris " horn." This shape has much to commend it.

from a rather long horn of small bore, whereas the human voice, especially bass and baritone, requires a considerably larger bore to prevent " muffle." The piano I have found a most difficult instrument to suit, for it brings out every latent defect of horn, loud-speaker, intervalve transformer, and so on. It is particularly prone to produce horn echoes, to prevent which a spiral form is useful (Fig. 6).

The following rules, which are the result of experience, should be borne in mind when attempting to produce a good all-purposes horn, and will, I think, be found a trustworthy guide.

(1) The narrow part of the bore should not be less than 10 in. in length, nor longer than about 30 in.

(2) The opening should be at least 10 in. in diameter.

(3) The bore should not be straight, nor parallel-sided in any part, but should taper from about 3 in. to 1 in. in diameter.

(4) The transition from the bore to the conical opening should be by a gradual fanning-out, as in Fig. 6, rather than by an abrupt change of angle, as in Fig. 4.

(5) Sharp bends and changes of direction in the bore are to be avoided, since they may cause horn echoes. Thus, Fig. 6 is a better shape than Fig. 3.

As regards the actual results given by the Plaster of Paris " horns " : the tone which they give is so remarkably pure that I would strongly urge their use wherever their bulk and weight is not objectionable. To make them look presentable they may be varnished and enamelled, or enclosed in a polished wood box with either a circular hole in its front or doors like those of a gramophone.

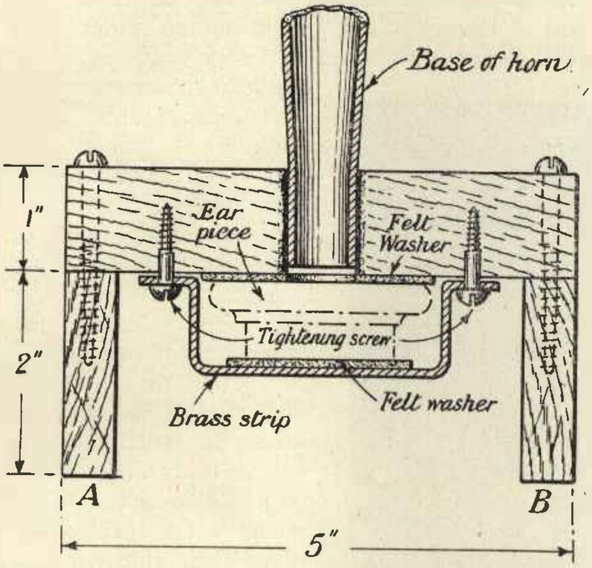


Fig. 7 (a). Section of an adapter for the conversion of an ordinary telephone earpiece into a small loud-speaker.

To experiment along the lines which I have indicated it is desirable to use a properly constructed loud-speaking receiver for the testing of the various types of horn, and such receivers can now be purchased without horns. Failing such a receiver, however, some results can be obtained with an ordinary single earpiece of good make; provided that the user of the instrument is content with a modest volume of sound, and does not overload it, very fair reproduction is obtainable. A little difficulty may be experienced in attaching the earpiece to a horn of the papier mâché description, but the adapter shown in section in Fig. 7 (*a*) will be found a good solution. It consists of a piece of hard wood, 3 in. by 5 in. by 1 in. thick, in the centre of which is drilled a hole, into which the horn fits tightly. Into this hole the horn is glued, and the earpiece is attached to the underside of the wooden block by means of a strip of brass, as indicated in the figure. It is desirable to interpose a felt washer between the earpiece and the wooden adapter, and another piece of felt between the brass clamping strip and the earpiece. These pieces of felt are also shown in Fig. 7 (*a*). To enable the adapter to stand evenly two pieces of wood (A and B) are attached to the ends of the block, as indicated in Fig. 7 (*a*) and (*b*).

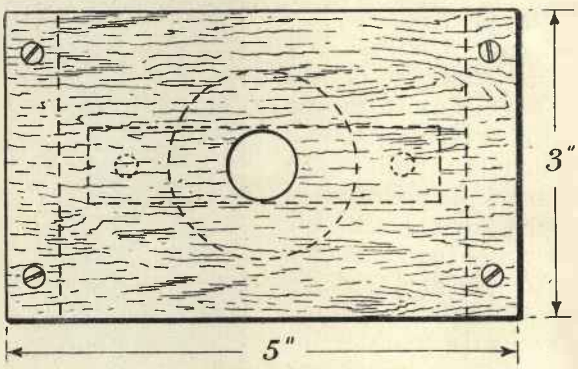


Fig. 7 (b). The adapter in plan.

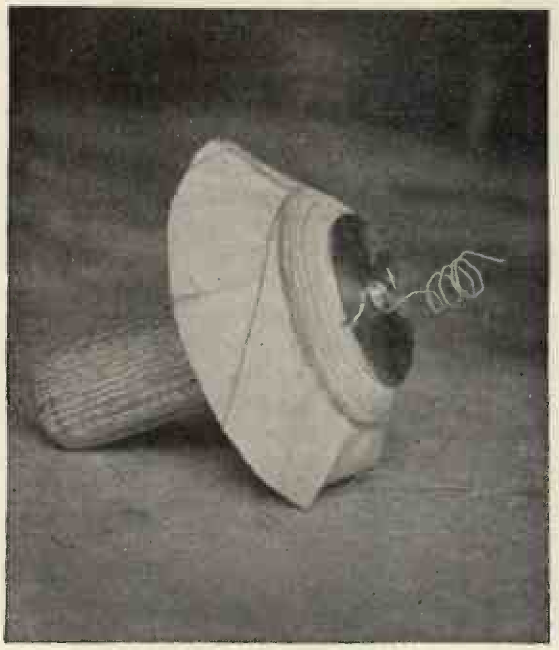
CORRESPONDENCE

Re "A Compact Broadcast Receiving Set."

To the Editor of MODERN WIRELESS

SIR,—In the March number of MODERN WIRELESS Mr. Redpath describes the construction of an admirably simple and efficient crystal receiver. The construction is well within the ability of everyone, and the results are most satisfactory. The set I have made readily receives Birmingham broadcasting at ten miles, and a number of stations transmitting Morse, though I am not sufficiently familiar with those to recognise them.

There is one operation in the construction of the set which is likely to present some difficulty if attempted just as Mr. Redpath describes. It is the transfer of the stator coils from the jig on which they are wound to their final positions in the hemispherical cavities in the stator. In my own case I found that the shellac varnish with which the coils were treated prior to the transfer invariably penetrated to the jig, and when the latter was withdrawn from the stator blocks it always brought away part of the coil with it. Exasperated by repeated failures, I cogitated and finally introduced a slight modification which renders the transfer simple and certain; in addition, it leaves a beautifully finished winding.



Illustrating Mr. Wilkes' method of winding with tracing paper between jig and wire.

Briefly the modification is to introduce between the coil and the jig some medium to which the shellac varnish may cement the coil, but which is impervious to shellac varnish and so will not in turn be cemented to the jig. When the coil is now covered with tacky shellac varnish and pressed into the cavity in the stator block, also varnished, the jig may be withdrawn immediately and will leave the coil and its covering in place in the stator cavity.

The medium I selected to separate the coil from the jig was engineers' tracing paper, and it fully justified its selection. The method of using it is shown so clearly by the photograph that little explanation is necessary A piece of the tracing paper, about 5 in. square, has a small hole made in the centre. It is placed on the end of the jig before the brass disc is screwed into place, so that when the brass disc is screwed on the paper is sandwiched between it and the end of the jig. The paper is then folded back and creased round the sharp edge of the jig. The crease is trimmed round with scissors and leaves a circle of paper that will roughly cover the jig. From the circumference of this circle, eight or ten scissor-cuts are made radially up to the brass disc, and leaves the paper arranged much like the petals of a flower. The winding is carried out in the usual manner, and as the coil grows it gradually folds the paper petals back against the jig. When the winding is complete the coil is treated with a liberal coat of shellac varnish, thin enough to penetrate to the tracing paper. It is then left for half an hour to obtain a good grip on the paper. Finally the coil and the stator cavity are treated with a copious coating of thick shellac varnish, and left for a few minutes till the varnish is really tacky. The jig is then pushed home hard, the ends of the coils unfastened, and the jig may be at once withdrawn. The operation is certain, and the coil is left with a covering of tracing paper, which is no disadvantage electrically, and is even advantageous mechanically, since it protects the coil from damp and any slight rubbing which may take place between the stator and rotor.

If tracing paper is not readily procurable, I imagine, though I have not tried it, that the grease-proof paper in which grocers wrap butter would serve equally well.

I may mention another minor point. In the photograph it will be noticed that I attach the brass plate to the jig with two screws, not one only. I found this necessary as the brass disc was liable to twist on its one central screw during the first turn or two of the winding.

S. H. Wilkes.

Brean Down, Dudley, Worcestershire.

The Dynatron and Super-Regeneration

To the Editor of MODERN WIRELESS

Sir,—In the first number of Modern Wireless Mr. Paul D. Tyers in his article on the dynatron outlined the principles of an application of the three-electrode thermionic valve which so far has received scant attention from most English amateur experimenters.

The plate-current curves of R, V 24, Ora, QX, and similar valves, when used as dynatrons

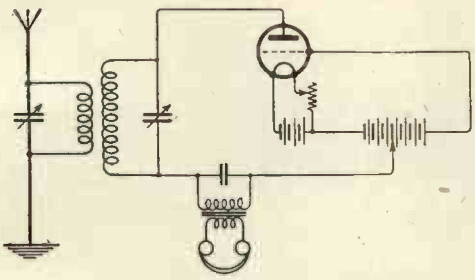


Fig. 1. A simple dynatron circuit.

with such low anode voltages as 50 to 150, all reveal the existence of a negative resistance effect to a greater or less extent. Owing to this effect any of these valves can be made to generate oscillations by connecting a suitable coil in the plate circuit. Rectification can also be obtained by so adjusting the plate voltage with respect to the anode voltage that one of the two bends of the plate-current curve is used.

The circuit shown in Fig. 1 seems in practice quite suitable for the reception of long-wave stations. It appears to be as efficient as the orthodox autodyne reaction circuit, and rather more so than de Forest's " Ultraudion " single-coil autodyne circuit. The grid of the valve is used as an anode, and the real anode as a plate or subsidiary anode.

However, the chief use of the dynatron, as far as amateurs are concerned, would seem to be as a simple independent generator of oscillations, though owing to the negative resistance effect it can also be used as a current or voltage amplifier, or to neutralise positive resistance, and, in fact, has countless applications.

It occurred to me some time ago that the first attempt at simplification of the Armstrong super-regenerative circuit should consist of an attack upon the 8,000- to 15,000-cycle oscillator, and that a receiving valve or small transmitting valve acting as a dynatron would be suitable for the purpose, being distinctly simpler than an ordinary reaction oscillator employing electro-magnetic or electrostatic coupling between grid and plate coils. Experiments have confirmed this conjecture, and in Fig. 2 is shown one of the many possible variations of the principle. The oscillating potentials produced by the action of the dynatron D across the inductance L, a No. 1500 duo-lateral coil, vary the anode voltage of the detector valve V at a frequency adjusted by means of the condenser C, to be just above the point of audibility for the reception of telephony, while for spark signals the frequency can be considerably lower. The battery B_1 has tappings at 3-volt intervals, so that the correct voltage for the plate of the dynatron is easily found. The voltage of B_2 need not be variable.

Owing to the arrangement of its electrodes, the QX valve seems especially suitable for use as a dynatron with low anode voltages, and as such provides a good subject for experiment.

It will also generally be found an advantage

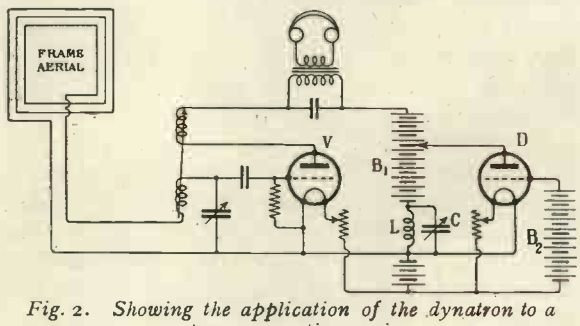


Fig. 2. Showing the application of the dynatron to a super-regenerative receiver.

when ordinary three-electrode valves only are available to use two in parallel as a single dynatron, for by this means the negative resistance portion of the plate-current curve is considerably steepened.

Guy C. Beddington.

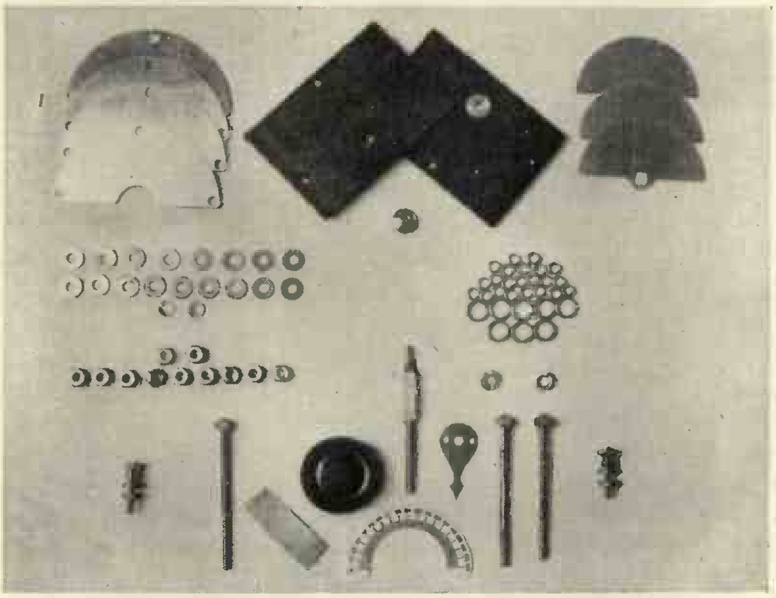
Trinity College, Cambridge.

HOW TO BUILD VARIABLE CONDENSERS FROM BOUGHT PARTS

By ALAN L. M. DOUGLAS, Associate Editor, WIRELESS WEEKLY

A constructional article dealing with the several methods of assembling variable condensers in accordance with the best practice so as to obtain freedom from trouble, and ease of adjustment.

THE true experimenter invariably has a desire to build his own variable condensers; but unfortunately the results are not always in accordance with his carefully thought-out plans, and very frequently difficulty is experienced in preventing all kinds of untoward things happening, such as stiffness of action, occasional short-circuiting of the plates—in fact, a general lack of resemblance to the purchased article. Now the careful experimenter can produce a much better condenser than any he may buy—save the most expensive patterns—if he will give a little thought to the design before assembly of the component parts. Let us briefly examine what are the essentials of a variable condenser of standard pattern and type, having an air dielectric.



Complete set of parts for the assembly of a variable condenser of 0·0001 μF. capacity.

It is necessary to have, firstly, top and bottom bearing plates of considerable strength. These may be made of ebonite if desired, but it should not be less than ¼ in. thick, and ⅜ in. is very desirable. The best patterns of commercial condensers are either built up on very heavy ebonite or on metal.

As this is the starting-point of all vane pattern condensers, emphasis is laid upon the necessity for really solid end plates, as a good foundation upon which to build. The small triangular pattern is now greatly in favour, and is unquestionably a sound investment in every way. The use of this shape of end plate also economises in space, which is very desirable where panel mounting is considered.

Suitable designs for bearing plates are given in Fig. 1. Attention is drawn to these as being worthy of study. The next consideration is, of course, that of capacity. It is becoming increasingly difficult to obtain condenser plates of any reasonable size, and on account of the present-day inclination to use very small plates with a radius of about 1¼ in., the following table of varying capacities has been drawn up—taking also into account the size of spacing washer with which one is most likely to come in contact.

This will be found very useful when basing an estimate for material on the capacity required. Now come several points which cause trouble to many ama eur mechanics. Firstly, let us consider the question of side supporting rods or frame members.

No. of Washers Required. Fixed.	Moving.	No. of Plates.	Capacity—μF. Spacing Washers ⅛ in. high.	
126	41	85	0·0015	Radius of moving plates, 1¼ in.
84	27	57	0·001	
63	20	43	0·00075	
42	13	29	0·0005	
27	8	19	0·0003	
18	5	13	0·0002	
9	2	7	0·0001	
6	0	3	0·00005	

It is often the practice to make these from No. 4 B.A. brass rod; this is much too light for the purpose, and it often happens that when much pressure is brought to bear on the nuts to adjust the assembly, the threads

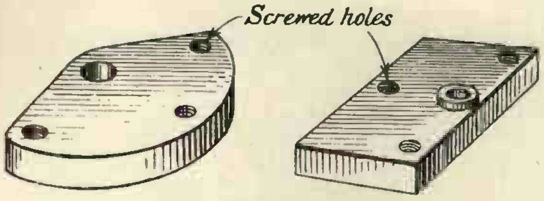


Fig. 1. Good types of end plates.

become stripped and the condenser is therefore useless. No. 2 B.A. brass rod should be the lightest used, but a much better plan, and one which very few experimenters would seem to avail themselves of, is to use screwed *steel* rod. This sounds rather a formidable proposition, but as a matter of fact screwed hard steel rod is very easily obtained in the form of "Meccano" spindles. These possess two great advantages, the first one being that they are dead straight, which of course is vital; and the second that they may be obtained cut to all sorts of convenient lengths. They have a $\frac{5}{32}$ in. Whitworth thread on them, and nuts of the same make are equally readily obtainable. In building up the side members, the arrangement indicated in Fig. 2 should be aimed at. This shows a means of assembly

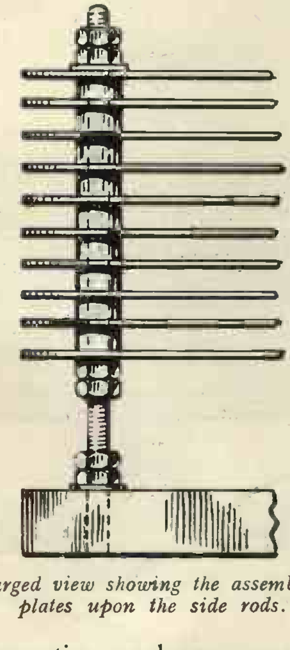


Fig. 2. Enlarged view showing the assembly of the fixed plates upon the side rods.

whereby the entire condenser, once built, may be so moved up and down the fixed rods as to obtain the position of regularity in regard to the clearance of the centre vanes. This is a very necessary provision.

Holes should be tapped in one of the end plates, preferably the lower one, to receive the rods; additional security may be given by means of a lock nut adjusted hard up against the end piece, and brass rods of a convenient length having been cut, they should be screwed home. It is not necessary here to go into details of how to tap threads in ebonite, suffice it to say that the tap should not be forced in, but given a half-turn back for every turn forwards; this will allow plenty of clearance in the threads, otherwise the rod may be difficult to insert, as tools have a habit of working smaller holes in ebonite than in metals. This should always be borne in mind.

Convenient lengths to cut the side rods are:

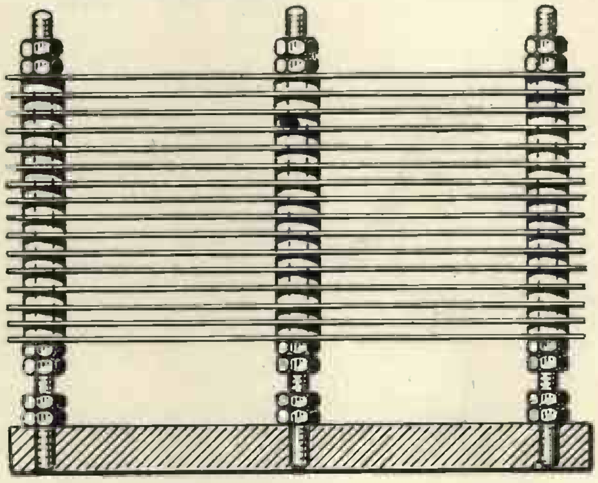
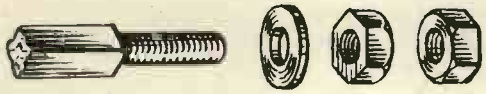


Fig. 3. Showing the assembly of the fixed plates.

0·0015, 8 in.; 0·001, 6 in.; 0·0005, 4 in.; 0·0003, $3\frac{1}{2}$ in.; 0·0002, 3 in.; 0·0001, 2 in.; 0·00005, 2 in. These facts will also be found of use. The centre spindles will be about $1\frac{1}{2}$ in. longer in all cases, unless of course required for special purposes, in which case they may be of almost any length desired. But to return to the fixed vane assembly again; the requisite plates and washers having been laid out, another couple of nuts should be run down each side rod in such a manner that they will lock themselves together about $\frac{3}{8}$ in. above the bottom end plate. These all having been adjusted to a height equidistant from the base, one fixed vane is slipped over them. This will rest upon the nuts, and three of the small spacing washers can be dropped down the rods so as to separate the next plate from the first one. Alternate series of plates and washers are then put on until the required number is complete. The whole should then be locked together by two more nuts per spindle, when the complete assembly will resemble Fig. 3. This must, of course, be carefully aligned so that it is absolutely level with the base plate. The top plate may now be slipped on, and it is important in drilling it to remember that the three side holes must be of such a diameter as to *clear* the screwed rods—that is, they must slip freely over them, but at the same time have no play. The top plate cannot, however, be fixed in position until the centre rotating portion is completed.

There is a common practice of using square brass rod for centre spindles, with a screwed



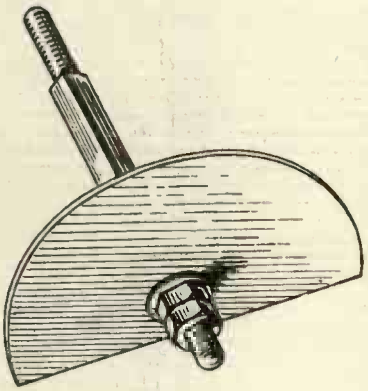


Fig. 4. Method of assembling the moving vanes upon a square centre spindle.

portion at each end to receive lock nuts, etc. This is an excellent idea where one can be certain of obtaining the rod of exactly the necessary length, but great care must be exercised in its selection; otherwise it is preferable to use ordinary round section rod of $\frac{1}{4}$-in. diameter, as most of the vanes now on the market have a $\frac{1}{4}$-in. square centre hole. If it is decided to use the squared rod, then the necessary length should be obtained and an arrangement of nuts and washers as in Fig. 4 attached to it as shown. This will greatly assist in the final adjustment of the condenser. Vanes and washers to the necessary number are then placed upon the centre rod in the same manner as for the fixed plates, and when all is complete the appearance will be as in Fig. 5. This also illustrates a bevelled dial and knob attached, which undoubtedly presents a good final appearance and allows of careful readings being taken.

It will now be time to assemble the condenser. To do this the end of the spindle carrying the moving vanes is placed in the hole in the lower

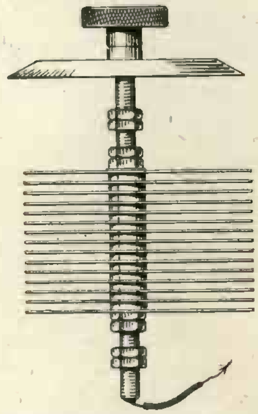


Fig. 5. Complete assembly of the moving vanes.

disc (which must, of course, be a good fit for it), and the vanes turned away from the fixed ones. They are now rotated until they slide between the fixed plates, when the top is put

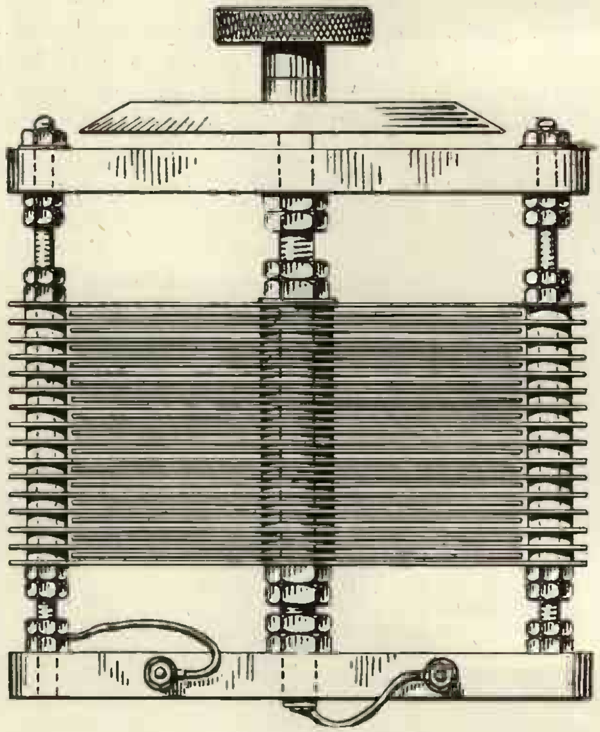


Fig. 6. The completed condenser.

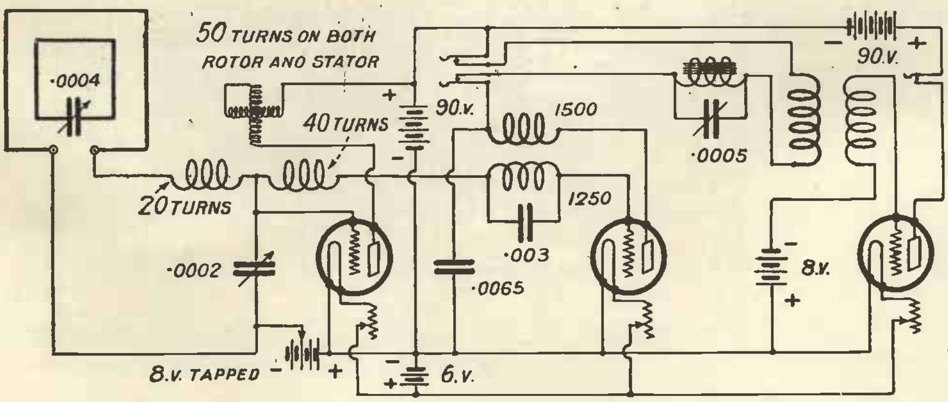
on and gently screwed down by hand. This, now, is the point where latitude in adjustment is appreciated; we will find that the moving vanes press up against the fixed ones, and in the first place the nuts on the moving rod are screwed up or down until a point is found where the spindle can be rotated. The top plate is, at this juncture, locked firmly in position ; but it will probably be discovered that upon rotating the spindle (which may be very stiff, but the stiffer the better) the movable vanes make contact at one or more points with the fixed ones. Now, however, that the end plates are rigid, we can gently screw the fixed assembly up or down until a clearance is established at all points in the rotation of the centre portion. One side may be raised or lowered a little irrespective of the other, which will prove to be very handy in cases of inequality of the centre spindle ; and once found, the correct setting may be securely locked by means of the various nuts provided. It will be noticed that so far no provision has been made for connections to the moving or fixed vanes. The rubbing contact is rather an uncertain method of carrying this out, and a thick flexible wire may be soldered to whatever portion of the spindle projects from beneath the lower plate. This is the most satisfactory arrangement, and if desired two small terminals can readily be mounted on the bottom of the plate, or screwed into the edge. This latter method is the better.

Contact with the fixed vanes is, of course, readily obtainable to any of the nuts securing the fixed spindles of the condenser. A bevelled ebonite dial and knob may be fitted, and at present these accessories are to be had at such a low price that they should certainly be used. No mention has been made of the use of metal end plates bushed with ebonite, as although the result is, of course, excellent mechanically, the trouble of making such end plates often proves too much for the experimenter who possesses limited workshop facilities. If he follows these instructions carefully he will succeed in making a first-class job, and having a condenser of such a nature as will stand up to all kinds of rough treatment, in addition to being electrically sound enough to be used for transmission. A typical condenser, such as the reader may expect to produce if he follows these instructions, is shown in Fig. 6. In conclusion, it might be said that the first size, 0·0015μF., is useful for series tuning, transmission, and wavemeter work ; the second, 0·001, for series tuning ; the third, 0·00075, for both series and parallel tuning ; the fourth, 0·0005, for secondary circuit tuning ; the fifth and sixth, 0·0003 and 0·0002, for tuning H.F. transformers and anode reactance coils ; and the seventh and eighth, 0·0001 and 0·00005, for vernier and very fine adjustment purposes.

THE WINNING CIRCUIT OF THE *RADIO NEWS* SUPER-REGENERATIVE COMPETITION

THE accompanying diagram illustrates the circuit of one of the receivers which won a prize in a competition conducted by the *Radio News* upon somewhat similar lines to that organised by the Radio Society of Great Britain.

One of the original features of this receiver is the second frame aerial arranged within the main receiving frame, which is stated by the constructor of the set to act as a "wave-trap," but which probably has also some effect in producing damping in the receiving circuit.



AN EFFICIENT FIVE-VALVE SET FOR GENERAL RECEPTION

This article deals with a receiver which is very sensitive, and which will be found to give very good results when receiving broadcasting and other telephony signals, and also spark signals.

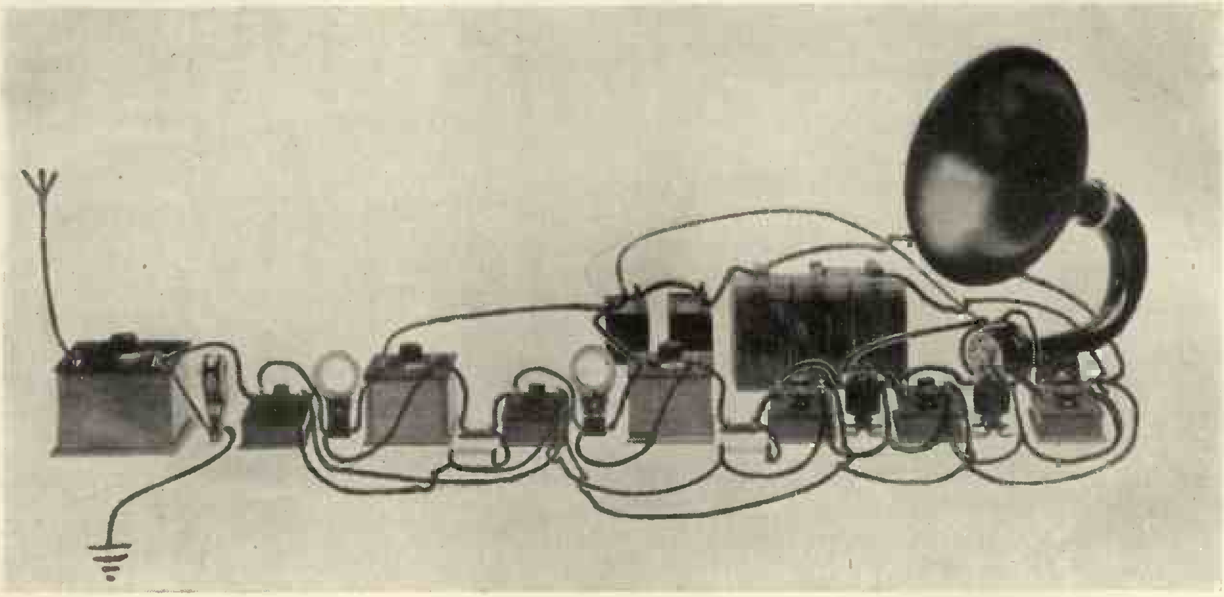


Fig. 1. Showing the arrangement of the apparatus.

THE five-valve set here described does not involve intentional reaction, as there is always a certain amount of natural reaction which helps to strengthen the signals, while not being sufficient to cause self-oscillation.

Fig. 2 shows the circuit employed. The first valve acts as a high-frequency amplifier, as also does the second. The third valve acts as a detector on the leaky grid principle, while the fourth and fifth valves act as note magnifiers.

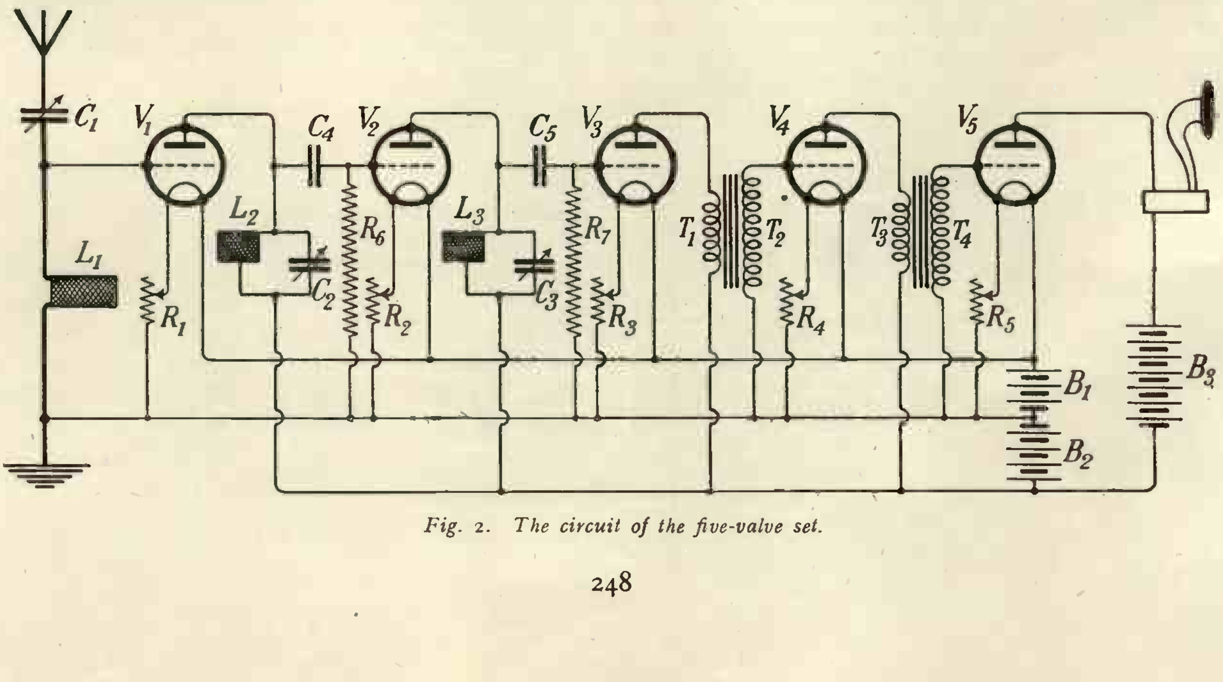


Fig. 2. The circuit of the five-valve set.

A loud-speaker is connected in the anode circuit of the last valve, although telephones might be employed if the signals were feeble, due to the long range covered.

On a standard post office aerial the three inductance coils L_1, L_2 and L_3 were Igranic honeycomb coils No. 50. The condensers C_1, C_2 and C_3 were 0·001 μF. capacity. The transformers T_1, T_2 and T_3, T_4 were reliable intervalve transformers, the primaries being connected in the anode circuit of the valve as shown. The inductance coils L_1, L_2 and L_3 were mounted in the usual ebonite holders fixed to the coils themselves, which may be purchased for a reasonable sum. Unfortunately, no manufacturer has apparently yet been sufficiently enterprising to put on the market a good holder, fitted with terminals, for single coils. If such could be obtained, or could be made, so much the better.

It will be seen that each valve is fitted with a separate rheostat. This is more or less of a luxury, but these rheostats appear in the circuit as purchased valve panels were employed. These panels are simply valve-holders mounted on small boxes with ebonite tops, four terminals and a rheostat being provided. No grid condensers or other accessories are on the valve panel. These panels are invaluable to every experimenter.

The battery B_2 has a voltage of 70 volts, and it is desirable if a large volume of sound be desired that an additional battery, B_3, having a value of about 36 to 70 volts, should be included in the anode circuit of the last valve, which valve incidentally should preferably be of the loud-speaker type placed on the market by different valve manufacturers to give power amplification. If an ordinary valve is used, there is no particular point in having the additional battery B_3. In fact, except for long distance reception of broadcasting, there would be no particular point in having the fifth valve at all.

Fig. 1 shows a photograph of the assembled apparatus, which is either laid out on the table or else mounted on a special board.

AN AWARD TO DR. ASTON

OUR readers will be interested to learn that Dr. F. W. Aston, F.R.S., whose article in the March number of MODERN WIRELESS aroused great interest, has been awarded the John Scott Medal and a money prize by the American Philosophical Society.

Dr. Aston's article, it will be remembered, dealt with "The Atoms of Matter: their Size and Construction," a branch of physical science in which his researches have led him to several notable discoveries. He is one of our chief authorities upon the influence of the electronic structure of the atom upon its chemical and physical properties.

RECENT ADDITIONS TO OUR LIST OF EXPERIMENTAL CALL-SIGNS

Continued from page 213 of the last issue. To be appended to our "WIRELESS DIRECTORY."

CALL.	NAME OF OWNER.	ADDRESS.
5 CB	K. E. HARTRIDGE	14, Westbourne Crescent, W.2.
5 GQ	F. W. NIGHTINGALE	Pitsford School, Northampton.
5 HP	CUNNINGHAM, LIMITED	169–171, Edgware Road, W.2.
5 HQ	E. A. POLLARD	Spring Bank, Limefield, Blackburn.
5 OD	R. BATES	"Holmside," St. Catherines, Lincoln.
5 SP	E. WARNER	"Dilnott," Horeham Road, Sussex.
5 ST	R. R. MORRISON	Spring Grove, Kilbarchan, Renfrewshire.
5 TH	S. H. SUTHERS	Tilmore. Petersfield, Hants.
5 TV	W. H. LLOYD	27, Copthall Gardens, Twickenham.
5 UL	L. COVERNEY	12, Wallwood Road, Leytonstone, E.11.
5 US	J. CROYSDALE	5, Elm Grove, Burley in Wharfedale, Leeds.
5 UV	L. A. JEFFREY	90, Harringay Road, Green Lanes, N.15.
5 VP	G. F. KITCHEN	10, Beech Road, Epsom, Surrey.
2 WZ	A. HARE-HOBSON	32, Wilbury Road, Hove, Sussex.

CORRECTIONS.—The following should be deleted from previous lists:

2 AM	MARLBOROUGH COLLEGE O.T.C.	
2 IY	Mr. BRIGGS	Birmingham.

MULTI-LAYER COILS

(*Continued from page 185.*)

By G. P. KENDALL, B.Sc., Associate Editor, MODERN WIRELESS

A consideration of further useful types of multi-layer inductances, including one which has not been described hitherto.

The Lattice Coil

TAKING into account its efficiency and its ease of winding, the " lattice " coil is perhaps the most suitable multi-layer for general amateur use. Its construction is very simple, for it is merely a layer-by-layer winding, the layers of which contain a small number of turns, and are separated by a special zigzag spacing turn, the coil being in the form of a disc of diameter up to 5 in., and thickness up to 1 in. (Fig. 1). A section of a portion of a lattice winding is given in Fig. 2.

The method of winding by hand is simple: A "former" is used, which consists of a wooden cylinder, say $1\frac{1}{2}$ in. in diameter and 2 in. long, in which are driven two radial rows of pins, say twelve in a row, the pins being " staggered " in the rows, and the rows separated by a distance depending upon the thickness of the coil to be wound (Fig. 3). Suitable pins for the purpose may be made by cutting No. 16 or 18 galvanised iron wire into lengths, or one can use slender wire nails, or the pins which joiners call " sprigs."

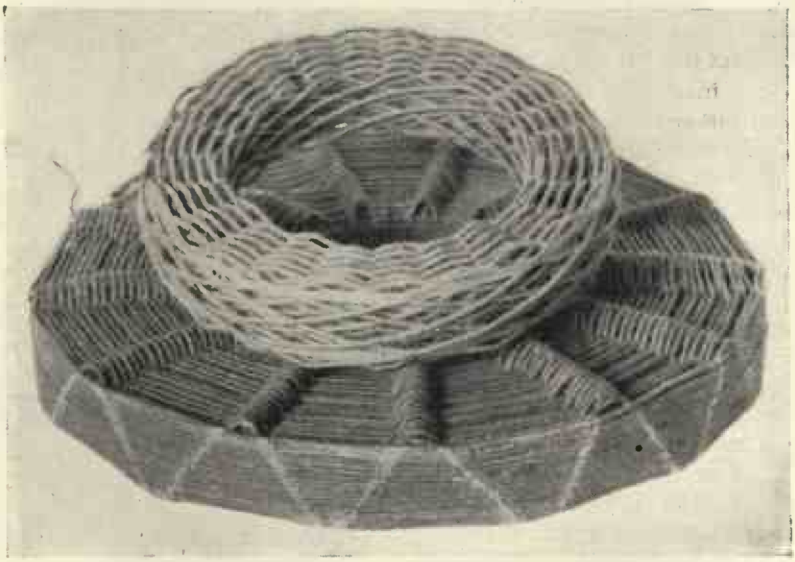


Fig. 1. Specimens of duo-lateral and lattice coils. Note the track of the zig-zag spacing turn in the lattice coil.

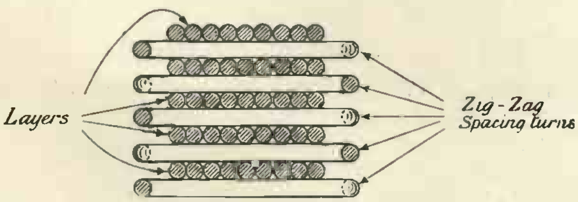


Fig. 2. Section of lattice winding.

The method of winding is to commence by putting on a zigzag turn round the outside of the pins, as shown in plan in Fig. 4 (*a*). On the completion of this turn the wire is wound on in a single layer across the former (Fig. 4 (*b*)), then another zigzag turn is put on, to be followed by another layer, and so on alternately until the required number of turns has been wound on. The coil is then well soaked in melted paraffin wax, taken out and drained as completely as possible, allowed to cool, and removed from the former by extracting the pins (with a pair of pliers) and pulling out the first zigzag turn, after which it will come away easily.

It will be found quite a simple matter to wind a set of lattice coils, especially if the former can be mounted on some sort of spindle (or chucked in a lathe, of course), so as to be easily revolved, and they will be found very

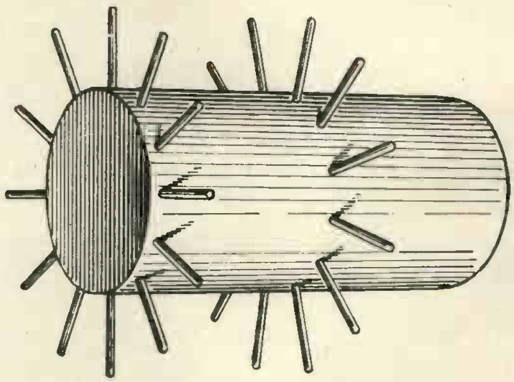
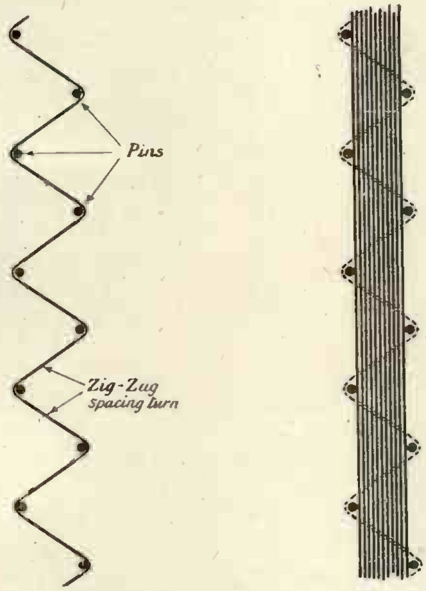


Fig. 3. Former for winding lattice coils.

satisfactory for medium- and long-wave tuning. Data for a set to cover approximately 1,000 to 20,000 metres are given below.

Coil.	Turns.	Turns per Layer.	Wire.
1	200	10	24 d.c.c.
2	300	15	24 ,,
3	400	20	26 ,,
4	500	20	26 ,,
5	750	20	30 ,,
6	1,000	30	30 ,,
7	1,250	30	30 ,,
8	1,500	40	30 ,,

Diameter of former, 5 cm.; number of pins per row, 12; distance between rows of pins (*i.e.*, thickness of coil): coil 1, 1 cm.; coils 2–5, 1·5 cm.; coils 6 and 7, 2 cm.; coil 8, 2·5 cm.



(*a*) (*b*)

Fig. 4. Illustrating the method of winding lattice coils.

The data given, it should be explained, have been worked out to give a good compromise between compactness on the one hand, and efficiency on the other; if greater compactness is desired, it can be obtained at a slight sacrifice of efficiency by winding coils 1–4 with No. 28 d.c.c. wire, and coils 5–8 with No. 32 d.c.c. wire.

Modifications of the Lattice Coil

I have found that the lattice coil is exceedingly useful as a starting-point for the origination of new systems of coil-winding, a little ingenuity sufficing to produce quite a variety of such modifications.

The two examples which follow are the most useful of the various types which I have obtained in this way. The first coil is of the flat disc or pancake type, which is convenient for some coupling purposes, and is intended to replace the basket coil, over which it has considerable

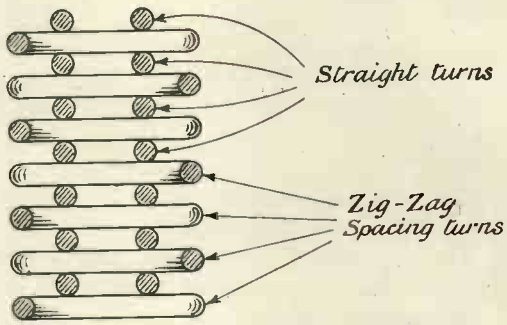


Fig. 5. Section of disc type lattice coil.

advantages in mechanical strength, compactness, and quickness of winding. It is simply a lattice coil of only two turns per layer, those two being spaced apart, as shown in section in Fig. 5. It is wound upon a former which differs from the one already described in that its two rows of pins are only 7 or 8 mm. apart, and the method of winding is as follows: First the zigzag turn with which every lattice coil begins, then a turn straight round close against the pins on one side of the former, across on a slant to the other side, and then one turn round against the other pins. Fig. 6 shows these first three turns, and should make the matter plain. After this, zigzag spacing turns alternate with layers composed of two straight turns until the coil is finished. On the completion of the coil tie the last turn tightly to the zigzag one beneath it with thread at two points, wax the coil and remove it from the former as before. It should perhaps be mentioned at this point that with all multi-layer coils it is generally worth while to tie the first turn to the one above it, and the last

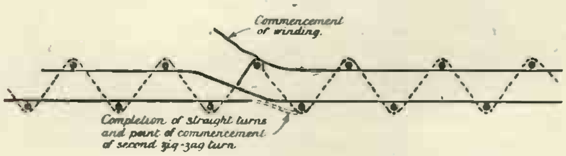


Fig. 6. Plan of disc type lattice coil.

turn to the one beneath it, to eliminate any tendency to unwind. (*Note:* In the case of lattice coils " first turn " does *not* mean the zigzag turn which is put on at the commencement of winding, since this is always intended to be pulled out after the coil has been waxed, to enable one to remove it from the former.)

The second type is one whose use for all short-wave purposes I strongly advocate, since it is distinctly the best multi-layer coil which I have yet tested. The system of winding is such that the superimposed turns are separated by quite as great a space as in the popular duo-lateral coil, and they are separated electrically by smaller differences of potential. This system was originated very simply from the preceding one by applying the duo-lateral principle and "staggering" the turns which come vertically above each other, as shown in section in Fig. 7. Instructions for winding this coil are scarcely necessary, the only points requiring mention being, first, that the straight turns are placed in position by eye, which will prove quite easy when once the first three-turn layer has been put on. Second, that all the straight-turn layers must commence on the same side of the former, and all must finish on the opposite side. Thus,

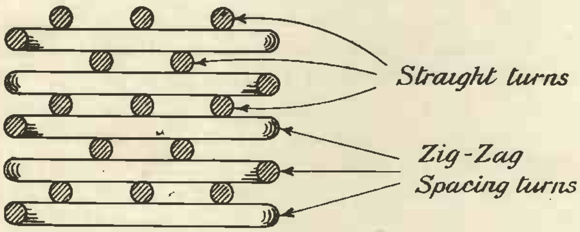


Fig. 7. Showing the application of the duo-lateral principle to lattice winding.

it will not do to begin a three-turn layer on the right and finish it on the left, and then begin the succeeding two-turn layer on the left and finish it on the right. The reason for this will become plain when the first coil is wound.

Coils of this type, by the way, are not upon the market, nor, so far as I am aware, are they likely to be.

Honeycomb and Duo-lateral Coils

The honeycomb coil in its improved form, the duo-lateral, is generally regarded as one of the best of multi-layer coils, and it is therefore regrettable that it is such a tedious and difficult one to wind. By hand it must be regarded as an impracticable task to wind anything but the smaller sizes, the large ones requiring either a coil-winding machine or an inexhaustible stock of patience. Small coils can be fairly easily wound by hand upon a former resembling that used for lattice coils, the only difference being that many more pins are required for the duo-lateral. Such coils are usually somewhat superior to those produced by a machine, since one can wind much thicker gauges of wire by hand than a machine will deal with satisfactorily, and can, therefore, produce a coil of lower resistance and lower internal capacity (the latter resulting from the greater spacing between turns caused by the thicker wire).

It is almost impossible to convey a clear idea of the nature of the honeycomb and duo-lateral systems by verbal description, and I must invoke the aid of some diagrams. The essential characteristic of both systems is that the wire in passing round the former travels slantingly from side to side of the coil. On the completion of each revolution a fresh turn is begun at a point a few degrees ahead of, or behind, the spot at which the previous one started. An attempt is made to show this in Fig. 8 (*a*) which is a plan of the surface of the former, with the pins represented by dots, upon which one turn of wire has been wound. It must be emphasised that

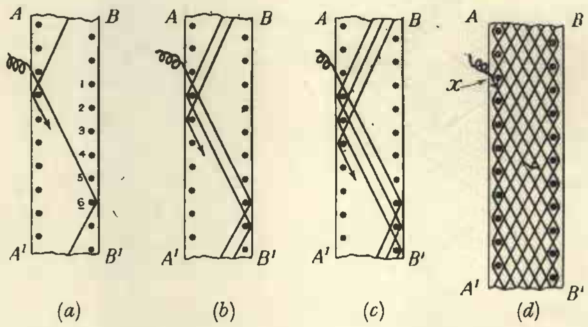


Fig. 8. Showing the method of winding a honeycomb coil.

the figure is a plan of the *whole* surface of the former, not half of it. Thus, to accurately represent the original, the paper would have to be bent round so that the lines AB, A_1B_1, met to make the diagram circular. Figs. 8 (*b*) and 8 (*c*) show the effect of adding turns one at a time, while Fig. 8 (*d*) shows the first layer completed. The second layer would begin at the point X, and would follow exactly the turns of the layer beneath (from which it is separated by the turns running crosswise), thus preserving the cellular structure seen in Fig. 8 (*d*) which gives the coil its name. It will be noted that the wire on passing round a pin on one side of the former slants across to the other side and passes round the *sixth* pin, counting six in this way every time it crosses over. This is indicated by the numbers on Fig. 8. In the case of the honeycomb any convenient number may be used, according to the closeness of winding desired (the larger the number the closer the winding). It is worth noting that the number of turns per layer is fixed by the number of pins "counted" in crossing over; in the example figured it can be ascertained by actual enumeration that each layer consists of twelve turns, which is twice the number of pins "counted." This rule holds good for all honeycomb and duo-lateral coils, irrespective of the number of pins on the former, and is very useful when one is designing, say, a series of coils to have specified numbers of turns. For example, suppose one has to wind a coil of 70 turns, and wants to know how many pins to count, and how many layers will be needed: try 5 layers:

$$70 \div 5 = 14$$
$$14 \div 2 = 7$$

Therefore, count 7 pins in crossing over, thus obtaining 14 turns per layer, and wind on 5

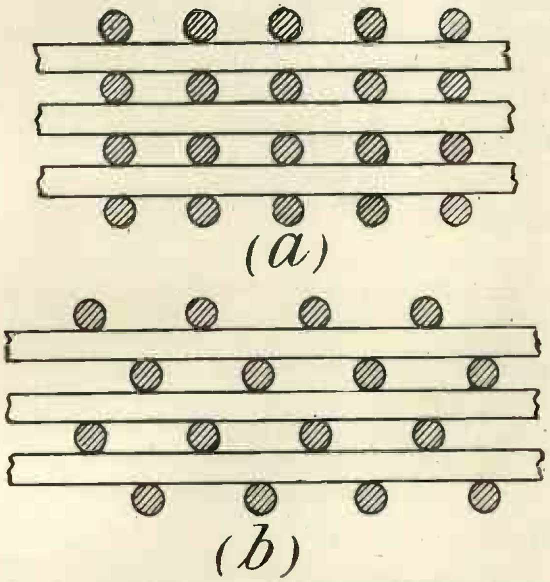


Fig. 9. Sections of honeycomb and duo-lateral windings.

layers. If greater openness of winding were required, to give a coil of greater bulk and extra low self-capacity, one could put the same number of turns into 7 layers, which would require 10 turns per layer, and therefore one would have to "count" 5 pins at each crossover.

The number of pins on the former may be any convenient figure, from 10 to 20 in each row, in the case of the honeycomb, but has to be one of certain definite numbers in the case of the duo-lateral. This latter coil is of a very similar cellular structure to the honeycomb, the difference being that in the duo-lateral the turns in one layer do not lie exactly above those in the one beneath, but come over the spaces between them. Fig. 9 shows this difference by means of sections through (*a*) a honeycomb, and (*b*) a duo-lateral winding. It is evident that the latter has nearly three times the space separating the turns in a vertical direction, and its capacity is, therefore, lower. The reduction is sufficiently considerable to make the duo-lateral almost universally used, the simple honeycomb now being rarely met with.

The actual difference in winding which produces the duo-lateral formation is difficult to describe, and, besides taking much space, would be of little interest or assistance. If the experimenter employs the following data and winds a coil, he will obtain a clearer idea of its structure than many pages of description could give him. To construct the duo-lateral winding it is necessary to use a former upon which the pins are separated by an *odd* number of degrees. Thus, 24 pins per row (48 in all) will fulfil the requirements. Also, certain fixed numbers must be counted at each cross-over in winding. Those most commonly used are 6, 7, and 9.

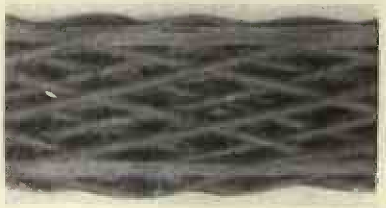


Fig. 10. An enlarged view of a portion of a duo-lateral coil.

One or two points deserve mention concerning the practical details of winding. It is desirable to tie the first and last turns above and below respectively at two or three points with thread, to prevent any unwinding of the coil during the operation of mounting on a plug when finished. In order to be able to remove the coil from the former easily after it has been soaked in wax and cooled, it is essential to make use of some such device as to wind upon the former a single layer of sewing cotton before starting the coil. Fasten the two ends of the layer of cotton where they will be easily got at, then after waxing the coil and extracting the pins, you can pull out the cotton and the coil will slip off quite freely. Finally, great care should be taken to drain all superfluous wax out of the coil, lest the interspaces of the winding remain filled with wax when cool, which would, of course, increase the self-capacity considerably.

This concludes our articles on the winding of multi-layer coils. In a future issue we hope to give details of methods of mounting them on plugs.

A GLOSSARY OF TECHNICAL TERMS USED IN WIRELESS TELEGRAPHY AND TELEPHONY

(*Continued from page* 236.)

Coupling, Direct or Conductive

Comprises a metallic connection between the two circuits.

Coupling, Electrostatic

Any method depending on the use of condensers, by which some proportion of the voltage in one circuit is impressed on the other.

Coupling, Intervalve

The method by which the output current of one valve is made to affect the input circuit of another.

Coupling, Intervalve Resistance

A method by which the varying anode current of one valve sets up varying voltages across a resistance, these being utilised to affect the grid of the next. Suitable for all but short wavelengths, but surpassed by transformer coupling at audio frequencies. Needs no tuning.

Coupling, Intervalve Reactance

A choke coil is substituted for the resistance above mentioned. Suitable for all frequencies with appropriate chokes, air or iron-core, but mostly used on short waves. May be sharply or flatly tuned, according to design.

Coupling, Intervalve Transformer

The best method for audio-frequency work. Also largely used for H.F., especially for short waves.

Coupling, " Loose "

A colloquial term—often used to include forms other than direct. It is an inexact expression when used in this sense ; properly, it conveys nothing as to the *method* of coupling, and merely implies that the *amount* is small. *See* Coupling, Coefficient of.

Coupling, Magnetic

The favourite method, depending on the use of coils so placed that the magnetic field of one partly embraces the other, one coil being in each of the circuits to be coupled.

Crystal

See Detector.

Current

The flow of electricity. Various types of current are particularised below.

Current, Alternating (A.C.)

A current whose direction is regularly reversed. The number of double reversals per second is known as the Frequency (*q.v.*).

Current, Continuous (C.C.)

A current whose direction is unchanged and whose amount is more or less constant, or at any rate undergoes no rapid periodic change.

Current, Direct (D.C.)

Continuous current.

Current, Eddy

A current induced in a solid conductor by varying currents in the neighbourhood. A serious source of loss in wireless work. *See* Losses.

Current, High Frequency

Oscillatory current.

Current, Oscillatory or Oscillating

An alternating current of high (radio) frequency.

Current, Pulsating

A current undergoing regular changes in amount but not in direction.

Current, Thermionic

The current formed by the stream of electric charges carried by electrons between filament and anode in a valve.

D

Damped Oscillations

Owing to unavoidable losses, oscillations set up in any circuit gradually decrease in amplitude unless energy is steadily supplied. Such decreasing oscillations are " damped."

Damped Wave

The type of ether disturbance radiated from an aerial in which damped oscillations are taking place.

(*To be continued.*)

THE PROGRESS OF AMATEUR RADIO

By PHILIP R. COURSEY, B.Sc., F.Inst.P., A.M.I.E.E.

Some conclusions from the Transatlantic tests, to whose success the writer's work contributed materially.

RECENT events have demonstrated that amateur radio activities have progressed beyond the limitations of town or state, beyond even the bounds of country or continent, and are fast becoming world-wide in their scope. The Transatlantic tests which were held in December of last year have demonstrated that by means of short wave-length transmissions from stations of comparatively low power, not only telegraphic messages, but the human voice as well can be transmitted across the Atlantic between amateur radio stations in America and Europe. During these tests signals were successfully transmitted not only from America to Europe, but also from both France and Great Britain back to America.

The most striking feature of the tests was the large number of receptions made in England and France of American amateur signals. Contrary to the results obtained in the previous year's tests, the stations heard were in this case scattered almost all over the United States, while a few were picked up from Canada, and one from the West Indies. Naturally of the 2,000 odd receptions of American stations which were reported in this country during the ten nights of the tests, a large proportion were near the American seaboard, since the signals from those stations farther west have to traverse a large part of Canada on their way to England. It is noteworthy, however, that signals, including code words, were intercepted from a United States station situated not far from the Pacific Coast, and the magnitude of this accomplishment may perhaps be emphasised by pointing out that this station is at approximately the same distance from London as is the centre of India. Verified code-word transmissions were received in England from 94 out of a total of 324 stations which were given individual transmission periods during the tests. The total number of stations reported was 507.

The above photograph shows a silver Waltham watch presented to Mr. P. R. Coursey, B.Sc., F.Inst.P., A.M.I.E.E., by the editor and proprietors of "Modern Wireless," as a token of their appreciation of the work which he did in connection with the recent Transatlantic tests.

It would appear from the results of these tests that during the past year the attention paid by amateur experimenters in this country to working on 180- and 200-metre signals has led to the development of receiving apparatus which is specially adapted to the reception of weak signals on these wave-lengths, and that their development accounts for the main part of the recent results.

It is noteworthy also in connection with these tests that some signals were heard on every night, although the number varied in a very marked manner. These changes, it would seem, must be due to variations in the transmission qualities of the Atlantic, since on one night in particular the number of signals recorded was extremely small, the bad transmission also being maintained during the next night until about 5 a.m., when a very sudden change was reported in the form of a rapid increase of signal strength which led to the reception of a considerable number of stations during the remaining three-quarters of an hour of the test period up to 6 a.m. On one night, too, in particular, the transmission qualities appeared to be extraordinarily good, as a very large number of receptions were reported from all parts of the country.

These variations in the transmission qualities of the Atlantic are apparently, however, in part at least, localised in their effects, since what was the worst night of the tests as far as English receptions were concerned was apparently about normal for reception in France, thus suggesting, if anything, something akin to the formation of a shadow which may move from place to place, thus fairly suddenly removing its effects from one part and blocking another.

The transmission of amateur radio signals over long distances is not, however, confined to the Atlantic, since records have recently been obtained to the effect that signals from the western states of America have been read off the coasts of Japan and also in Australia.

Such tests as the foregoing may be the means of carrying on extensive investigations into these peculiar transmission phenomena, as well as into the question of fading, an effect which causes the strength of the received signals to vary considerably from moment to moment. Both these phenomena are very commonly attributed to the Heaviside layer, but it would seem that further information as to the nature of the phenomena, and in particular their variations from place to place and at different times of the year, would be very desirable. These effects, too, may also be different for transmissions in different directions across the Atlantic, since although the transatlantic tests showed that signals could as easily be sent from England to America as from America to England, using approximately the same power and wavelength, yet it by no means follows that such transmission in opposite directions is subject to the same fading phenomena at the same time.

In the United States one of the main objects of the American Radio Relay League and similar organisations is to further the arrangements for the transmission of messages and other similar radio traffic between different parts of the country solely through the medium of amateur radio stations, and their enthusiasm for developing long-distance records has undoubtedly been the means of stimulating interest in Europe on such communication; but whether such interest will ever reach to the extent of co-operating with the Americans in the establishment of regular relay routes for amateur messages it is rather difficult to foresee. International co-operation for the purposes of definite experimental investigations, such as those mentioned above, is, however, highly desirable. The assistance of many observers is also of great value in any such investigations, since it thus becomes possible to obtain much more valuable information than is obtainable from isolated scientific investigations in the different countries.

In any case, however, such communications would necessarily be of a rather variable nature, and would in no way achieve the reliability of long-distance commercial radio service. Under normal conditions, however, such transmissions might vie with the commercial services on the point of rapidity, as is instanced by a recent case in which an amateur message dispatched from near the Atlantic coast of America was relayed to the addressee in the Hawaiian Islands, and a reply received back again in less than 4½ minutes.

This extension of the bounds of amateur radio communications has brought to light a difficulty which can only be remedied satisfactorily by proper international agreements. The call-signs allocated to amateur transmitting stations are usually prefixed by a figure, but these initial figures are not confined to different countries, with the result that there are now within signalling range of each other several stations holding the same call-signs. Various schemes have been formulated for overcoming this difficulty, but not all of them are workable under the existing regulations of some of the countries concerned. Some form of international regulation of the allocation of amateur call-signs has now become necessary, and it is to be hoped that some such course will be adopted in the near future. Amateur radio has now reached such a stage of development as should entitle it to adequate representation and consideration at future International Radio Conventions.

THE DATE OF PUBLICATION OF "MODERN WIRELESS"

Commencing with this number, MODERN WIRELESS will appear on the first of each month. We think our readers will find this arrangement a more convenient one.

UP-TO-DATE LIST OF AMERICAN BROADCASTING STATIONS

All stations operate on 360 metres, except as below.

*Those with * on 400 ; † on 485 ; o following any sign indicates "only" ; thus †o means 485 metres only.*

Call Letter	Name	City and State
KDKA	Westinghouse Elec. & Mfg. Co.,	East Pittsburgh, Pa.
†KDN	Leo. J. Meyberg Co.,	San Francisco, Cal.
KDPM	Westinghouse Elec. & Mfg. Co.,	Cleveland, Ohio
KDPT	Southern Electrical Co.,	San Diego, Cal.
†KDYL	Telegram Publishing Co.,	Salt Lake City, Utah
KDYM	Savoy Theatre	San Diego, Cal.
KDYO	Carlson & Simpson...	San Diego, Cal.
†KDYQ	Oregon Inst. of Technology,	Portland, Ore.
KDYS	Great Falls Tribune,	Great Falls, Mont.
KDYV	Cope & Cornwell Co.,	Salt Lake City, Utah
KDYW	Radio Dept. Smith Hughes Machinery Co.......	Phœnix, Ariz.
KDYX	Honolulu Star Bulletin,	Honolulu, T.H.
KDYY	Rocky Mountain Radio Corp.,	Denver, Colo.
KDZA	Arizona Daily Star....	Tucson, Ariz.
KDZB	Frank E. Siefert....	Bakersfield, Cal.
KDZE	The Rhodes Co.......	Seattle, Wash.
KDZF	Automobile Club of Southern California........	Los Angeles, Cal.
KDZG	Cyrus Pierce & Co.,	San Francisco, Cal.
†KDZH	Fresno Evening Herald..	Fresno, Cal.
KDZI	Electric Supply Co.,	Wenatchee, Wash.
KDZK	Nevada Machinery & Elec. Co.,	Reno, Nev.
KDZL	Rocky Mountain Radio Corp.,	Ogden, Utah
KDZM	E. A. Hollingsworth,	Centralia, Wash.
KDZP	Newbery Electric Corp.,	Los Angeles, Cal.
KDZQ	Wm. D. Pyle Motor Generator Co.,	Denver, Colo.
KDZR	Bellingham Publishing Co.,	Bellingham, Wash.
KDZT	Seattle Radio Association,	Seattle, Wash.
KDZW	Claude W. Gerdes,	San Francisco, Cal.
KDZX	Glad Tidings Tabernacle,	San Francisco, Cal.
KDZZ	Kinney Bros. & Sipprell,	Everett, Wash.
KFAC	Glendale Daily Press..	Glendale, Cal.
KFAD	McArthur Bros., Mercantile Co.,	Phœnix, Ariz.
KFAE	State College of Washington,	Pullman, Wash.
KFAF	Western Radio Corp...	Denver, Colo.
KFAJ	University of Colorado,	Boulder, Colo.
KFAN	The Electric Shop....	Moscow, Idaho
KFAP	Stand Publishing Co...	Butte, Mont.
KFAQ	City of San José......	San José, Cal.
KFAR	Studio Lighting Service Co.,	Hollywood, Cal.
KFAS	Reno Motor Supply Co.,	Reno, Nev.
KFAT	S. T. Donohue.........	Eugene, Ore.
†KFAU	High School..........	Boise, Idaho
KFAV	Abbot Kinney Co......	Venice, Cal.
KFAW	Register-Radio-Den-Radiophone,	Santa Ana, Cal.
†KFAY	Virgin Radio Service..	Medford, Ore.
KFAZ	C. H. Weatherill......	Reedley, Cal.
KFBB	F. A. Buttrey & Co...	Havre, Mont.
KFBC	Normal Heights Station (W. K. Azbill)....	San Diego, Cal.
KFBD	Mercantile Trust Co....	Hanford, Cal.
KFBE	R. H. Horn (Cline's Electric Shop)......	San Luis Obispo, Cal.
KFBG	First Presbyterian Church,	Tacoma, Wash.
KFBH	Thomas Musical Co.,	Marshfield, Ore.
†KFBK	Kimball-Upson Co...	Sacramento, Cal.
KFBL	Leese Bros...........	Everett, Wash.
KFBM	Cook & Foster & Astoria Hardware Co.......	Astoria, Ore.
KFBN	Borch Radio Corp. (Portable)..	Cal.
KFBQ	Savage Electric Co...	Prescott, Ariz.
KFBS	Trinidad Gas & Electric Co. and Chronicle News....	Trinidad, Colo.
KFBU	The Cathedral (Bishop Thomas),	Laramie, Wyo.
KFBV	Clarence O. Ford,	Colorado Springs, Colo.
†KFC	Northern Radio & Electric Co.,	Seattle, Wash.
KFCB	Nielsen Radio Supply Co.,	Phœnix, Ariz.
KFCC	Auto Supply Co......	Wallace, Idaho
KFCD	Salem Electric Co......	Salem, Ore.
KFCF	Frank A. Moore..	Walla Walla, Wash.
KFCH	Electric Service Station, Inc.,	Billings, Mont.
KFCK	Colorado Springs Radio Co.,	Colorado Springs, Colo.
†oKFCL	Los Angeles Union Stock Yards,	Los Angeles, Cal.
KFCM	Richmond Radio Shop,	Richmond, Cal.
KFCQ	Motor Service Station (Norman R. Hood)..	Casper, Wyo.
KFDA	Adler's Music Store......	Baker, Ore.
KFDB	John D. McKee..	San Francisco, Cal.
KFDC	Radio Supply Co. (E. B. Craney),	Spokane, Wash.
KFDD	St. Michael's Cathedral..	Boise, Idaho
KFDF	Wyoming Radio Corp..	Casper, Wyo.
KFDH	University of Arizona,	Tucson, Ariz.
KFDJ	Oregon Agricultural College,	Corvallis, Ore.
KFDL	Knight-Campbell Music Co.,	Denver, Colo.
KFEB	City of Taft............	Taft, Cal.
KFEC	Meier & Frank Co.....	Portland, Ore.
KFED	Billings Polytechnic Inst.,	Polytechnic, Mont.
KFEJ	Guy Greason........	Tacoma, Wash.
KFEP	Radio Equipment Co...	Denver, Colo.
KFFA	Dr. R. O. Shelton..	San Diego, Cal.
KFFE	Eastern Oregon Radio Co.,	Pendleton, Ore.
KFGG	Astoria Budget........	Astoria, Ore.
KFGH	Stanford University,	Stanford University, Cal.
KFHJ	Fallon Co........	Santa Barbara, Cal.
KFI	Earle C. Anthony, Inc.,	Los Angeles, Cal.
KFV	Foster-Bradbury Radio Store,	Yakima, Wash.
KFZ	The Doerr Mitchell Elec. Co.,	Spokane, Wash.
KGB	Wm. A. Mullins Electric Co.,	Tacoma, Wash.
KGG	Hallock & Watson Radio Service,	Portland, Ore.
KGN	North-west Radio Mfg. Co.,	Portland, Ore.
KGO	Altadena Radio Laboratory,	Pasadena, Cal.
KGU	Marion A. Mulroney,	Honolulu, Hawaii
*oKGW	Portland Morning Oregonian,	Portland, Ore.
KGY	St. Martin's College....	Lacey, Wash.
†KDH	C. F. Aldrich Marble & Granite Co.,	Colorado Springs, Colo.
*KHJ	Times Mirror Co...	Los Angeles, Cal.
KHQ	Louis Wasmer	Seattle, Wash.
KJC	Standard Radio Co..	Los Angeles, Cal.
KJJ	The Radio Shop....	Sunnyvale, Cal.
KJQ	C. O. Gould........	Stockton, Cal.
KJR	Vincent I. Kraft (operated by North-west Radio Service),	Seattle, Wash.
KJS	Bible Institute of Los Angeles,	Los Angeles, Cal.
KLB	J. J. Dunn & Co.....	Pasadena, Cal.
KLN	Monterey Electric Shop,	Del Monte, Cal.
KLP	Colin B. Kennedy Corp.,	Los Altos, Cal.
KLS	Warner Bros.........	Oakland, Cal.
KLX	Oakland Tribune......	Oakland, Cal.
†KLZ	Reynolds Radio Co...	Denver, Colo.
KMC	W. W. Lindsay, Jr.....	Reedley, Cal.
†KMJ	San Joaquin Light & Power Corp.,	Fresno, Cal.
KMO	Love Electric Co.....	Tacoma, Wash.
KNI	T. W. Smith..........	Eureka, Cal.
*KNJ	Roswell Public Service Co.,	Roswell, N. Mex.
KNN	Bullock's..........	Los Angeles, Cal.
KNT	Gray's Harbor Radio Co. (Walter Hemrich)........	Aberdeen, Wash.
KNV	Radio Supply Co...	Los Angeles, Cal.
KNX	Electric Lighting Supply Co.,	Los Angeles, Cal.
†oKOA	Young Men's Christian Assoc.,	Denver, Colo.
†KOB	New Mexico College of Agriculture and Mechanic Arts,	State College, N. Mex.
KOG	Western Radio Electric Co.,	Los Angeles, Cal.
KON	Holzwasser, Inc.....	San Diego, Cal.
KOP	Detroit Police Dept...	Detroit, Mich.
KPO	Hale Bros........	San Francisco, Cal.
KQI	University of California,	Berkeley, Cal.
KQP	Hood River News (Radio Shop of Hood River)....	Hood River, Ore.
KQV	Doubleday Hill Elec. Co.,	Pittsburgh, Pa.
KQW	Chas. D. Herrold....	San José, Cal.
KQY	Stubbs Electric Co.....	Portland, Ore.
KRE	Maxwell Electric Co...	Berkeley, Cal.
*†oKSD	Post Dispatch........	St. Louis, Mo.
KSL	The Emporium...	San Francisco, Cal.
KSS	Prest & Dean Radio Co.,	Long Beach, Cal.
KTW	First Presbyterian Church,	Seattle, Wash.
†KUO	San Francisco Examiner,	San Francisco, Cal.
KUS	City Dye Works & Laundry Co.,	Los Angeles, Cal.
KUY	Coast Radio Co., Inc..	El Monte, Cal.
KVQ	Sacramento Bee (Jos. McClatchy Co.)	Sacramento, Cal.
KWG	Portable Wireless Telephone Co.,	Stockton, Cal.
†KWH	Los Angeles Examiner,	Los Angeles, Cal.
KXD	Herald Publishing Co...	Modesto, Cal.
KXS	Braun Corp.	Los Angeles, Cal.
KYI	Bakersfield Californian,	Bakersfield, Cal.
†KYJ	Leo J. Meyberg Co...	Los Angeles, Cal.
KYQ	Electric Shop......	Honolulu, Hawaii
*†oKYW	Westinghouse Elec. & Mfg. Co.,	Chicago, Ill.
KYY	Radio Telephone Shop,	San Francisco, Cal.
KZC	Public Market & Dept. Stores Co.,	Seattle, Wash.
†KZM	Preston D. Allen....	Oakland, Cal.
†KZN	The Deseret News,	Salt Lake City, Utah
KZV	Wenatchee Battery & Motor Co.,	Wenatchee, Wash.
KZY	Atlantic & Pacific Radio Supply Co.,	San Francisco, Cal.
WAAC	Tulane University..	New Orleans, La.
WAAD	Ohio Mechanics Institute,	Cincinnati, Ohio
†WAAF	Chicago Daily Drover's Journal,	Chicago, Ill.
WAAH	Radio Dept. Commonwealth Electric Co..........	St. Paul, Minn.
WAAJ	Eastern Radio Institute,	Boston, Mass.
†WAAK	Gimbel Bros.......	Milwaukee, Wis.
WAAL	Anderson Beamish Elec. Co.,	Minneapolis, Minn.
WAAM	I. R. Nelson Co.......	Newark, N.J.
†WAAN	University of Missouri,	Columbia, Mo.
†WAAP	United Electric Co...	Wichita, Kans.
WAAQ	New England Motor Sales Co.,	Greenwich, Conn.

Call Letter.	*Name.*	*City and State.*
WAAS	Georgia Radio Co.	Decatur, Ga.
†WAAW	Omaha Grain Exchange	Omaha, Nebr.
WAAX	Radio Service Corp.	Crafton, Pa.
WAAY	Yahrling-Rayner Music Co.	Youngstown, Ohio
WAAZ	Hollister-Miller Motor Co.	Emporia, Kansas
†WAH	Midland Refining Co.	El Dorado, Kansas
WBAA	Purdue University	West Lafayette, Ind.
WBAB	Andrew J. Potter	Syracuse, N.Y.
WBAD	Sterling Electric Co.	Minneapolis, Minn.
WBAF	Fred M. Middleton	Moorestown, N.J.
†WBAG	Diamond State Fibre Co.	Bridgeport, Pa.
WBAH	The Dayton Co.	Minneapolis, Minn.
WBAJ	The Marshall Gerken Co.	Toledo, Ohio
WBAN	Wireless Phone Corp.	Paterson, N.J.
WBAO	James Millikin University	Decatur, Ill.
*†oWBAP	Wortham-Carter Pub. Co.	Fort Worth, Texas
WBAU	Republican Publishing Co.	Hamilton, Ohio
†WBAV	Erner & Hopkins	Columbus, Ohio
WBAW	Marietta College	Marietta, Ohio
WBAX	John H. Stenger, Jr.	Wilkes-Barre, Pa.
*oWBAY	American Tel. & Tel. Co.	New York, N.Y.
WBL	T. & H. Radio Co.	Anthony, Kansas
WBS	D. W. May, Inc.	Newark, N.J.
†WBT	Southern Radio Corp.	Charlotte, N.C.
WBU	City of Chicago	Chicago, Ill.
*oWBZ	Westinghouse Elec. & Mfg. Co.	Springfield, Mass.
WCAB	Newburgh Daily News	Newburgh, N.Y.
†oWCAC	John Fink Jewelry Co.	Fort Smith, Ark.
WCAD	St. Lawrence University	Canton, Ohio
*oWCAE	Kaufman & Baer Co.	Pittsburgh, Pa.
WCAG	Daily States Pub. Co.	New Orleans, La.
WCAH	Entrekin Electric Co.	Columbus, Ohio
†WCAJ	Nebraska Wesleyan University	University Place, Nebr.
WCAK	Alfred P. Daniel	Houston, Texas
WCAL	St. Olaf College	Northfield, Minn.
WCAM	Villanova College	Villanova, Pa.
WCAO	Sanders and Stayman Co.	Baltimore, Md.
†WCAP	Central Radio Service	Decatur, Ill.
WCAQ	Tri-State Radio Mfg. & Supply Co.	Defiance, Ohio
WCAR	Alamo Radio Elec. Co.	San Antonio, Texas
WCAS	Wm. Hood Dunwoody Industrial Institute	Minneapolis, Minn.
†oWCAT	S. Dakota School of Mines	Rapid City, S. Dak.
†WCAU	Philadelphia Radiophone Co.	Philadelphia, Pa.
WCAV	J. C. Dice Electric Co.	Little Rock, Ark.
†WCAW	Quincy Electric Supply Co.	Quincy, Ill.
WCAX	University of Vermont	Burlington, Vt.
WCAY	Kesselman O'Driscoll Co.	Milwaukee, Wis.
WCAZ	Robt. E. Compton and Carthage College	Carthage, Ill.
WCE	Findley Electric Co.	Minneapolis, Minn.
WCK	Stix Baer & Fuller Co.	St. Louis, Mo.
†WCM	University of Texas	Austin, Texas
†WCN	Clark University	Worchester, Mass.
*†oWCX	The Detroit Free Press	Detroit, Mich.
*†oWDAC	Illinois Watch Co.	Springfield, Ill.
†WDAE	Tampa Daily Times	Tampa, Fla.
*†oWDAF	Kansas City Star	Kansas City, Mo.
WDAG	J. Laurance Martin	Amarillo, Texas
†WDAH	Mine & Smelter Supply Co.	El Paso, Texas
†WDAI	Hughes Electrical Corp.	Syracuse, N.Y.
†WDAJ	Atlanta & West Point R. R. Co.	College Park, Ga.
WDAK	The Hartford Courant	Hartford, Conn.
†WDAL	Florida Times-Union	Jacksonville, Fla.
WDAO	Automotive Elec. Co.	Dallas, Texas
WDAP	Midwest Radio Central, Inc.	Chicago, Ill.
WDAQ	Hartman Riker Elec. & Machine Co.	Brownsville, Pa.
WDAR	Lit Bros.	Philadelphia, Pa.
WDAS	Samuel A. Waite	Worcester, Mass.
WDAU	Slocum & Kilburn	New Bedford, Mass.
WDAV	Muskogee Daily Phœnix	Muskogee, Okla.
WDAX	First National Bank	Centerville, Iowa
†WDAY	Fargo Radio Service Co.	Fargo, N. Dak.
WDM	Church of the Covenant	Washington, D.C.
WDT	Ship Owners Radio Service	New York, N.Y.
WDV	John O. Yeiser, Jr.	Omaha, Nebr.
WDY	Radio Corp. of America	Roselle Park, N.J.
WDZ	J. L. Bush	Tuscola, Ill.
WEAA	Fallian & Lathrop	Flint, Mich.
†WEAB	Standard Radio Equipment Co.	Fort Dodge, Iowa
†WEAC	Baines Electric Service Co.	Terre Haute, Ind.
WEAD	Northwest Kansas Radio Supply Co.	Atwood, Kansas
WEAE	Virginia Polytechnic Inst.	Blacksburg, Va.
*oWEAF	Western Electric Co.	New York, N.Y.
WEAG	Nichols-Hineline-Bassett Laboratory	Edgewood, R.I.
†WEAH	Wichita Board of Trade & Lander Radio Co.	Wichita, Kansas
WEAI	Cornell University	Ithaca, N.Y.
WEAJ	University of So. Dakota	Vermillon, S. Dak.
WEAK	Julius B. Abercrombie	St. Joseph, Mo.
WEAM	Borough of No. Plainfield	North Plainfield, N.J.
†WEAN	Shepard Co.	Providence, R.I.
†WEAO	Ohio State University	Columbus, Ohio
†WEAP	Mobile Radio Co.	Mobile, Ala.
WEAR	Baltimore American & News Publishing Co.	Baltimore, Md.
WEAS	Hecht Co.	Washington, D.C.
WEAT	John J. Fogarty	Tampa, Fla.
WEAU	Davidson Bros. Co.	Sioux City, Iowa
WEAV	Sheridan Electric Service Co.	Rushville, Nebr.
WEAW	Arrow Radio Laboratories	Anderson, Ind.
†WEAX	T. J. M. Daly	Little Rock, Ark.
WEAY	Will Horwitz, Jr.	Houston, Tex.
WEB	Benwood Co.	St. Louis, Mo.
†WEH	Midland Refining Co.	Tulsa, Okla.
†WEV	Hurlburt-Still Electrical Co.	Houston, Tex.
†WEW	St. Louis University	St. Louis, Mo.
†WEY	Cosradio Co.	Wichita, Kansas
*†oWFAA	Dallas News-Dallas Journal	Dallas, Tex.
WFAB	Carl F. Woese	Syracuse, N.Y.
WFAC	Superior Radio Co.	Superior, Wis.
WFAD	Watson Weldon Co.	Salina, Kansas
WFAF	H. C. Spratley Radio Co.	Poughkeepsie, N.Y.
WFAG	The Radio Engineering Laboratory	Waterford, N.Y.
WFAH	Electric Supply Co.	Port Arthur, Texas
WFAJ	Hi-Grade Wireless Instrument Co.	Ashville, N.C.
WFAM	Times Publishing Co.	St. Cloud, Minn.
†WFAN	Hutchinson Electric Service Co.	Hutchinson, Minn.
WFAQ	Missouri Wesleyan College & Cameron Radio Co.	Cameron, Mo.
WFAS	United Radio Corp.	Fort Wayne, Ind.
†WFAT	Daily Argus Leader	Sioux Falls, So. Dak.
WFAU	Edwin C. Lewis	Boston, Mass.
†WFAV	University of Nebraska	Lincoln, Nebr.
WFAW	Miami Daily Metropolis	Miami, Fla.
WFAY	Daniels Radio Supply Co.	Independence, Kansas
†WFAZ	South Carolina Radio Shop	Charleston, So. Car.
*†oWFI	Strawbridge & Clothier	Philadelphia, Pa.
WGAB	ORV Radio Co.	Houston, Tex.
WGAD	Spanish American School of Radio-telegraphy	Ensenada, P.R.
WGAH	New Haven Electric Co.	New Haven, Conn.
WGAI	W. H. Gass	Shenandoah, Iowa
WGAK	Macon Electric Co.	Macon, Ga.
WGAL	Lancaster Elec. Supply & Construction Co.	Lancaster, Pa.
WGAM	Orangeburg Radio Equipment Co.	Orangeburg, So. Car.
WGAN	Cecil E. Lloyd	Pensacola, Fla.
WGAQ	Glenwood Radio Corp.	Shreveport, La.
†WGAR	Southwest American	Fort Smith, Ark.
WGAS	The Ray-Di-Co. Organisation	Chicago, Ill.
WGAT	American Legion, Dept. of Nebraska	Lincoln, Nebr.
WGAU	Marcus G. Limb	Wooster, Ohio
WGAW	Ernest C. Albright	Altoona, Pa.
WGAX	Radio Electric Co.	Washington Court House, Ohio
WGAY	Northwestern Radio Co.	Madison, Wis.
WGAZ	South Bend Tribune	South Bend, Ind.
†WGF	The Register & Tribune	Des Moines, Iowa
†WGI	American Radio & Research Corp.	Medford Hillside, Mass.
WGL	Thos. F. J. Howlett	Philadelphia, Pa.
*oWGM	Atlanta Constitution	Atlanta, Ga.
†WGR	Federal Telephone & Telegraph Co.	Buffalo, N.Y.
†WGV	Interstate Electric Co.	New Orleans, La.
*†oWGY	General Electric Co.	Schenectady, N.Y.
†WHA	University of Wisconsin	Madison, Wis.
WHAA	State University of Iowa	Iowa City, Iowa
†WHAB	Clark W. Thompson (Fellman's Dry Goods Co.)	Galveston, Tex.
WHAC	Cole Bros., Electric Co.	Waterloo, Iowa
†WHAD	Marquette University	Milwaukee, Wis.
WHAE	Automotive Electric Service Co.	Sioux City, Iowa
WHAF	Radio Electric Co.	Pittsburgh, Pa.
WHAG	University of Cincinnati	Cincinnati, Ohio
WHAH	Hafer Supply Co.	Joplin, Mo.
WHAI	Radio Equipment & Mfg. Co.	Davenport, Iowa
WHAK	Roberts Hdwe. Co.	Clarksburg, W. Va.
WHAL	Lansing Capital News	Lansing, Mich.
†WHAM	University of Rochester	Rochester, N.Y.
WHAO	Frederic A. Hill	Savannah, Ga.
WHAP	Otta and Kuhns	Decatur, Ill.
WHAQ	Semmes Motor Co.	Washington, D.C.
WHAR	Paramount Radio & Elec. Co.	Atlantic City, N.J.
†WHAS	Courier-Journal and Louisville Times	Louisville, Ky.
WHAV	Wilmington Electrical Specialty Co., Inc.	Wilmington, Del.
WHAW	Pierce Electric Co.	Tampa, Fla.
WHAY	The Huntington Press	Huntington, Ind.
*oWHAZ	Rensselaer Polytechnic Inst.	Troy, N.Y.
*†oWHB	Sweeney School Co.	Kansas City, Mo.
WHD	West Virginia University	Morgantown, W. Va.
WHK	Radiovox Co. (Warren R. Cox)	Cleveland, Ohio
WHN	Ridgewood Times Publishing Co.	Ridgewood, N.Y.
†WHU	Wm. B. Duck Co.	Toledo, Ohio
†oWHW	Stuart W. Seeley	East Lansing, Mich.
WIAB	Joslyn Automobile Co.	Rockford, Ill.
†WIAC	Galveston Tribune	Galveston, Texas
WIAD	Ocean City Yacht Club	Ocean City, N.J.
WIAE	Mrs. Robert E. Zimmerman	Vinton, Iowa
WIAF	Gustav A. De Cortin	New Orleans, La.
WIAH	Continental Radio & Mfg. Co.	Newton, Iowa
WIAI	Heer Stores Co.	Springfield, Mo.
WIAJ	Fox River Valley Radio Co.	Neenah, Wis.
†WIAK	Daily Journal-Stockman	Omaha, Nebr.
WIAO	School of Engineering & Wisconsin News	Milwaukee, Wis.
WIAQ	Chronicle Publishing Co.	Marion, Ind.
WIAR	Paducah Evening Sun	Paducah, Ky.
WIAS	Burlington Hawkeye & Home Electric Co.	Burlington, Iowa

(Continued on page 264.)

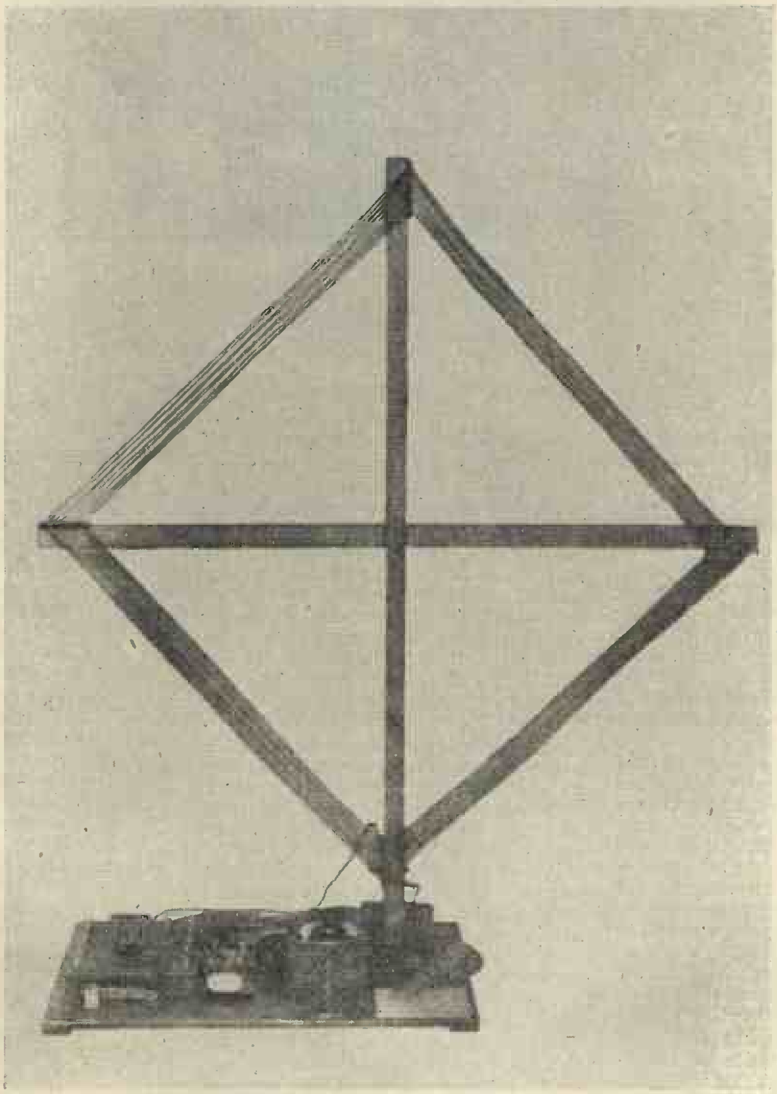
AN IMPROVED SINGLE-VALVE SUPER-REGENERATIVE RECEIVER

By A. D. COWPER, M.Sc., A.I.C., Associate Editor (Research), Radio Press.

The only published description giving full constructional details of the Armstrong receiver which won the first prize in the recent competition organised by the Radio Society of Great Britain. This receiver will be found extremely practical and simple in operation.

MANY amateur experimenters have been interested in the accounts recently published of the work of Major E. H. Armstrong and his disciples, chiefly on the other side of the Atlantic, with the super-regenerative principle, apparently first indicated by Turner (British Patent 130408), and by Captain Bolitho (B.P. 156330), and subsequently developed into a number of different circuits, using one, two or more valves, by Major Armstrong. Not a few enthusiasts, also, have tried one or other of the circuits indicated, very tersely, by Major Armstrong in his startling introduction of this most remarkable principle before the Institute of Radio Engineers on June 7 of last year; but it is a matter of common knowledge that very many found themselves baffled by the uncommon trickiness and apparent inherent instability of the circuits as published.

The single-valve circuit in particular has come in for a generous share of literary abuse and deprecation; the real reasons for this unanimity of distrust will be explained presently. Quite a number of versions, or alleged versions, of these circuits have been published recently, chiefly in the American radio press; some with what claimed to be practical constructional details, but in practically every case the warnings implied as to the importance of the precise relative positions of the parts, complication of adjustments, etc.; as to the wonderful assortment of howls obtainable in tuning-in, and the elaborate ceremony that this operation implied—apart altogether from the rather forbidding complication and expense of the lay-out—these were such as to discourage any but the most ambitious experimenter from tackling the job.



The receiver with the frame aerial in position.

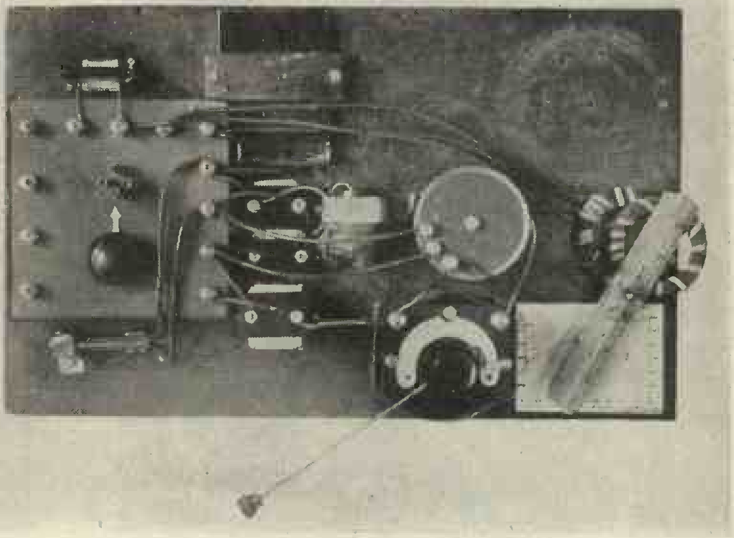
However, the recent competition organised by the Radio Society of Great Britain, with the aid of certain very generous firms and individuals who offered the prizes, for Armstrong Super-Regenerative Receivers, revived some interest in the problem of producing a practical working version of it in England; and at least two receivers, quite tamed and "possible," were produced for the competition. That others have also been successful here in operating these tricky circuits is indicated by occasional references in the press.

The extremely simple single-valve circuit is described here as worked out by the writer in connection with this competition—the original Armstrong one-valve, which in his original paper he warns others to beware of as "very critical in operation"—slightly altered in order to eliminate every detail that is not absolutely essential for successful operation, adjusted for use with English valves, and completely tamed and deprived of that inherent instability and fickleness, simply by putting in the right optimum values for the components (which published circuits hitherto have failed to do), and by attending to certain simple principles, the correct fulfilment of which is absolutely essential for any success. With these slight but important alterations, the circuit becomes a great deal more stable than an ordinary single valve with reaction; as easy to tune in as many crystal sets; quite indifferent as to exact distribution of parts, or exact values of components (so long as they are of the right order indicated here), and remarkably free from those irritating body-capacity effects which are the bane of small frame-aerial circuits—while still retaining that almost incredible sensitiveness and amplifying power with which Major Armstrong astonished his audience in the famous demonstration. But a word of warning: the signa strength obtainable with one valve will always be limited, even when using a small power valve, as is advisable.

It is understood, of course, that the circuit as described will be covered by various patents, and will be subject in use, accordingly, to the usual restrictions.

The lay-out is that of an experimenter's horizontal panel set, with separate 2-ft. square frame aerial, recently constructed by the writer as a modification of the portable receiver submitted by him for the Radio Society's competition, the alterations being made with a view to simplifying construction and for accessibility. The former receiver has also proved very successful and stable in operation.

Many components, including the conventional type of valve panel itself, already in the possession of the experimenter can be utilised — actually for many who may have the usual miscellaneous collection of scrap material and odd components, the only new fittings to be made or purchased are the two Armstrong inductances, Nos. 1,500 and 1,250 (or thereabouts), and their large bridging condensers. The *cost* of the whole apparatus, excluding batteries, 'phones and valve (which presumably will already be in the possession of anyone competent to attempt this circuit) need not exceed thirty shillings, if the Armstrong inductances and large condensers are at hand, or are made according to the instructions here; if Igranic, Burndept, or similar well-known coils and Dubilier condensers are purchased the cost will be some seventy shillings in all. The extra high tension can be readily obtained at 1*d*. a volt by purchasing pocket flash-lamp batteries by the dozen and building up the battery by soldering the longer brass strip of each to the shorter of the next in the usual manner—they will last quite a time with only one valve to feed.



A plan view of the receiver with the frame removed.

Range of the Receiver

This depends as much on the wavelength as on the actual power of the transmissions, as the amplification varies inversely as the square of the wavelength. The wavelength range is from about 260 to just under 600 metres with the frame aerial and 0·0005 μF. tuning condenser as shown. At the upper limit reception is no louder than with a good crystal and P.M.G. aerial (except that C.W. can be read). With telephony on medium wavelengths signal strength corresponds roughly to that with P.M.G. aerial and ordinary valve with reaction in skilful hands; but with powerful transmissions at only a few miles the limiting factor of the valve used comes in, so that "loud speaking" is barely attainable. On the shorter waves the Armstrong circuit really excels; amateur 10-watt transmissions at several miles coming out at loud-speaker strength. If the aerial is tapped so as to bring in the 200-metre transmissions, however, loud jamming from harmonics of commercial stations becomes unendurable. Between 300 and 400 metres loud stations can easily be read at 200 miles or more with careful tuning and if not too badly jammed. A larger frame brings them in a little clearer, but is clumsy to use.

Interference

No anxiety need be felt as to interference by radiation from the little frame aerial. The Armstrong "quenching" oscillation (on about 30,000 metres), which uses the greater part of the power of the valve, effectively checks the radio-frequency oscillation building up in the aerial from the tiny impetus given by the received signal, stopping it completely some 10,000 times a second and holding the circuit quiescent for one-half the whole time of operation. So that there is no steadily oscillating aerial—even a 2-ft. high one—to radiate disturbance, and critical tests show that an Armstrong receiver, if operating correctly at all, cannot be detected at a distance of a few yards, in fact, can be used in the same room, and even supplied off the same H.T. battery as a many-valve set receiving on the same wavelength. Only by extraordinary abuse or peculiarly close coupling can annoyance be caused.

Materials and Components

Wood: 6 ft. of 1 in. by 1 in.
- 4 in. by 4 in. by 1 in.
- 1 ft. by 1 ft. 6 in.; 3/8 in. thick; 2 battens.
- 2 strips, 6 in. by 7/8 in. by 1/2 in.
- Disc, 2 in. diam. by 1 in. thick.
- Penny ruler.
- Odd pieces for winding machine.

Fibre (or ebonite):
- Panel: 1/8 in. thick, 6 in. square (or 1/4-in. ebonite).
- 4 pieces, 2 1/2 in. by 1 in. (or 1/4-in. ebonite).
- 6 pieces 2 in. by 3 in. (for fixed condensers).
- 2 discs, 3 in. diam.

Wire: 1/2 lb. No. 18 s.c.c. for aerial.
- 2 oz. No. 22 s.c.c., for vario-coupler.
- 2 oz. No. 36 enamel, for Armstrong inductances.
- 4 oz. No. 32 enamel, for Armstrong inductances.
- 2 oz. No. 40 enamel, for auto-transformer.
- 1/4 lb. iron core-wire, 7 in. long (about No. 22), for transformer.
- 4 yds. No. 18 bare, for wiring.
- 1 yd. ordinary flex, for wiring.

Variable condenser, 0·0003 or 0·0005 μF.; parts, or complete. Fine adjustment handle.

1 1/2 doz. terminals.

4 valve sockets or legs.

1 filament resistance.

1 grid leak and condenser, 0·0002–0·0003 μF. and ½ megohm (or 1 megohm).

1 Mansbridge fixed condenser, 2 μF. or thereabouts.

3 fixed condensers, 0·005 to 0·007μF. (if obtainable), otherwise about 6 sq. ft. tin-foil with waxed paper.

1 ft. No. 2 B.A. screwed brass rod.

1 doz. nuts.

½ doz. large spacing washers.

4 yds. systoflex insulating sleeving.

Perforated zinc: 1 ft. by 1 ft. 6 in.; 14 in. by 3½ in.

Insulating tape; cardboard; waxed silk; small screws; brass scrap; paint, and shellac varnish.

Construction

The receiver can be divided roughly into four main parts—the aerial; the valve panel and accessories; the Armstrong inductances and condensers; the tuning devices, A.T.C. and vario-coupler.

Aerial

Any convenient frame aerial that is of low resistance and which will tune over the required range with a tuning condenser of reasonable size can be used. The shape or mode of winding is largely immaterial, though thick wire and good spacing gives better results. Even much smaller aerials can be used with success, but for convenience the 2-ft. frame seems to be a happy compromise. To build this two pieces of wood about 1 in. square are required, the one 34 in., the other 37 in. long. These are notched half-way through at 17 in. from either end and nailed together to form the cross of the aerial, then the odd long end is nailed into a notch cut in the middle of one side of a square of wood of 4 in. sides and 1 in. thick, which forms the base. The latter is bolted down, so that it rotates at will easily and steadily, by a No. 2 B.A. brass bolt in the centre to the base-board. Four combs of ⅛-in. fibre (or thicker ebonite) are required to hold and space the wire, each 2½ in. by 1 in., with nine notches ¼ in. deep at ¼-in. intervals along one side (which notches can be made slightly slanting with advantage). The four pieces are best held in a vice together, and the notches made by a thick hacksaw simultaneously. The combs are fixed by small screws along the ends of the cross, on corresponding sides, so that the bottoms of the notches are clear of the wood. The No. 18 s.c.c. wire is then wound in the notches, pulling it as tight and straight as possible, and fastening the ends through small holes in the fibre; these ends should be at the bottom of the aerial. A thick coat of shellac varnish, repeated as to the combs and the wires in the notches, finishes the frame aerial.

Base-board

This is made 1 ft. by 1 ft. 6 in. of ⅜ in. or similar thickness, with two stiffening battens at the ends. The bottom is covered with the perforated zinc, tacked on.

Panel

Any existing single-valve panel which shows terminals for "reaction" can be used if desired. Otherwise a square of ⅛-in. fibre, of 6 in. side (or thicker ebonite), is required. This is marked out and drilled, as indicated in the plan, for four valve-legs or sockets (best marked out by pressing a piece of stout paper on the pins of a valve—see that they are not bent first—placing on the panel and pricking through), for the stem of the filament resistance and for the twelve terminals which are arranged symmetrically round three sides. As purchased filament resistances vary in dimensions of stem and method of fixing, details are not given for this. It does not pay to make such a low-priced component.

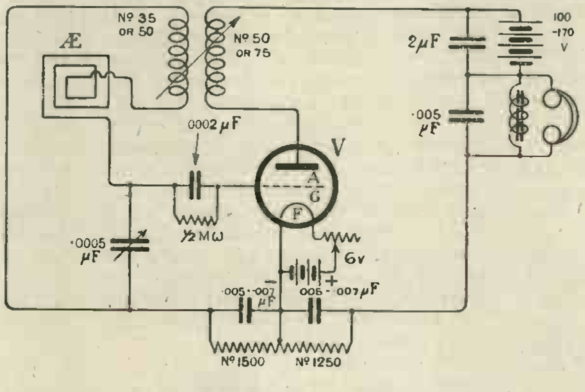


Fig. 1. The circuit of the receiver.

The simple wiring is done with No. 18 bare wire, cut to size and covered with systoflex insulating sleeving (see wiring diagram). The panel is mounted on two bearer pieces, 6 in. long by ¾ in. by ½ in., to give clearance for wiring, etc., and screwed to the base-board at one end, as shown in plan.

The accessories are arranged around the panel—grid condenser and leak on one side, Mansbridge blocking condenser and three 0·005 μF. phone and Armstrong bridging condensers along the other—all screwed down by neat brass screws to the base-board, on which are later mounted the phone transformer (if used), Armstrong inductances, A.T.C. and vario-coupler, in their places as indicated in the plan. When all accessories have been assembled and their places fixed a good coat of paint, followed by shellac varnish, will improve the appearance of the receiver. The panel itself, if of fibre, may also receive a coat of shellac varnish to avoid damp.

Values of Accessories

The value of the grid condenser is not critical—0·0002 to 0·0003 μF. is indicated as the customary value. For the leak, rather a lower value is preferable for steadiness. Existing 1 or 2 megohm leaks can be improved by a couple of thick lines of Indian ink drawn down them by a pen, smearing it well around the ends, so as to get something of the order of ½ megohm. The Mansbridge condenser calls for no comment; its exact value is immaterial. The phone blocking condenser must be of much higher than customary value in order to filter out to some extent the objectionable (but inevitable) high-pitched whistle of the Armstrong quenching oscillation. Condensers of this value (0·005 to 0·007 μF.) are not easily purchasable, though some makers (*e.g.* Dubilier) stock them; accordingly instructions are given in a later section for the construction of a tin-foil and wax-paper substitute.

An ordinary telephone transformer (which should be of a reliable make, as high voltages are used and the plate current at times may amount to 5 milliamperes) for low-resistance telephones is mounted in the middle of the board, next to the condensers. If it be preferred to use high-resistance phones, an auto-transformer should certainly be made up as described here to protect them from the unusually high plate voltage and current, and mounted by a thin metal strap passed round it and screwed down in the same position on the base-board.

Auto-transformer

A core about ⅜ in. in diameter and 7 in. long of iron core-wire is wrapped round for 1½ in. of its length in the middle with several thicknesses of waxed silk; waxed cardboard rings, 1½ in. in diameter, are fixed with paraffin wax so as to form cheeks on the wrapped portion, and 2 ozs. of No. 40 enamel-covered wire are wound between the cheeks, the starting end being brought out through a pinhole in one cheek. The winding is rapidly done by mounting the core, wired up into a solid rod, on a long knitting needle as spindle, in temporary bearings in the form of holes in a rough wooden frame, and driving the core by a belt from the family sewing machine, the spool of wire being mounted where the cotton reel is usually placed. When wound, the temporary spindle is removed, the hole filled up by a few more strands of iron wire, the bindings removed, the wire covered by a layer of insulating tape, through which the end is brought, then, protecting both loose ends of wire by insulating sleeving, the ends of the core wire are brought back over the windings in the usual way to complete the magnetic circuit, and the whole is finally taped over and mounted as described.

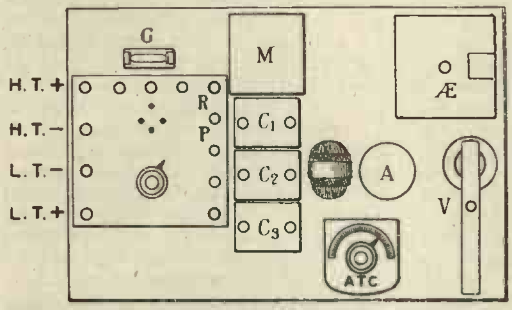


Fig. 2. *Plan of the base-board. Æ, frame aerial on base. A, Armstrong inductances. ATC, aerial tuning condenser. V, vario-coupler. M, Mansbridge blocking condenser. G, grid condenser and leak.* C_1, C_2, C_3, *telephone blocking, and Armstrong bridging condensers. R, reaction terminals. P, telephone terminals.*

Armstrong Inductances, etc.

For these, the coils No. 1,500 and 1,250 of Igranic, Burndept, or other well known make are indicated. They must be mounted with *fixed, close coupling*. The simple principles essential for success with this circuit, referred to in the introduction, are: (1) the necessity of producing a powerful quenching-frequency oscillation, and therefore of having a fixed, close coupling between the Armstrong inductances which produce this oscillation, together with maximum high-tension volts and maximum safe filament temperature; (2) of having exceedingly free and undamped high-frequency oscillations, built up in the minimum time, in the grid circuit, and therefore *large* bridging condensers across these Armstrong inductances, with minimum *effective* high frequency resistance. A considerable amount of careful experiment has shown that the optimum coupling with the duolateral type of coil is with centres at 1¼ in.; this gives a powerful oscillation of a frequency of the order of 10,000 cycles, with reasonable latitude for the superimposed high-frequency oscillations. Too close coupling must also be avoided, as it makes tuning impossibly narrow. (These are points about which published accounts of the circuits are almost unanimously silent.)

Occasionally wave-wound slab-coils (not solid waxed slabs) of about 1,000 turns are obtainable; these make almost ideal inductances for this purpose, mounted with distance-pieces of dry wood, etc., at about 1-in. centres, and fixed by a single centre bolt of No. 2 B.A. brass between fibre discs in the place indicated on the base-board. If coils with plug mounts are used, these can be taken off and the coils mounted as the slabs, or connection simply made to the mounts by soldered leads, and the coils laid down on the base-board with thin packing between. It is most inadvisable to use an ordinary stand tuner, as the coupling is bound to get loosened at some time, which will entirely upset the circuit and may produce interference with others near. Coils No. 1,250 and 1,000 can be used; these give a higher note for the whistle, almost at the upper limit of audibility, but less amplification. If it be desired to economise at this point, effective substitutes, though of course of lessened efficiency, can be made by winding multiple slab coils on a built-up cardboard former as follows: Cardboard about $\frac{1}{16}$ in. thick is thoroughly soaked in *hot* molten paraffin wax; 8 discs, each 2½ in. diameter, and 20 each 1 in. diameter, together with 8 rings of paper, 2½ in. external, 1 in. internal diameter, and split. These discs are strung on a piece of No. 2 B.A. screwed brass rod 4 in. long, with the two end-pieces in the form of fibre discs, 3 in. diameter, in this order: first a nut and the fibre disc, then two small discs, large disc, two small discs, with a paper split-ring loose over them, a large disc, two small, etc., until eight winding grooves are produced; then four small discs together with a paper ring, and finally the other end disc, and a nut to hold and press the whole tightly together (see Fig. 3).

Construction of the Armstrong Inductance

Four ounces of No. 32 enamel-covered wire are wound on in the eight grooves, about 150 turns per groove—little time will be saved by mounting in a winding-machine, on account of the tendency of the wire to slip over into the wrong groove—the starting end of the wire being passed through a small hole in the fibre cheek, and the wire at the end of each section being passed down to the bottom of the next groove in a diagonal knife-cut in the disc-edge, and covered by the split paper ring, smoothed and stuck down on that side of the groove (so as to protect the wire) with the aid of a heated knife-blade. Care must be taken not to loosen this protecting ring when winding the wire in that groove. After putting on the 1,200 turns, the end of the wire is made fast through a pin-hole in the cardboard cheek, and the winding of the *Armstrong Reactance* proceeded with. Two ounces of No. 36 enamel-covered wire are required, and are wound on in the same direction in the single ¼-in. groove, the beginning end being protected by the paper washer as before, the wire wound on fairly evenly in the groove, and the finishing end secured in a pin-hole in the cardboard. Three terminals are then mounted at the edge of the first disc; the beginning end of the (multiple) inductance coil is brought to the first ("aerial") terminal; the other end of this coil, and the finishing end of the (single) reactance coil—both being wound in the same way—are brought to the middle ("earth") terminal, while the beginning end of the reactance coil is brought to the third ("H.T. −") terminal. The coils may now be covered, if desired, with a varnished cardboard cylinder, or to taste, and fastened down by means of the No. 2 B.A. bolt, which should project far enough for this purpose, in its place on the base-board.

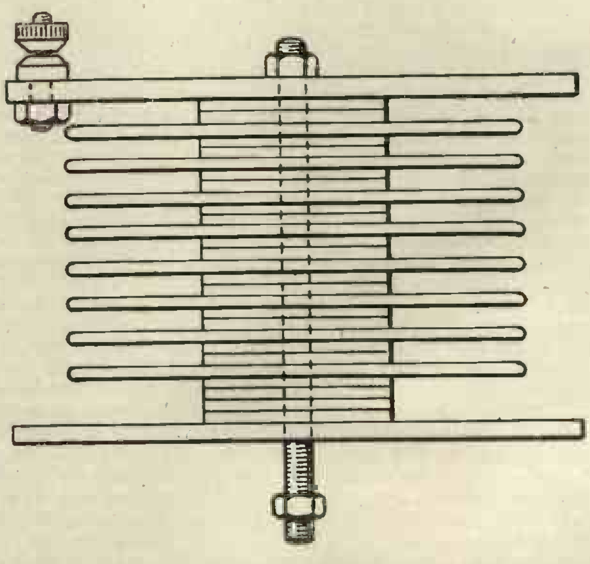


Fig. 3. *Former for the Armstrong inductance and reactance.*

Armstrong Bridging Condensers

In accordance with the second principle mentioned above, for effective and stable action of the circuit there will be needed two uncommonly large fixed condensers, far larger than indicated in most accounts of the circuit. As in the case of the phone blocking (and filter) condenser, those of the size needed cannot always be readily obtained. In default of large Dubilier, or other makes, paraffined paper and tin-foil condensers can be cheaply and easily made up as follows. For the three 0·005 to 0·007 μF. condensers about 6 sq. ft. of tin-foil are needed, and corresponding amount of waxed paper (typewriting paper soaked in *hot* molten wax and drained), 6 pieces of $\frac{1}{8}$-in. fibre (or ebonite) each 2 in. by 3 in. will be required, and six terminals with nuts and fairly long shanks. The foil is cut up into rectangles, $2\frac{1}{2}$ in. by $1\frac{3}{4}$ in.; the waxed paper into rectangles of about $2\frac{3}{4}$ in. by 2 in., and the tin-foil and paper interleaved in the usual manner with foil projecting alternately at opposite ends, in three approximately equal piles, pressed with a hot iron between folds of newspaper, and mounted between the fibre (or ebonite) plates, held together by the binding screws, which pass through holes $\frac{3}{16}$ in. from the ends, so as to pass through the ends of the tin-foils and make contact with the latter. The condensers should be tested before going any further with a single dry cell and telephone for short circuits.

When tested successfully the condensers are mounted by small screws through the base plates in their positions on the base board; the ends of the terminals which project through the bottom plate being insulated from the wood by slips of paraffined paper, if desired.

Another alternative for these condensers is to purchase several smaller mica condensers, take them apart, and mount the plates all in one casing so as to make up the desired values, but this is rather expensive.

Tuning Devices

A variable condenser of some 0·0003 to 0·0005 μF. maximum capacity is needed. Many experimenters will doubtlessly possess one already; one even of 0·001 μF. capacity could be used, utilising only part of the scale. Otherwise the parts, or a complete one, must be procured. It is needless here to describe the assembling of the condenser; only it is essential to provide a long, fine adjustment handle for exact tuning — the experienced will provide a vernier three-plate condenser in parallel with the other. In mounting it on the base-board, it must be thoroughly screened by a metal shield—perforated zinc is easy to apply—connected to the zinc lining of the base-plate by a wire or screw through the board. The extension handle also should be insulated from the spindle. Without these precautions tuning will be a most arduous task.

This will tune over the range 260 to nearly 600 metres, as indicated, with the frame aerial described; a lower range can be reached by putting a tapping or two in the aerial, if desired.

Vario-coupler

The regulation two-coil tuning stand with plug-in coils Nos. 35, 50 or 75, of Igranic, Burndept, or other standard make, is most convenient. A fine, steady, easily adjustable device is needed; this, and the wavelength adjustment, are the only critical adjustments in this form of the circuit. In default of the purchased coils and holder, a substitute can be made as follows.

On a wooden former, a disc 2 in. in diameter and about 1 in. thick, with one or two rows of holes for pegs (nails, etc.) which are subsequently

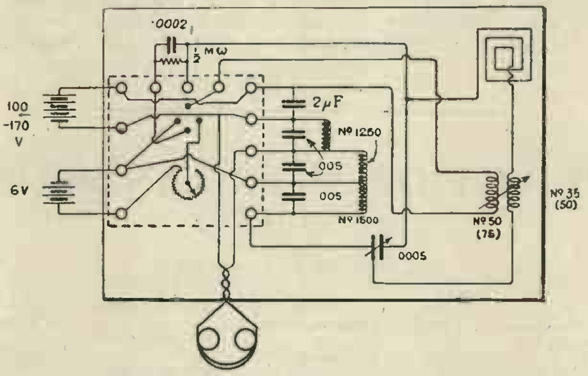


Fig. 4. *Wiring diagram of the set.*

withdrawn, a coil of 40 turns of No. 22 s.c.c. wire is wound, in any one of the familiar low-capacity windings —or even as a very loose bunch or anchor-ring — well shellacked and baked; the pegs and former withdrawn, and the coil taped up, the tape being also shellacked. Two coils of the same size will be required. One is fixed down on the base-board, where indicated, by thin wires over insulating tape sleeves and the other fixed similarly at the end of a swinging arm (a penny ruler serves admirably), the pivot of which consists of a No. 2 B.A. screwed brass rod, $2\frac{1}{2}$ in. long, with half a dozen or so large condenser spacing washers on it topped by a nut, screwed through the base board, with a back nut; a stiff spring washer and nut above give steady movement without backlash. The spacing washers are chosen so as to give just enough clearance for the swinging coil to pass above the fixed reaction coil.

Wiring Up

Connection should be made, following the wiring diagram, with No. 18 bare wire in insulating sleeving, bending the stiff wire so as to keep high-frequency circuits well isolated and away from the plate circuits, except in the vario-coupler, and well away from the hands when tuning-in. Short lengths of ordinary flex must be interposed between the frame aerial and A.T.C., frame aerial and vario coupler, and vario coupler and A.T.C. respectively; these should be as short as possible. The "low tension minus" must be connected by a short wire through the base board to the zinc lining; a wire should also be taken from the zinc lining along the telephone leads to the metal band of the telephone, so as to "earth" the observer too, when high resistance telephones are used. This increases the signal strength as well as making the circuit much more stable in use.

Testing

It must always be borne in mind that the circuit will not operate until and unless a strong shrill whistle—the Armstrong quenching frequency oscillation (of the order of 10,000 cycles)—is heard on switching on and raising the filament temperature to the maximum safe value. A hard valve and at least 100 volts high tension should be used—better 150. With a soft valve, as low as 30 volts will give *some* results, as the circuit will oscillate, though feebly, at this P.D., but both signal strength and stability are very disappointing without high voltage. If the whistle is not heard while the high frequency vario-coupler is swung right away, try reversing the connections of the Armstrong inductance *or* reactance. If persistent howls are heard, try the effect of more Indian ink on the grid-leak, or look for a break in the grid circuit. It is useless to go further until steady powerful Armstrong oscillations are obtained.

Then swing up the vario-coupler. If nothing happens, *i.e.*, the whistle persists unchanged, try reversing the connections of one of the vario coupler coils. A short-circuit in one of these coils, or too low filament temperature, will have similar effect; also too much resistance in the Armstrong reaction coil, insufficient plate voltage, or faulty bridging condensers. Momentarily short circuiting the three terminals of the Armstrong inductance and reactance, turning the circuit into an ordinary single valve circuit with reaction, will often give much information. The valve should oscillate freely on the high frequency to be effective. The sign of successful operation is that on swinging up the high-frequency reaction coil there is heard, on the top of the shrill Armstrong whistle, the well-known "thud" which announces oscillation, followed at a brief interval, as the coupling is pushed closer, by a loud shriek or howl—which prompts one to immediate withdrawal. On loosening the coupling, after a very short space of steady oscillation (or "liveliness," with the familiar "rushing" sound superimposed on the Armstrong whistle) the thudding point is passed—further out this time—and high-frequency oscillations cease. If this space—thud to shriek—is too narrow, it implies either too low filament temperature, too small-powered a valve, or else too close coupling of the Armstrong coils. The remedies are obvious.

Tuning and Operation

To tune in, the A.T.C. is set approximately to the desired wavelength, —a wavemeter buzzer is very useful here—the reaction-coil swung out, and the current switched on, so that the characteristic whistle is heard. Then the reaction coil is cautiously swung in until the thud is heard; then the A.T.C. is rocked over a small arc until the signals are picked up, keeping in the "Armstrong region" (between "thud" and "shriek") by slight adjustment of the reaction coil if necessary; then the coupling of the reaction coil is loosened until the circuit is just on the point of coming *off* oscillation (just the reverse of ordinary valve-with-reaction circuits), and any heterodyne note tuned out by very slight adjustment on the A.T.C. Here is where a vernier condenser in shunt with the main A.T.C. is useful. The process takes less time to carry out than to describe, and is actually less sensitive than with an ordinary circuit with critical reaction. If a valve with large filament current (and therefore filament emission) is used, or preferably a small power valve (the R. 4 works very well), the tuning becomes all the easier, as there is greater latitude for the high-frequency oscillations, as well as considerably increased signal strength.

The Armstrong whistle seems, at first, to be troublesomely prominent, but the ear soon becomes used to it, and ignores it, particularly if it is raised to nearly the upper limit of audibility by using smaller values for the Armstrong inductances. The greater part of the whistle is filtered out by the large telephone blocking condenser; more elaborate "filter circuits" of high resistances or inductances shunted by large condensers can be made up if desired. The writer found on actual trial that considerable loss of signal strength resulted long before the whistle could be completely silenced. If a second valve as note magnifier be used, the problem becomes more serious, as the whistle is amplified as well. A fair-sized blocking condenser across the secondary of the inter-valve transformer helps a bit, at the cost of some 25 per cent. of the signal strength; but some more complex form of coupling, that will effectively filter out the whistle, appears to be required. A loose-coupled crystal circuit, with the second valve as note-magnifier to this, showed promise, though much extra complication. In any case, a transformer of reliable make must be used, as in the case of the telephone transformer, and, in general, either separate H.T. or separate L.T. batteries.

UP-TO-DATE LIST OF AMERICAN BROADCASTING STATIONS

(*Continued from page* 258.)

Call Letter.	Name.	City and State.
WLAT	Radio Specialty Co.,	Burlington, Iowa
WLAV	Electric Shop	Pensacola, Fla.
WLAW	Police Dept. of New York City,	New York, N.Y.
WLAX	Putnam Electric Co.,	Greencastle, Ind.
WLAY	Northern Commercial Co.,	Fairbanks, Alaska
WLAZ	Hutton & Jones Electric Co.,	Warren, Ohio
†WLB	University of Minnesota,	Minneapolis, Minn.
†WLK	Hamilton Mfg. Co.,	Indianapolis, Ind.
†WLW	Crosley Mfg. Co.	Cincinnati, Ohio
WMAB	Radio Supply Co.	Oklahoma, Okla.
WMAC	J. Edw. Page (Clive B. Meredith),	Cazenovia, N.Y.
WMAD	Atchinson County Mail,	Rock Port, Mo.
WMAF	Round Hills Radio Corp.,	Dartmouth, Mass.
WMAG	Tucker Electric Co.	Liberal, Kans.
WMAH	General Supply Co.	Lincoln, Nebr.
†WMAJ	Drovers Telegram Co.,	Kansas City, Mo.
WMAK	Norton Laboratories,	Lookport, N.Y.
WMAL	Trenton Hardware Co.,	Trenton, N.J.
†WMAM	Beaumont Radio Equipment Co.,	Beaumont, Texas
WMAN	Broad St. Baptist Church,	Columbus, Ohio
WMAP	Utility Battery Service	Easton, Pa.
WMAQ	The Fair Corp. & Chicago Daily,	Chicago, Ill.
WMAR	Waterloo Electrical Supply Co.,	Waterloo, Iowa
†WMAT	Paramount Radio Corp.,	Duluth, Min.
†WMAV	Alabama Polytechnic Inst.,	Auburn, Ala.
WMAW	Wahpeton Electric Co.,	Wahpeton, N. Dak.
WMAX	K & K Radio Supply Co.,	Ann Arbor, Mich.
WMAY	Kingshighway Presbyterian Church,	St. Louis, Mo.
WMAZ	Mercer University	Macon, Ga.
WMB	Auburn Electrical Co.	Auburn, Me.

Call Letter.	Name.	City and State.
†WMH	Precision Equipment Co.,	Cincinnati, Ohio
WMU	Doubleday-Hill Electric Co.,	Washington, D.C.
WNAB	Park City Daily News,	Bowling Green, Ky.
WNAC	Shepard Stores	Boston, Mass.
WNAD	Oklahoma Radio Engineering Co.,	Norman, Okla.
†WNAF	Enid Radio Distributing Co.,	Enid, Okla.
WNAG	Rathert Radio & Electric Shop,	Cresco. Iowa
WNAH	Wilkes-Barre Radio Repair Shop,	Wilkes-Barre, Pa.
WNAJ	Benson Co.	Chicago, Ill.
WNAK	Manhattan Radio Supply Co.,	Manhattan, Kan.
WNAL	R. J. Rockwell	Omaha, Nebr.
WNAM	Ideal Apparatus Co.,	Evansville, Ind.
WNAN	Syracuse Radio Telephone Co.,	Syracuse, N.Y.
WNAP	Wittenberg College,	Springfield, Ohio
WNAQ	Charleston Radio Electric Co.,	Charleston, S. C.
WNAR	C. C. Rhodes	Butler, Mo.
WNAS	Texas Radio Corp. & Austin Statesman	Austin, Tex.
WNAT	Lennig Bros. Co.	Philadelphia, Pa.
WNAV	Peoples Telephone & Telegraph Co.,	Knoxville, Tenn.
WNAW	Peninsular Radio Club,	Fort Monroe, Va.
WNAX	Dakota Radio Apparatus Co.,	Yankton, S.D.
WNAY	Ship Owner's Radio Service,	Baltimore, Md.
WNJ	Shotton Radio Mfg. Co., Inc.,	Albany, N.Y.
WNO	Wireless Telephone Co. of Hudson County, N.J.	Jersey City, N.J.
WOAA	Dr. Walter Hardy	Ardmore, Okla.
WOAB	Valley Radio	Grand Forks, N.D.
WOAC	Maus Radio Co.	Lima, Ohio
WOAD	Friday Battery & Elec. Co.,	Sigourney, Iowa
WOAE	Midland College	Fremont, Nebr.

Call Letter.	Name.	City and State.
WOAF	Tyler Commercial College,	Tyler, Texas
WOAG	Apollo Theatre	Belvedere, Ill.
WOAH	Palmetto Radio Corp.,	Charleston, S.C.
WOAI	Southern Equipment Co.,	San Antonio, Tex.
WOAJ	Ervine Electrical Co.	Parsons, Kan.
WOAK	Collins Hdwe. Co.	Frankfort, Ky.
WOAL	Wm. E. Woods,	Webster Groves, Mo.
WOAN	Vaughn Conservatory of Music,	Lawrenceburg, Tenn.
WOAO	Lyradion Mfg. Co.	Mishawaka, Ind.
WOAP	Kalamazoo College.	Kalamazoo, Mich.
WOAQ	Portsmouth Radio Assoc.,	Portsmouth, Va.
WOAR	Henry P. Lundskow	Kenosha, Wis.
WOAS	Bailey's Radio Shop,	Middletown, Conn.
WOAT	Boyd M. Hamp	Wilmington, Del.
WOAU	Sowder Bolling Piano Co.,	Evansville, Ind.
WOAV	Second Battalion, 112th Inf., P.N.G.,	Erie, Pa.
WOAW	Woodmen of the World,	Omaha, Nebr.
WOAX	Franklyn J. Wolff (Monument Pottery Co.)	Trenton, N.J.
WOAY	John M. Wilder	Birmingham, Ala.
†WOAZ	Penick Hughes Co.	Stamford, Texas
*†oWOC	Palmer School of Chiropractic,	Davenport, Iowa
WOE	Buckeye Radio Service Co.,	Akron, Ohio
WOH	Hatfield Electric Co.,	Indianapolis, Ind.
†WOI	Iowa State College	Ames, Iowa
WOK	Arkansas Light & Power Co. (Pine Bluff Co.)	Pine Bluff, Ark.
*†oWOO	John Wanamaker	Philadelphia, Pa.
†WOQ	Western Radio Co.	Kansas City, Mo.
*oWOR	L. Bamberger & Co.	Newark, N.J.
†WOS	Missouri State Marketing Bureau,	Jefferson City, Mo.
†WOU	Metropolitan Utilities District,	Omaha, Nebr.
†WOZ	Palladium Printing Co.,	Richmond, Ind.
†WPA	Fort Worth Record,	Fort Worth, Tex.

(*Continued on page* 268.)

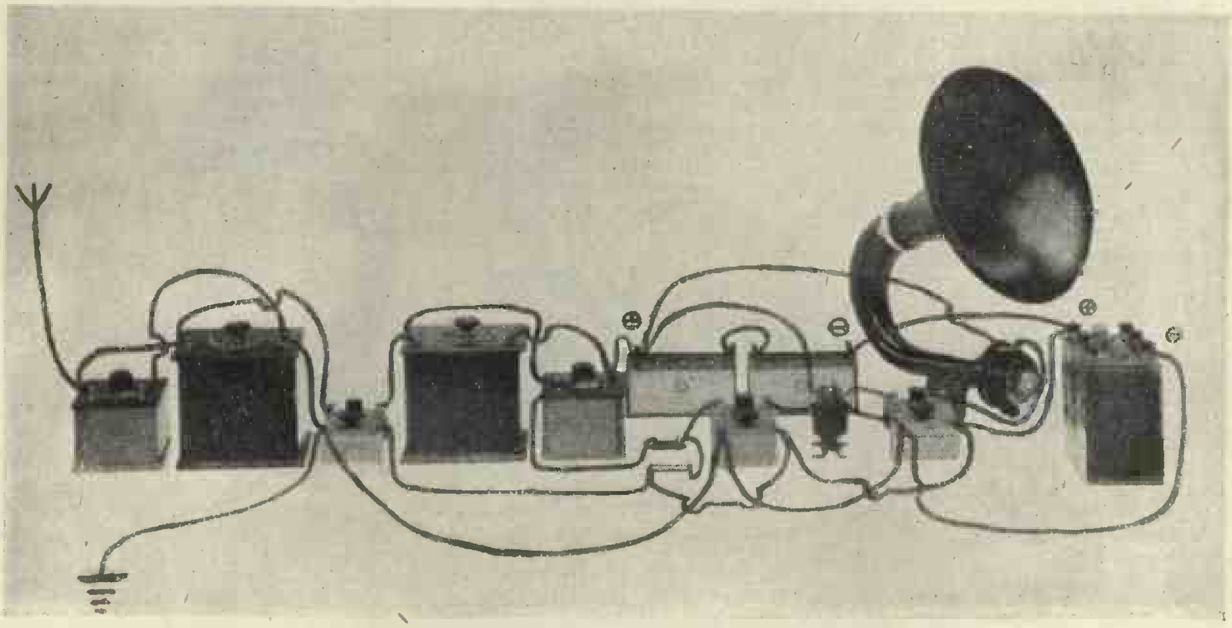


Fig. 1. The three-valve set, with the aerial tuning condenser connected in parallel for long-wave reception.

A THREE- OR FOUR-VALVE RECEIVER COVERING A WAVELENGTH RANGE OF 200 TO 5,000 METRES

A continuation of the two-valve set described in the April issue of MODERN WIRELESS (Vol. 1, No. 3). The three- or four-valve set may be used with a loud-speaker for broadcast reception, and excellent results are obtainable with it.

THE following article explains how the receiver already described may be made to give louder results by the addition of one or two low-frequency amplifying valves. The additional parts required in the case of a three-valve set are :

(*a*) An additional valve panel ;
(*b*) An iron-core step-up intervalve transformer.

The valve panel suitable for this purpose has already been described in the previous issues of this journal. Full details of the panel are given on p. 217, and the additional valve panel is of exactly the same type.

The intervalve transformer should preferably be purchased, and a reliable type obtained. An extra few shillings makes a great deal of difference in an intervalve transformer.

The Circuit used

Fig. 2 shows the circuit used for the three-valve set. It will be seen that a tuned anode circuit is employed, but this circuit is not coupled intentionally to the aerial circuit. There is therefore practically no danger of self-oscillation, and the apparatus lends itself particularly to the reception of broadcasting. At a distance of about fifteen miles from the London Broadcasting Station this three-valve set gives excellent results on a loud-speaker.

The condenser C_1 should preferably be 0·001 μF., but 0·0005 μF. can be used. The same applies to the condenser C_2. The condenser C_3 is a grid condenser, having a value of about 0·00025 μF., or 0·0003 μF. The grid leak R_4 has a value of 2 megohms. The winding T_1 of the step-up transformer T_1T_2 is the primary winding and is connected in the anode circuit of the second valve as shown. The secondary winding T_2 is connected across the grid of the third valve and the negative terminal of the filament accumulator B_1. The telephones T are connected in the anode circuit of the third valve as shown. A condenser, C_4, having a capacity of 0·002 μF., is connected across the

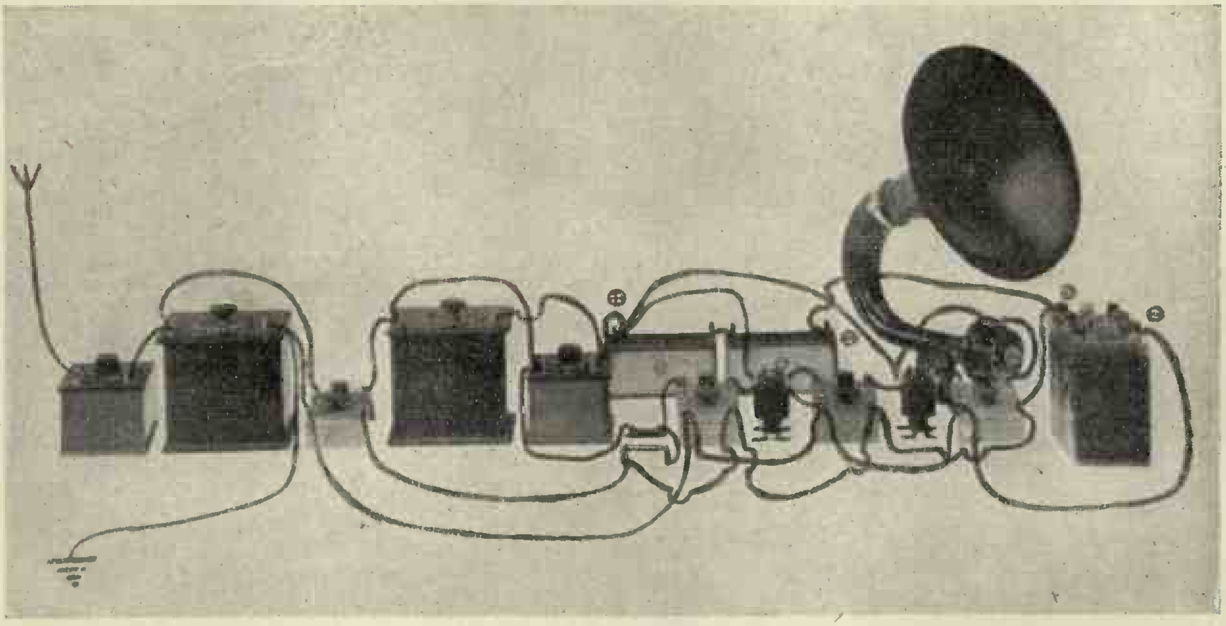


Fig. 4. The four-valve set.

primary winding T_1 of the step-up transformer T_1T_2. The telephones T, of course, should be of high resistance if included in the anode circuit of the third valve.

Fig. 3 shows a pictorial wiring diagram of the different components used in the three-valve circuit of Fig. 2.

The operation of this circuit is no different from that of the two-valve set. If it is desired to receive long wave-lengths, including Paris (2,600 metres), the aerial condenser should be connected in parallel with the inductance L_1 instead of in series with it as shown. In all cases, the aerial condenser C_1 should be tried both in series with the coil L_1 and in parallel with it.

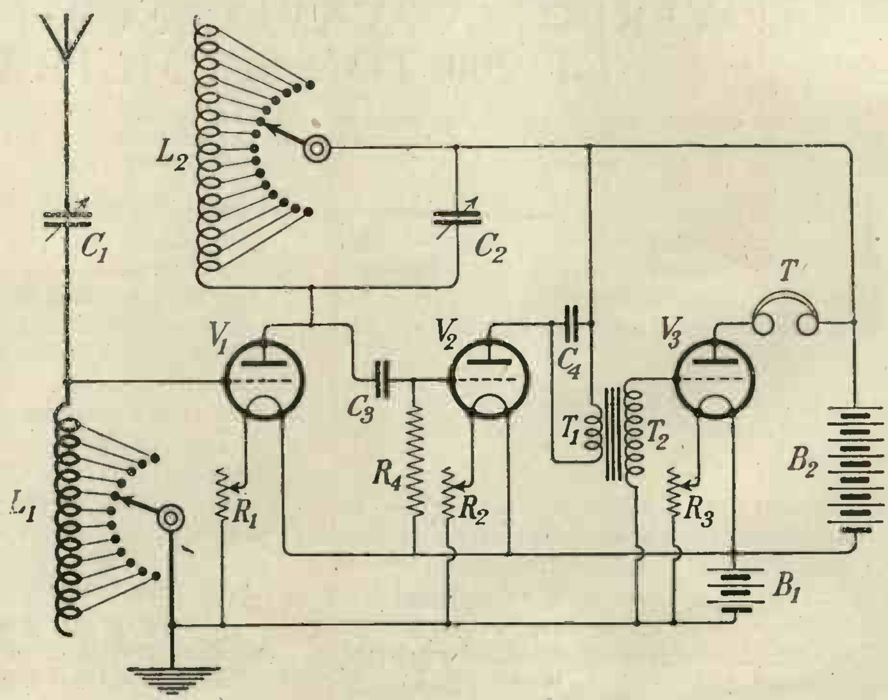


Fig. 2. Three-valve circuit.

The Four-valve Set

The four-valve set is nothing more or less than a reproduction of the three-valve set with an additional valve panel of the type already referred to and a step-up intervalve transformer. Very much louder signals, of course, are obtainable with a four-valve set, or, alternatively, a longer range may be obtained.

Fig. 4 is a photograph of the apparatus actually employed. The circuit used is shown in Fig. 5. It will be seen that an additional step-up transformer, T_3T_4, has been provided. A pictorial wiring diagram is shown in Fig. 6, and from

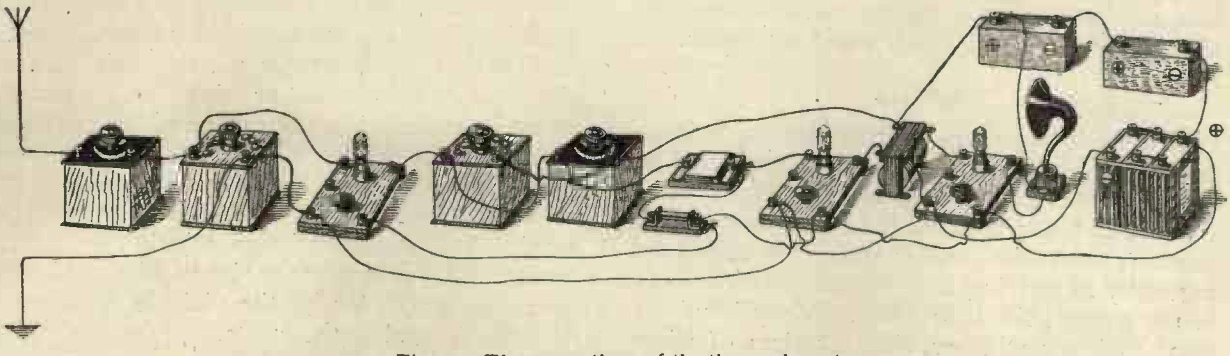


Fig. 3. The connections of the three-valve set.

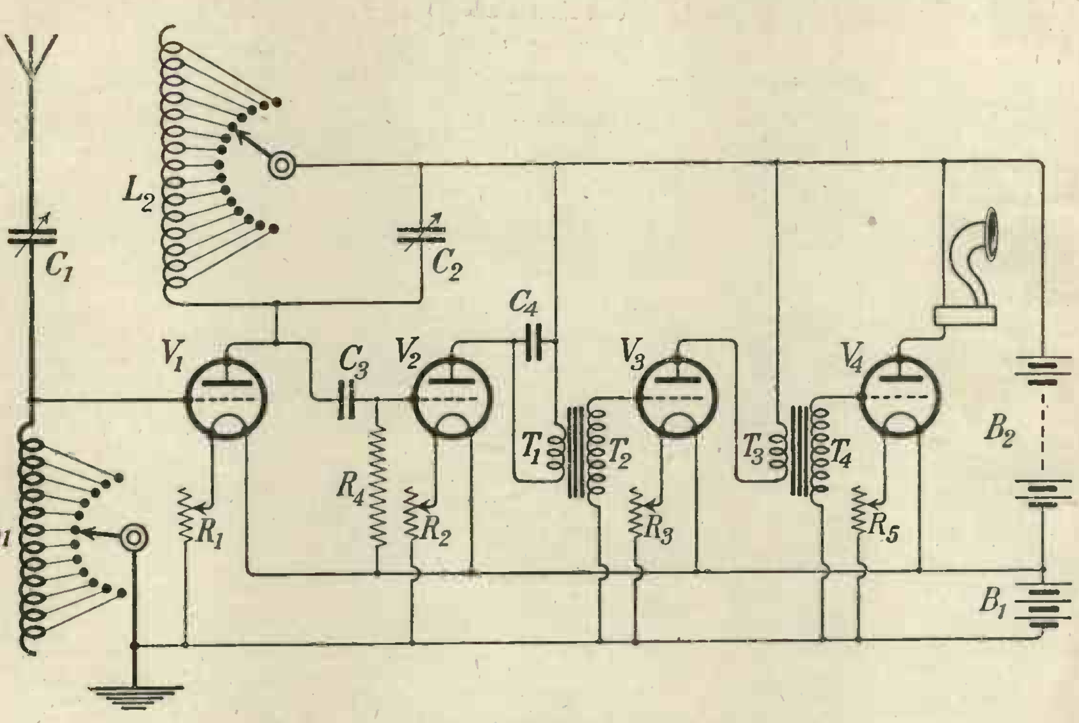


Fig. 5. Four-valve circuit.

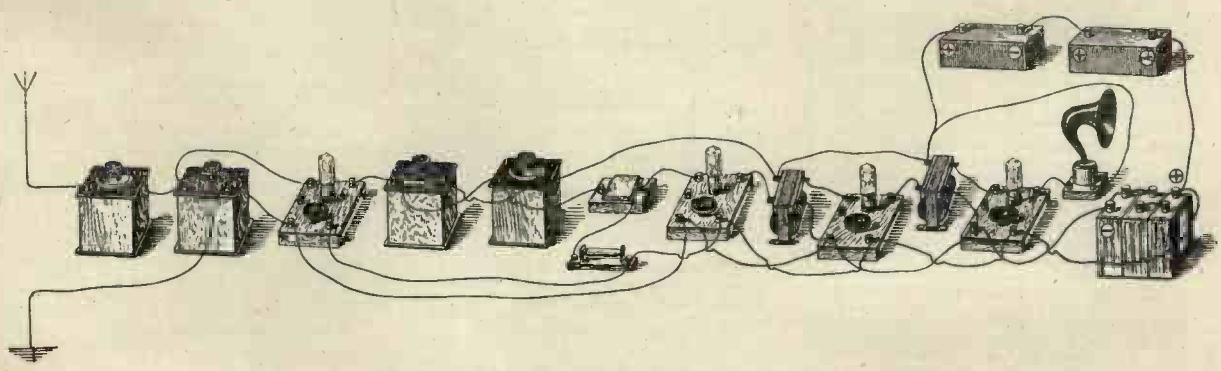


Fig. 6. The connections of the four-valve set.

this set the veriest beginner should have no difficulty in obtaining really excellent results.

A Note

It is perhaps as well to note that there is no obligation to have the inductances mounted in special boxes as has been described. The inductances may be mounted in any convenient manner, and the reader may use his own ingenuity in arriving at a satisfactory settlement of the constructional problem. Many inquirers want to know whether different sizes of wires may be employed. Generally speaking, when sufficient tappings are provided, as in this case, it does not much matter whether the wire is double cotton-covered or single silk-covered, or even enamelled. The same number of turns, however, should be adhered to. The actual size of the wire is not a vital matter, and usually any size between No. 20 and No. 30 may be used. Any slight variation which may occur owing to the change in the size of wire used may be compensated for by the variable condensers C_1 and C_2 used in these sets.

UP-TO-DATE LIST OF AMERICAN BROADCASTING STATIONS

(Continued from page 264.)

Call Letter.	*Name.*	*City and State.*
WPAA	Anderson & Webster Elec. Co.,	Wahoo, Nebr.
WPAB	Pennsylvania State College,	State College, Pa.
WPAC	Donaldson Radio Co.,	Okmulgee, Okla.
WPAD	W. A. Wieboldt & Co.,	Chicago, Ill.
WPAF	Peterson Radio Co.,	Council Bluffs, Ia.
WPAG	Central Radio Co.,	Independence, Ill.
†oWPAH	Wisconsin Department of Markets,	Waupaca, Wis.
WPAJ	Doolittle Radio Corp.,	New Haven, Conn.
†WPAK	North Dakota Agricultural College,	Agricultural College, N.D.
WPAL	Superior Radio & Tel. Equipment Co.,	Columbus, Ohio
WPAM	Auerbach & Guettel..	Topeka, Kans.
WPAP	Theodore D. Phillips.	Winchester, Ky.
WPAQ	General Sales & Engineering Co.,	Frostburg, Md.
WPAR	R. A. Ward..........	Beloit, Kans.
WPAS	J. & M. Electric Co.,	Amsterdam, N.Y.
WPAT	St. Patricks Cathedral,	El Paso, Texas
†WPAU	Concordia College..	Moorhead, Minn.
WPAV	Paul Tinetti & Sons..	Laurium, Mich.
WPAW	Radio Installation Co.,	Wilmington, Del.
WPAX	S W Radio Co. (J. R. Shumate, Jr.),	Thomasville, Ga.
WPE	Central Radio Co...	Kansas City, Mo.
WPG	Nushawg Poultry Farm,	New Lebanon, Ohio
WPI	Electric Supply Co...	Clearfield, Pa.
WPJ	St. Joseph College..	Philadelphia, Pa.
WPM	Thomas J. Williams,	Washington, D.C.
WPO	United Equipment Co.,	Memphis, Tenn.
WQAA	Horace A. Beale, Jr.,	Parkesburg, Pa.
WQAB	Southwest Missouri State Teachers College...........	Springfield, Mo.
WQAC	E. B. Gish..........	Amarillo, Tex.
WQAE	Moore Radio News Station (Edmund B. Moore)........	Springfield, Vt.
WQAK	Appel-Higley Electric Co.,	Dubuque, Iowa
WQAL	Coles County Telephone & Telegraph Co.........	Mattoon, Ill.
WQAQ	West Texas Radio Co.,	Abilene, Texas
WQAY	Gaston Music & Furniture Co.,	Hastings, Nebr.
WRAA	Rice Institute......	Houston, Texas
WRAN	Black Hawk Electrical Co.,	Waterloo, Iowa
WRAR	Jacob C. Thomas..	David City, Nebr.
WRAU	Amarillo Daily News,	Amarillo, Tex.
WRAY	Radio Sales Corp.....	Scranton, Pa.
WRK	Doron Bros. Elec. Co.,	Hamilton, Ohio
WRL	Union College....	Schenectady, N.Y.
WRM	University of Illinois....	Urbana, Ill.
WRP	Federal Institute of Radio Telegraphy............	Camden, N.J.
†WRR	City of Dallas, Police & Fire Signal Dept...............	Dallas, Texas
WRW	Tarrytown Radio Research Laboratory...........	Tarrytown, N.Y.
WSAJ	Grove City College..	Grove City, Pa.
WSAS	Bureau of Markets, State Dept. of Agr...............	Lincoln, Nebr.
WSAT	Plainview Electric Co.,	Plainview, Tex.
WSAV	Clifford W. Vick Radio Const. Co.,	Houston, Texas
*†oWSB	Atlanta Journal........	Atlanta, Ga.
WSL	J. & M. Electric Co.....	Utica, N.Y.
WSN	Ship Owner's Radio Service Inc.,	Norfolk, Va.
WSX	Erie Radio Co............	Erie, Pa.
†WSY	Alabama Power Co.,	Birmingham, Ala.
WTAC	Penn Traffic Co.....	Johnstown, Pa.
WTAU	Ruegg Battery & Electric Co.,	Tecumseh, Nebr.
WTAW	Agricultural & Mechanical College,	College Station, Tex.
†oWTG	Kansas State Agricultural College,	Manhattan, Kansas
WTP	George M. McBride,	Bay City, Mich.
WWAC	Sanger Bros...........	Waco, Texas
WWAD	Wright & Wright, Inc.,	Philadelphia, Pa.
WWAX	Wormser Bros.......	Laredo, Texas
WWB	Daily News Printing Co.,	Canton, Ohio
WWI	Ford Motor Co......	Dearborn, Mich.
*oWWJ	Detroit News........	Detroit, Mich.
WWL	Loyola University,	New Orleans, La.
WWT	McCarthy Bros. & Ford,	Buffalo, N.Y.
WWZ	John Wanamaker..	New York, N.Y.
WIAT	Leon T. Noel..........	Tarkio, Mo.
WIAU	American Trust & Savings Bank,	Le Mars, Iowa
WIAV	New York Radio Laboratories,	Binghamton, N.Y.
WIAW	Saginaw Radio & Electric Co.,	Saginaw, Mich.
WIAX	Capitol Radio Co.....	Lincoln, Nebr.
WIAY	Woodward & Lothrop,	Washington, D.C.
WIAZ	Electric Supply Sales Co.,	Miami, Fla.
WIK	K & L Electric Co...	McKeesport, Pa.
WIL	Continental Electrical Supply Co.,	Washington, D.C.
†WIP	Gimbel Bros.......	Philadelphia, Pa.
†WIZ	Cino Radio Mfg. Co.,	Cincinnati, Ohio
WJAB	American Radio Co...	Lincoln, Nebr.
WJAC	Redell Co..............	Joplin, Mo.
WJAD	Jackson's Radio Engineering Laboratories..............	Waco, Texas
†WJAE	Texas Radio Syndicate,	San Antonio, Texas
WJAF	Muncie Press-Smith Electric,	Muncie, Ind.
WJAG	Norfolk Daily News..	Norfolk, Nebr.
WJAJ	Y.M.C.A............	Dayton, Ohio
†WJAK	White Radio Laboratory,	Stockdale, Ohio
WJAL	Victor Radio Corp....	Portland, Me.
WJAM	D. M. Perham..	Cedar Rapids, Iowa
WJAN	Peoria Star-Peoria Radio Sales Co.,	Peoria, Ill.
WJAP	Kelley-Duluth Co.....	Duluth, Minn.
WJAQ	Capper Publications....	Topeka, Kan.
WJAR	Outlet Co. (J. Samuels & Bro.),	Providence, R.I.
WJAS	Pittsburgh Radio Supply Co.,	Pittsburgh, Pa.
WJAT	Kelley-Vawter Jewelry Co.,	Marshall, Mo.
WJAU	Yankton College..	Yankton, So. Dak.
WJAX	Union Trust Co.....	Cleveland, Ohio
WJAZ	Chicago Radio Laboratory,	Chicago, Ill.
WJD	Richard H. Howe...	Granville, Ohio
WJH	White & Boyer Co.,	Washington, D.C.
WJK	Service Radio Equipment Co.,	Toledo, Ohio
WJX	De Forest Radio Telephone & Telegraph Co.........	New York, N.Y.
WJZ	Westinghouse Elec. & Mfg. Co.,	Newark, N.J.
†WKAA	H. F. Paar (Republican Times),	Cedar Rapids, Iowa
WKAC	Star Publishing Co...	Lincoln, Nebr.
WKAD	Charles Looff (Crescent Park),	East Providence, R.I.
WKAF	W. S. Radio Supply Co.,	Wichita Falls, Texas
WKAG	Edwin T. Bruce, M.D.,	Louisville, Ky.
WKAH	Planet Radio Co.,	West Palm Beach, Fla.
WKAK	Okfuskee County News,	Okemah, Okla.
WKAL	Gray & Gray........	Orange, Texas
WKAN	Alabama Radio Mfg. Co.,	Montgomery, Ala.
WKAP	Dutee W. Flint......	Cranston, R.I.
WKAQ	Radio Corp. of Porto Rico,	San Juan, P.R.
WKAR	Michigan Agricultural College,	East Lansing, Mich.
WKAS	L. E. Lines Music Co.,	Springfield, Mo.
WKAV	Laconia Radio Club..	Laconia, N.H.
WKAW	Turner Cycle Co.......	Beloit, Wis.
WKAX	William A. MacFarland,	Bridgeport, Conn.
WKAY	Brenau College......	Gainesville, Ga.
WKAZ	Landau's Music & Jewelry Co.,	Wilkes-Barre, Pa.
WKC	Joseph M. Zamoiski Co.,	Baltimore, Md.
†WKN	Riechman Crosby Co.,	Memphis, Tenn.
†WKY	WKY Radio Shop,	Oklahoma City, Okla.
WLAC	North Carolina State College,	Raleigh, N.C.
WLAF	Johnson Radio Co.....	Lincoln, Nebr.
*†oWLAG	Cutting & Washington Radio Corp.,	Minneapolis, Minn.
WLAH	Samuel Wordworth..	Syracuse, N.Y.
†WLAJ	Waco Electrical Supply Co.,	Waco, Texas
WLAK	Vermont Farm Machine Corp.,	Bellows Falls, Vt.
WLAL	Tulsa Radio Co.........	Tulsa, Okla.
WLAM	Morrow Radio Co...	Springfield, Ohio
WLAN	Putnam Hardware Co...	Houlton, Me.
WLAO	Anthracite Radio Shop,	Scranton, Pa.
WLAP	W. V. Jordon........	Louisville, Ky.
WLAQ	A. E. Schilling....	Kalamazoo, Mich.
WLAR	Mickel Music Co.,	Marshalltown, Iowa
WLAS	Central Radio Supply Co.,	Hutchinson, Kansas

A SIMPLE TUNER WITH MANY USES

By R. W. HALLOWS, M.A.

The ordinary type of three-coil holder is by no means an ideal appliance, and is, moreover, difficult to make and expensive to buy. The type of coil-mounting described in this contribution will be found extremely cheap and easy to construct, and to give much greater variations of coupling.

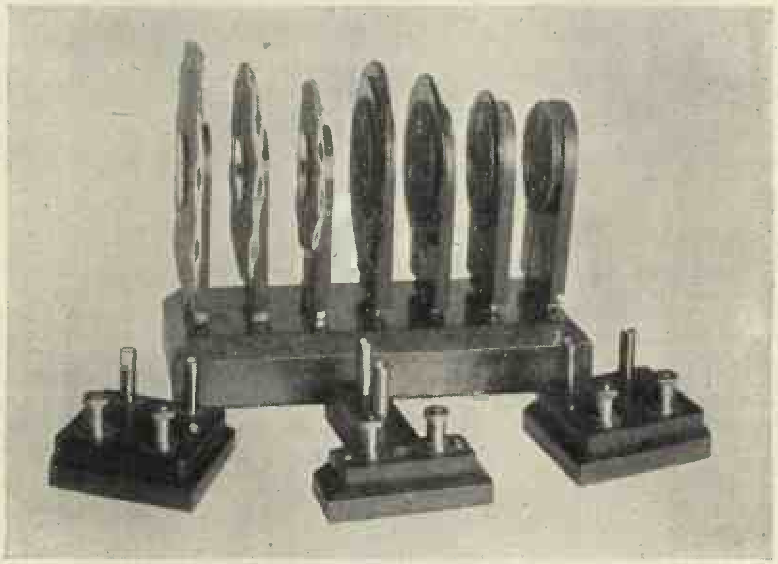
NEARLY a year ago now I conceived the idea of making up a little tuner designed on the simplest possible lines that would do everything that the most complicated and expensive affairs could accomplish, and a good deal more besides. The first experimental model was made up in the roughest way in an hour or two, and it gave such promising results that a decently finished set of apparatus was put in hand at once. Since then it has been in constant use on a six-valve set and nothing could have been more satisfactory. Tuning is delightfully simple; the most minute adjustment of the coupling between coils can be obtained on all wavelengths between 100 and 30,000 metres in the easiest possible way. The total cost was as follows:

	s.	d.
Set of basket coils ..	5	0
Set of slab coils ..	7	6
6 terminals	0	6
6 valve sockets ..	1	0
30 valve pins	2	6
Ebonite ..	5	0
Total	£1 1	6

Thus for less than the cost of a good three-coil holder alone, one has not only the stands themselves, but also a full set of coils covering all wavelengths.

The basket coils, seven in number, allow the set to be tuned from 100 to 3,700 metres, whilst the eight slabs range from 300 to 30,000 metres. For the short wavelengths basket coils are very efficient indeed, owing to their low self-capacity. Slab coils are comparatively inefficient and they are not very easy to use on a large set, since they have an inherent tendency to cause circuits to fall into oscillation; still, one does not often work at much over 4,000 metres and the slab coils, if carefully used, will be found quite good enough for ordinary purposes.

The tuner consists of three little stands made of polished wood, each with an ebonite top. The middle stand (Fig. 1) is made T-shaped in order that quite close coupling may be obtained when necessary. In use it is screwed to the middle of a polished base made of ½-in. mahogany and measuring 12 in. in length by 5 in. in width. On this base the other two holders, little wood blocks 2½ in. by 2 in. are manœuvred by hand. The lines ruled across the baseboard (see Fig. 2) enable the user to note down the degree of coupling that gives the best results for any particular station. Fig. 3 gives details of the moving holders.



The coil-holders and rack of coils.

The construction of the holders is so simple that anyone can undertake it, even if his workshop contains none but the most ordinary tools. The stands may be cut from any kind of wood, but it is very important to hollow out the top of each so that the lower ends of the valve legs and terminals and the bare wires joining these make no contact with the wood, otherwise a loss of signal strength may occur. High-frequency currents are kittle cattle, always ready to take advantage of any kind of short circuit, and wood is as a rule of very little use as an insulator where they are concerned. The hollowing out can be done by making shallow recesses with a brace and a good sized bit to take the nuts of valve legs and terminals, and by cutting a groove deep enough to clear the connecting wires. The ebonite tops are cut out with a stiff-backed saw and the edges finished up with a fine file, receiving their final trimming with 000 emery-cloth and turpentine. Each little ebonite plate requires eight holes to be bored in it, four for the holding-down screws and two each for terminals and valve legs. Valve legs are usually threaded 4 B.A. and terminals with the same thread should be used.

Use a 4 B.A. tapping drill to make this second set of holes, and tap them out; terminals and valve legs can then be screwed firmly into place, and there will be no risk of their working loose later.

Should you wish to use duo-lateral or honeycomb coils on these stands, pins and sockets to fit them should be fixed on to the ebonite plates instead of the valve legs. Little blocks containing one pin and one socket may be purchased ready made for 1s. apiece, and these can be mounted just as they are on the stands. In order to make the moving holders quite steady when carrying heavy honeycomb coils it would be as well to make them of rather larger dimensions than those already given, say 3 by 3½ in.

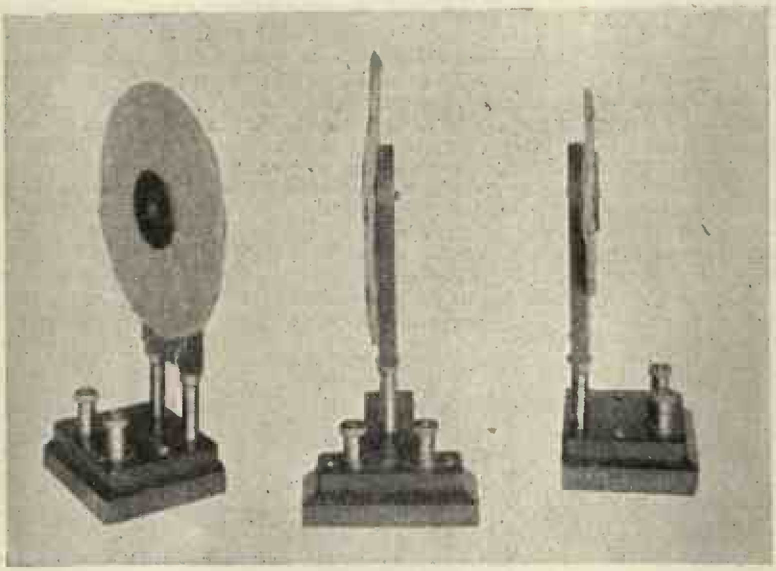
For baskets and slabs the valve pins and socket mounting is excellent, and it can be recommended if these coils only are to be used. If, however, the reader desires to use honeycombs as well, he had better adopt the large plugs and sockets throughout.

The set illustrated in the photographs was made for the former types of coil only. It was found convenient to space legs and sockets just an inch apart, but those who desire to construct similar tuners can, of course, adopt just the distance that suits them best in case they have sets of coils already mounted.

The mounting of the coils themselves is again a job that no one need shrink from. Fig. 4 shows the shape and dimensions of the ebonite strips used for baskets, and Fig. 5 those for the mountings of slab coils. The latter had to be made rather wider since the holes in the middle of slab coils are considerably bigger than those of the baskets.

Basket coils were fixed in place by means of a single 4 B.A. screw passed through a disc of ⅛-in. ebonite 1½ in. in diameter. To prevent the disc from cracking under pressure—thin ebonite is very brittle stuff to work with—the hole of the coil was filled up with a rubber washer cut from an old inner tube, so that it might have something springy to bear against.

As a matter of fact, there is no need at all to use ebonite for the discs, and fibre was chosen when it came to tackling the slabs. Besides being less brittle, this material has a decided advantage for the purpose, for it enables the maximum and minimum wavelengths of each coil to be stamped on its disc with a figuring punch. As the larger slabs are very heavy it was found better to secure them with three screws rather than with a single one, in order to make a solid job.



Showing three basket coils mounted in the holders.

To give the best results all coils, no matter what their size, should be concentric when placed on the stands of the tuner. The single hole for the retaining screw of the basket coils was drilled 2¼ in. from the bottom of the ebonite; the three screws of the slab coils are on the circumference of a 1½-in. circle, the centre of which occupies the same position.

In order that there may be no difficulty about drilling the holes for the valve pins, the mounts should be made of ¼ in. ebonite, which allows plenty of room. The holes are tapped with a 4 B.A. thread and the pins are screwed tightly in, each being provided with nut and washer to secure the ends of the wires from the coils. It is important that all coils should be mounted so that their windings are in the same direction. To ensure that this is the case, always take the wire from the inside of the coil to the left-hand pin and that from the outside to the right. When using the tuner adopt the rule of making the discs of all coils face to the right. The moving holders are connected to the appropriate terminals of the set by means of flexible leads.

When made the tuner is an instrument which may be put to a very great variety of uses. The most obvious one is to employ it simply as an aerial tuning inductance. In this case one of the moving holders takes the primary coil, the secondary is slipped into the sockets of the fixed T, and the reaction coil is placed in the other moving holder. This arrangement must not, of course, be used on broadcasting wavelengths during the specified hours, since it is no longer permissible to couple the reaction coil even to the secondary of the A.T.I. We shall see in a moment how this difficulty can be overcome.

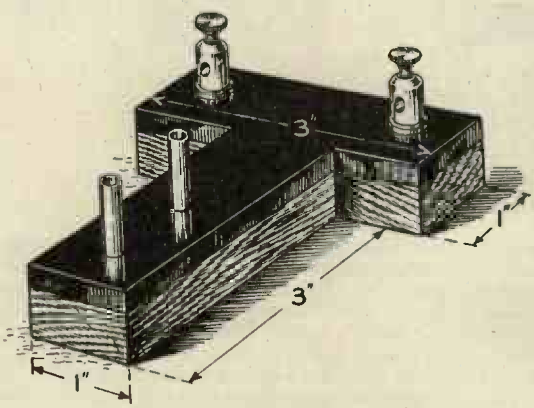


Fig. 1. The middle holder.

The best method of handling the tuner when used in this way is as follows: Having chosen suitable coils for the transmission which it is desired to pick up—the secondary will usually be one size larger than the primary if the A.T.C. is in parallel, and the reaction coil one size smaller—bring primary and secondary fairly close together, keeping them parallel to one another; the reaction coil may remain further away for the time being. Tune with aerial and closed circuit condensers in the ordinary way until signals are at their best, next obtain a rough coupling adjustment by moving the primary coil nearer to or farther from the other straight along the polished base. When you have done the best that is possible in this way make fine adjustments by turning the primary at a slight angle in one direction or the other, which owing to its "vernier" effect enables extraordinarily sharp tuning to be accomplished. Then deal with the reaction coil in the same manner.

It will be noticed that the coils can be placed in *any* position in relation to one another. Your adjustments are not confined, as they are with the ordinary three-coil holder, to variations in the angles between the coils. Fig. 6 shows a few only of the combinations possible. Only one of these (*c*) can be obtained with the three-coil holder of the usual type.

As may be imagined, a tuner which allows such a variety of couplings is extremely selective; in fact even on such a crowded wavelength as 600 metres it is usually possible to pick out one set of signals from the babel that first meets the ears and to tune it to the exclusion of the rest. This is due largely to the amazingly fine adjustments that are possible in the couplings between coils.

The reaction coil may be used in rather a novel way to control a set which insists upon falling into oscillation: simply turn its coil-holder right round, the direction of the flow of current is thus reversed and the coil exercises a damping instead of a "boosting" effect.

The moving coil-holders may, if desired, be fitted with long handles, but I have never found this to be necessary. If the effects of body capacity are noticeable when the hand approaches the holders a pencil may be used to move them, but if the set is properly controlled by means of a

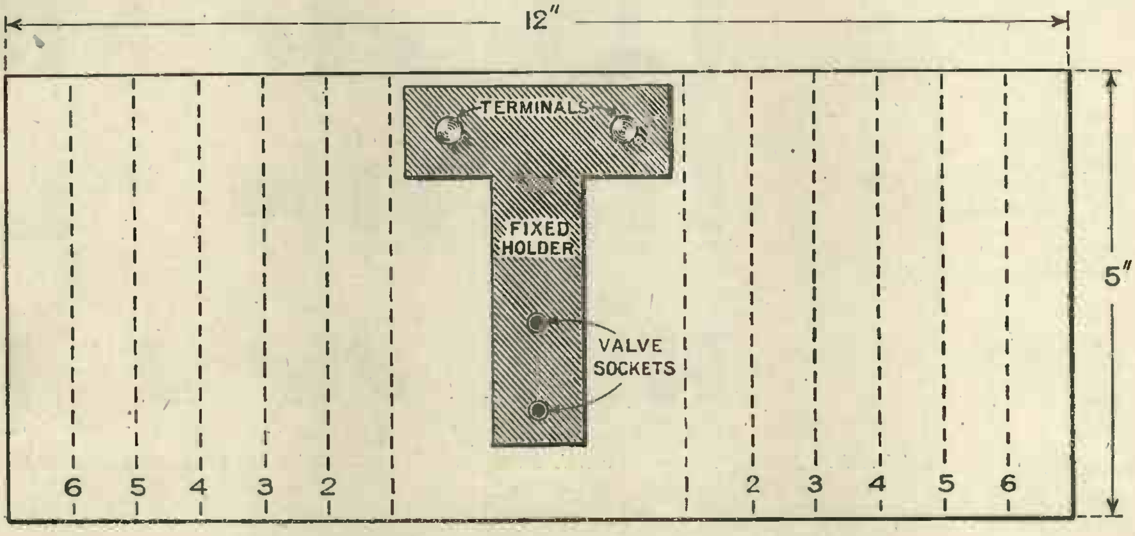


Fig. 2. Showing the middle holder in position on the base-board.

potentiometer, these effects will not occur, except perhaps when slab coils are in use on the greater wavelengths, and even then they are not serious.

For broadcast reception, where it is desired to make use of reaction in a legitimate way, the little holders and their coils can be used to great

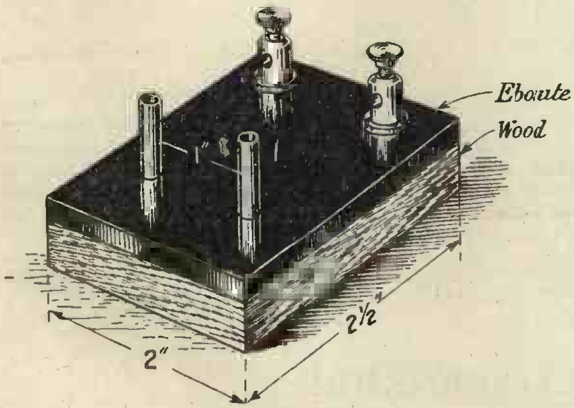


Fig. 3. The moving holder.

advantage. One very simple way is to make a fresh pair of moving holders to take primary and secondary coils, and to convert the trio already constructed into a high-frequency transformer with reaction coupled to its secondary, as shown in Fig. 7. Basket coils used in this way make an excellent transformer, and as the coupling is variable to any extent, very sharp and selective tuning becomes at once possible with little or no risk of causing interference with others' reception by means of re-radiation.

If tuned-plate coupling is used for the H.F. valve or valves, one of the little holders makes a first-rate stand for the anode coil. Reaction may be obtained—this again is a permitted circuit for broadcast reception—by employing a pair of holders and wiring them as shown in Fig. 8.

To reach very long wavelengths several basket coils may be used in series to form an aerial tuning inductance or closed circuit inductance. All that is necessary is to mount each on a stand of its own and to connect them so that currents flow in the same direction.

There are, in fact, numbers of useful purposes which these little coil holders can be made to serve in the set. One can even obtain a variometer effect by connecting two together and varying the coupling between them.

As there are no gear wheels or other moving parts there is nothing to get out of order; indeed there is no reason why they should not withstand many years of constant use and still be as good as ever.

There is one point, by the way, about basket coils which is worth noting. Many of those on the market are very flimsy affairs, loosely held together by a very meagre coating of paraffin wax. If these are purchased and mounted they will be a constant source of annoyance owing to their habit of starting to come to pieces almost as soon as they are handled. There are three ways of dealing with them. One is to give them a little more backbone either by brushing them over with wax melted down from a worn-out high-tension battery, or by applying stiff shellac varnish. Another and better method of prolonging their lives and of saving one's

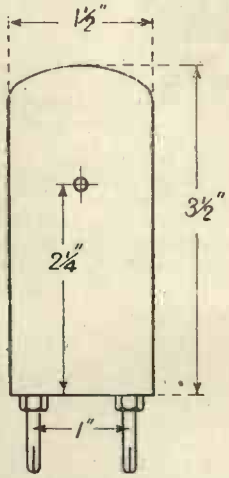


Fig. 4. Ebonite strip for mounting basket coils.

own temper is to "tape" them with sticking plaster. The best of all is to cut out two plates of thin celluloid with a diameter rather larger than that of the coil, and to place one on each side of it as a protector when fixing it to the ebonite mount.

The smallest sized baskets are of very little use—in fact it is not really worth while to mount them at all. The best plan for obtaining good reception on the lowest wavelengths is to make up a set yourself, using No. 26 double cotton-covered wire and winding them on stiff cardboard formers in which an odd number of slits have been cut. If the aerial tuning condenser is in series, as it should be, the primary can be quite large, with a corresponding increase in efficiency. A point in favour of card-wound coils is that they need have no shellac applied to them. Shellac is first-rate as a stiffener, but by providing an excellent dielectric between the turns it must be admitted that it increases the self-capacity of the coils, which is always a feature to be avoided if possible.

To whatever type of coils you adapt it, you will find this simplest of all tuners a thoroughly sound piece of apparatus. On my set it has performed so well and proved so easy to handle that no other has been used since it was installed.

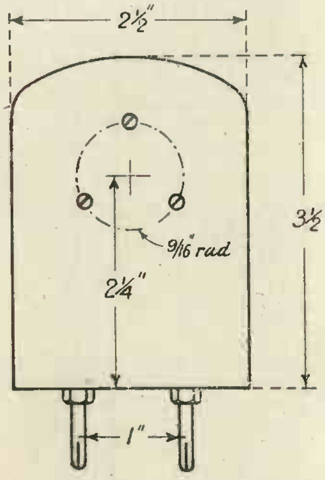


Fig. 5. Strip for mounting slab coils.

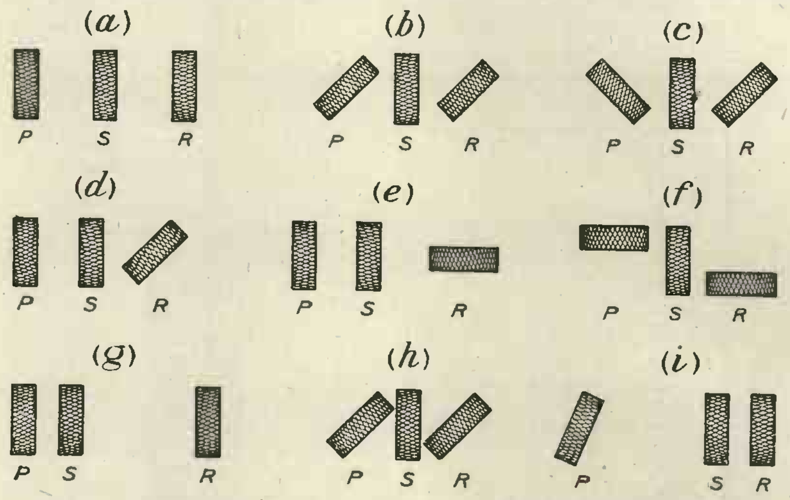


Fig. 6. Possible arrangements of coils which can be obtained with the holders.

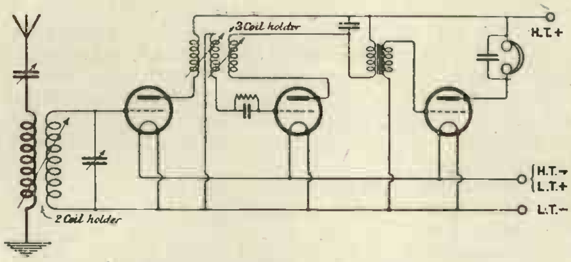


Fig. 7. Showing the use of the coil-holders to form a high-frequency transformer.

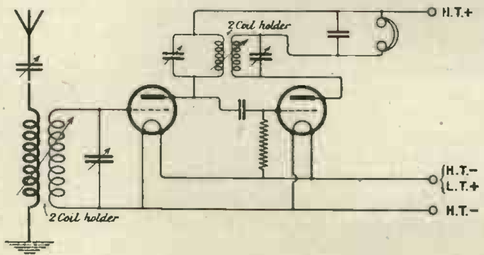


Fig. 8. The use of coil-holders in a tuned anode circuit.

DECORATIVE LOUD-SPEAKERS

An interesting development in loud-speaker design is described in a very artistically produced booklet which we have received from Messrs. Western Electric, Ltd. This pamphlet contains illustrations of a new series of loud-speakers the horns and bases of which are decorated with hand-painted coloured designs in a variety of types, ranging from Chinese dragons in gold upon a black background to a floral design in green and orange.

NOTES ON REACTION

By JOHN SCOTT-TAGGART, F.Inst.P.

Author of "Thermionic Tubes in Radio Telegraphy and Telephony," "Elementary Text-book on Wireless Vacuum Tubes," "Wireless Valves Simply Explained," "Practical Wireless Valve Circuits," etc., etc.

This month our regular leading article on wireless valves deals with reaction and there is much information which will be of interest both to the beginner and the more advanced reader. The subject is treated from an essentially practical standpoint.

REACTION has awakened in recent times an appreciable amount of criticism. There are those who say it would have been a blessing if reaction had never been invented. There are, on the other hand, those who maintain that it would have been better if some of the *users* of reaction had never been invented. Whichever view one takes, there is no doubt that the very large amount of interference due to oscillating valves causing squeals, howls and other noises, is making many wonder whether it is not very largely due to ignorance that so much trouble is being caused. Some of those who are most emphatic on the question of interference are, however, themselves causing a great deal of the trouble. They use a circuit which they believe will not cause radiation from the aerial, yet it actually does so.

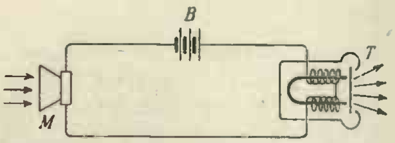


Fig. 1. A simple microphonic amplifying circuit.

Reaction is responsible for much. Not only is it the cause of radiation interference, but it has done a very great deal to prevent the development of radio science. The loud signal strength obtainable by the use of reaction has, for example, prevented all developments of rectification methods. The actual detection of oscillations is no more advanced to-day than it was nearly twenty years ago, and the fact that we make up, by reaction, for defects in other directions is, in a sense, a high tribute to that very useful method of increasing the strength of the incoming oscillations, for that, after all, is the chief result of reaction.

What is Reaction?

Reaction is a phenomenon by the utilisation of which it is possible to strengthen oscillating currents. The phenomenon may be used for strengthening potentials of any kind, but we are at present only concerned with the strengthening of wireless oscillations. The three electrode valve may be employed as a high-frequency amplifier in the manner described in our last month's issue. An amplification of about seven times is possible by this means, but we have another method, and this is known as the reaction method of amplification. The word implies an "acting back" and we find many alternative expressions for conveying the same idea. For example, in America they speak of the "regenerative" system, while we over here frequently speak of "retroaction." All these words imply a strengthening or building-up effect produced by transferring energy from the circuit in which the amplified currents are flowing to the circuit in which are flowing the currents to be amplified.

The History of Reaction.

The idea of reaction is very old, probably hundreds of years old. The ordinary steam-engine involves a species of reaction, just as does an ordinary watch or clock. In electrical science the idea was employed in the nineteenth century. In wireless matters, the phenomenon of reaction was well known even as far back as 1906 when discharge tubes, very similar in their action to ordinary valves, were used.

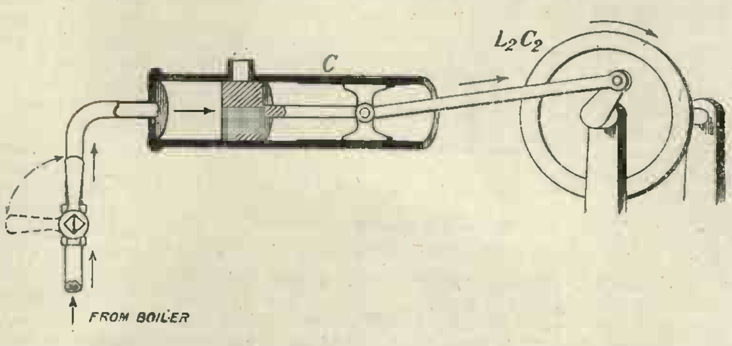


Fig. 3. Diagrammatic representation of an early type of steam-engine.

It is not my intention to discuss here the history of reaction, but I would add that its application to wireless reception is of much more recent origin.

There are degrees and degrees of reaction. A *small* amount of energy may be transferred from the output side of an amplifier to the input side, or the amount may be *large*. If the amount is large the amplifier will produce continuous oscillations and may be used as a generator for wireless purposes. If the amount is small an amplification effect is obtainable which is exceedingly valuable for wireless reception. E. H. Armstrong in 1912 appears to have invented the reaction system of reception in the United States and, in this country, C. S. Franklin—the brilliant Marconi engineer—apparently invented the same thing independently.

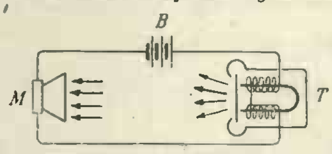


Fig. 2. A microphone circuit arranged to illustrate the principle of reaction.

Although we are primarily concerned with the use of reaction for wireless reception, yet it is impossible to consider the phenomenon without considering also the phenomenon of self-oscillation. Many of the new-comers to wireless are confusing the two phenomena.

The Principles of Reaction

Briefly stated, reaction in a wireless receiver is obtained by transferring some of the oscillatory energy from the anode circuit of a valve acting as a high-frequency amplifier to the grid circuit. This is usually done by connecting an inductance coil in the anode circuit of the valve and coupling it variably to the grid circuit. Sometimes the phenomenon is used even when the valve is not primarily intended as a high-frequency amplifier, as in the case where the valve is used as a detector.

I propose first to discuss one or two simpler examples of reaction before coming to its actual employment in wireless receiving circuits.

Fig. 1 shows a circuit containing a microphone, M, a battery, B, and a telephone receiver, T. If we speak into the microphone M, we will vary the current flowing round the circuit through the telephones, the result being that the telephones will give forth amplified speech; the sound

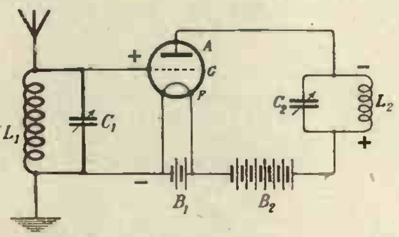


Fig. 4. A simple oscillating valve circuit.

waves set up by the telephone diaphragm will be of greater strength than those affecting the microphone, which is really a form of amplifier.

If we now take the microphone and telephone and place them close together, as shown in Fig. 2, it is highly probable that the arrangement will howl; a steady note will be emitted from the apparatus, but if we draw the microphone apart from the telephone receiver, the howl will cease. The howl is nothing more or less than a continuous low-frequency oscillation. The device is really a generator of low-frequency alternating currents which actuate the telephone and cause it to give out the musical note heard. What we have now done is to transfer some of the loud sound energy from the telephone T back into the microphone; this is then amplified, operates the telephone, which then gives forth a louder sound, which again affects the microphone, and so on until a maximum loudness is obtained and the apparatus becomes automatic. The transference of energy from telephone T to the microphone M is a species of reaction and advantage is taken of the phenomenon in Brown's microphone relay.

If the microphone be held at a certain distance from the telephone receiver, it is possible to carry out an interesting experiment. By producing a steady whistling note near to the apparatus, it will be found that the latter takes up the whistle and will even continue to emit the steady note after the original whistle has ceased. By gradually bringing the microphone closer to the telephone receiver, it will be found that the apparatus will continue to emit the note for an even longer period than before. After a few seconds, however, the note dies out. Now bring the microphone and telephone receiver still closer to each other. If you whistle, it will be found that the apparatus takes up the note and will continuously emit it. If the microphone is brought still nearer to the telephone, the apparatus will become self-exciting and no "start" will be necessary. This is due to some minute current variation producing a very small note which is almost instantaneously built up to a loud one.

When the apparatus is in the non-oscillating condition, we have what is equivalent to reaction in a wireless receiving circuit. If we whisper into the microphone or give a very feeble whistle, the microphone-telephone apparatus will take up the sound and greatly magnify it. So, in the same way, a reaction valve circuit will pick up feeble currents by the aerial and build them up to a considerable strength.

The Steam-engine Analogy

Quite a useful analogy is the one I have previously employed for explaining the self-oscillation of a three-electrode valve. Fig. 3 is a theoretical arrangement of one of the earliest types of steam-engine. Steam from a boiler passes along a pipe provided with a tap to the cylinder, C. This cylinder contains a piston which is connected through a piston rod to a crank connected to a fly-wheel, L_2C_2. If we give the fly-wheel L_2C_2 a few turns it would very soon come to rest owing to friction losses.

The method of working this engine was to turn on the tap (the operation was accomplished by a boy) and so let steam into the cylinder C, thus

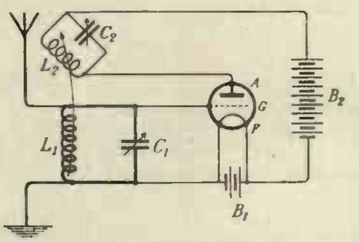


Fig. 5. An elementary reaction circuit.

forcing out the piston and rotating the fly-wheel. The boy had to turn off the steam, of course, after the wheel had made half a revolution to avoid the dead-centre effect. When the fly-wheel came round to the most suitable point again the steam was turned on, and this was done at every revolution, thus keeping the fly-wheel revolving, its own momentum carrying it through the inactive period.

This kind of a steam-engine is not unlike an ordinary valve amplifier. In Fig. 3 we have a means of controlling the steam, viz. the tap, which in a sense is somewhat similar to the grid of a valve; the fly-wheel corresponds to the output circuit of the valve, and the power developed is consequent on the regulation of the steam by the tap.

It occurred to the operator who turned the tap on and off that if some method of making the steam-engine self-acting could be devised, a great deal of trouble would be avoided. He noticed that the tap was always turned on at a certain position of the fly-wheel, and ingeniously connected

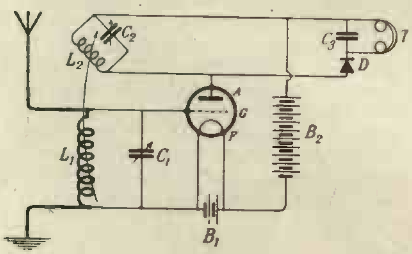


Fig. 6. A practical reaction circuit.

the tap to the fly-wheel by means of a rope which turned the tap on just when the fly-wheel was in the right position, the tap being turned off in other positions. In other words, what he did was to couple the output or power side of the steam-engine to the controlling side, or input side, which was the tap. The whole engine then became self-acting, or self-oscillating, and continued to work as long as steam was provided.

The Self-oscillating Valve

Having regarded these other examples of amplifiers, for even a steam-engine is, in a sense, an amplifier, we may now come back to the three-electrode valve and consider how its amplifying properties may be turned to advantage in special ways.

Fig. 4 shows a simple oscillating valve circuit in which an oscillation circuit, L_1C_1, is connected across the grid and filament, or input side, of a three-electrode valve. In the output or anode circuit of the valve we have another circuit, L_2C_2, tuned to the same frequency as the circuit L_1C_1.

Let us assume that an aerial and earth are connected to the circuit L_1C_1. If a feeble oscillation takes place in the circuit L_1C_1, magnified oscillations of the same frequency will flow in the circuit L_2C_2. These oscillations, however, will only persist as long as the oscillations in L_1C_1 persist. The valve is in a stable condition and merely acts as a high-frequency amplifier. If now we can transfer some of the energy from the output circuit L_2C_2 to the input circuit L_1C_1 we will strengthen the initial oscillations in L_1C_1.

Fig. 5 shows one method of doing this. The inductance L_2 of the circuit L_2C_2 is now coupled to the inductance L_1 in such a manner as to hand back some of the energy in L_2C_2 to the input circuit L_1C_1. This transference from the more powerful circuit L_2C_2 to the feebler circuit L_1C_1 has the effect of boosting up the oscillations in the grid circuit, and these will be found considerably stronger. These stronger oscillations in the grid circuit will be amplified by the valve and will cause still stronger oscillations to appear in the circuit L_2C_2. These stronger oscillations will now cause more energy to be transferred back into the grid circuit and these grid circuit oscillations will now become stronger than ever. A certain point is reached when it is not possible, for various reasons, to increase the strength above a certain point. If we transfer more than this amount of energy the whole circuit becomes unstable and the valve oscillates. This effect is produced when the inductance L_2 is brought too close to the inductance L_1.

Before we get to the "self-exciting" stage we obtain the effect generally known as "reaction amplification," but when we increase the reaction above a certain point the transfer of energy from the anode circuit to the grid circuit is sufficient to make the apparatus oscillate of its own accord. All that is necessary is for something to set up a very feeble oscillation in the circuit L_1C_1. Even after the origin of the oscillation has disappeared the minute oscillations are built up almost instantaneously to a maximum value, and the valve becomes a generator of alternating current, the frequency of which will be determined by the constants of the circuits L_1C_1 and L_2C_2.

We are now getting an effect similar to that in the steam-engine and the microphone buzzer of Fig. 2.

The generating, or self-oscillating, condition of the valve is useful for the transmission of wireless waves and also when receiving such continuous waves, but it is not desirable to have it when receiving speech or music by radio.

It is to be noticed that the transference of energy may take place either in such a way as to strengthen the oscillations in the grid circuit or to enfeeble them by introducing into the grid circuit oscillations of directly opposite phase—that is to say, when the original oscillation in the grid circuit is flowing in one direction, the oscillation induced from the anode circuit tends to flow in the opposite direction. In this case the two cancel out and no amplification effect is obtained.

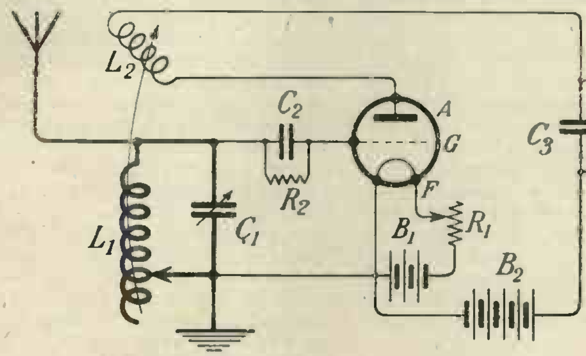


Fig. 7. Reaction circuit using the valve as a rectifier.

Reactive Receiving Circuits.

Fig. 6 shows a circuit similar to Fig. 5, except that we now have a crystal detector, D, and telephones, T, connected across the anode oscillatory circuit L_2C_2. The inductance L_2 is coupled to the inductance L_1 in such a way that the magnified currents in L_2 induce into the circuit L_1C_1 and strengthen the oscillations existing in that circuit due to the incoming wireless waves. The effect in this circuit is simply that when the grid is being made *positive*, say, by the incoming currents, there is an increase of electron flow to the anode A and round through the inductance L_2, this flow of current inducing a similar current into the circuit L_1, which flows in such a direction as to make the grid *more* positive. When the oscillations in L_1C_1 reverse and the grid is made *negative*, there is a decrease of electron current round the anode circuit, and this decrease causes electromotive forces to be induced into L_1 in such a direction as to make the grid G still more negative. As long as the coupling between L_2 and L_1 is not too tight, a piece of music may be readily received, but the moment that we bring the coil L_2 too close to the coil L_1, or in other words couple the two coils too tightly, the valve will commence to generate continuous oscillations of its own accord; but these may be stopped by drawing the coil L_2 away from the coil L_1 once more. A very careful adjustment of the coupling between L_2 and L_1 is necessary in order to get the maximum amplification effect owing to the building up of the oscillations in L_1C_1 without actually causing the valve to become a generator of oscillating currents of its own accord. The built-up oscillations in the anode circuit of the valve are detected in the usual way by the crystal.

It is to be noted that although an initial small oscillation or current variation is necessary to start the self-oscillation process, yet such self-oscillation will set in even if there is no oscillation applied from outside. This is because there are always very small current variations in one or other of the valve circuits, and these suffice to set the valve oscillating.

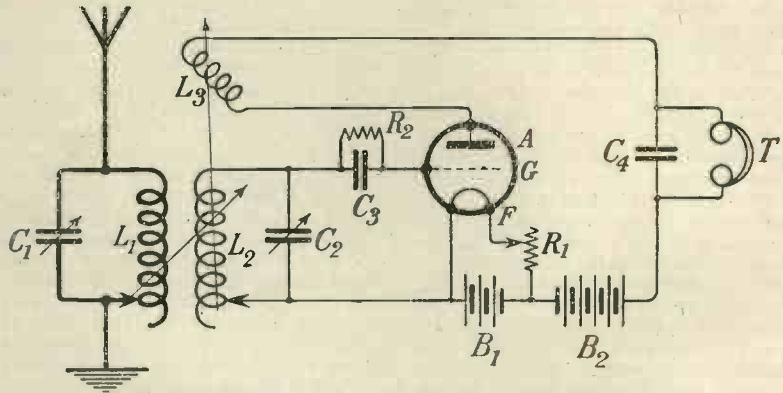


Fig. 8. A loose-coupled reaction circuit.

Instead of using a crystal detector, we may use the valve itself, not only as a means of obtaining reaction, but as a detector, and Fig. 7 shows a very usual arrangement. We now have a grid condenser, C_2, shunted by a resistance R_2, of, say, two megohms value. The use of the grid condenser in this manner is well known and is for the purpose of causing the valve to act as a rectifier. In the anode circuit of the valve we have telephones, T, shunted by a condenser, C_3 of about 0·002 μF., this condenser acting as a short-circuit to the telephones as regards the passage of high-frequency currents.

In operating this circuit it is very important to see that the coil L_2 is coupled the right way round to L_1, otherwise the oscillations passing through L_2 will have the effect of acting in opposition to the original oscillations in L_1C_1. If no increase in the strength of signals is obtained as a result of bringing L_2 closer to L_1, even when the circuit L_1C_1 is re-adjusted, it is a clear indication that the coil L_2 is coupled incorrectly to the coil L_1. The simplest method of remedying this is to change round the connections to the coil L_2. When honeycomb or similar plug-in coils are used, it is not sufficient simply to reverse the coil in the holder, as no different effect is then obtained, for the simple reason that not only is the coil reversed, but also the connections to it. The correct thing to do is to change the leads to the terminals on the coil holder.

Use of Aperiodic Reaction Coils

The reaction coil L_2 shown in Fig. 7 is not part of a tuned anode circuit. In the case of Fig. 6 it is desirable to have a tuned anode circuit because we are deriving the energy for the crystal detector from this tuned circuit, whereas in Fig. 7 we are not actually using the anode circuit oscillations but only those in the grid circuit. The anode circuit oscillations are only utilised to strengthen those flowing in the grid circuit.

The advantage of using an aperiodic reaction coil is that it is possible to use the same coil for a wide range of wavelengths. It is possible, for example, to use the same coil to cover a wavelength range of from 200 to 1,000 metres. One of the troubles of a tuned reaction coil is that, in the first place, it needs to be adjusted accurately to the incoming oscillations, and therefore necessitates an extra adjustment; another is that the valve tends too much to oscillate of its own accord. Tuned reaction coils are therefore not to be recommended except where it is not possible to obtain sufficient reaction by means of an aperiodic coil. Sometimes, when using honeycomb coils, sufficient reaction cannot be obtained by using an ordinary aperiodic reaction coil. This is often because it is not possible to couple the two inductances sufficiently tightly, as is possible using two tubes sliding one inside the other. In such cases, a tuned reaction circuit is an advantage.

The Size of Reaction Coils

The size of the reaction coil is of considerable importance. It should neither be smaller nor larger than a certain size best found by experiment. A mistake commonly made by those who use honeycomb coils is that they imagine that because they obtain louder results with a large reaction coil that this should always be recommended. This is not so. It depends entirely upon the degree of coupling which may be obtained between the grid and anode circuits of the valve. When plug-in coils are used, it is often very difficult to get sufficiently tight coupling between the two, and it is therefore common practice to use a larger reaction coil, partly to get an increased coupling effect, but also very largely because when a larger reaction coil is used the anode circuit contains what is virtually a tuned reaction circuit. It is tuned because even a so-called aperiodic coil in the anode circuit has, when connected in that position, a small capacity across it, and when the frequency of the combination approaches that of the grid circuit, a very strong reaction

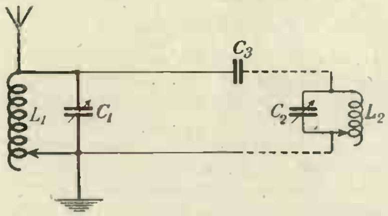


Fig. 9. Illustrating the theory of capacity reaction.

effect is obtained and self-oscillation often sets in.

For these reasons those who use honeycomb coils, or cannot couple their grid or anode circuits sufficiently tightly together, should use larger coils in their anode circuits than in their grid circuits, and it is important to try different reaction coils before being satisfied. For example, in a certain circuit not of the kind shown in Fig. 6, but one using reaction, it was found that while the grid circuit contained a honeycomb coil having 50 turns, the best results were obtained when the anode circuit reaction coil had 75. When a 50-coil was tried, it was found that the maximum reaction effect could not be obtained. When a coil having 100 turns was tried, the valve tended to oscillate too much, and moreover the signal strength was actually reduced as the coupling was tightened.

The moral is, of course, to select your reaction coil very carefully. This advice applies specially to those who cannot obtain tight coupling between anode and grid circuits.

The Use of Reaction for Reducing Damping

A very important use of reaction is for the reduction of damping in wireless receiving circuits. If an oscillation is set up in a wireless receiving circuit, one might expect the oscillation to go on for ever; but the energy of the oscillation is dissipated in various ways, the principal one being the conversion of the energy into heat owing to the resistance of the circuit. Every wireless oscillation circuit possesses resistance, and this wastes the oscillatory current. If we could cut down the resistance to zero, the oscillation would become very strong and would practically persist. Resistance in an oscillatory circuit damps out the oscillation. An oscillation induced into a circuit having very low resistance will be prolonged, even after the force which set up the oscillation has disappeared.

If we take a pendulum and give it a sharp tap, the pendulum will go on swinging long after we have given it the tap. If, however, instead of having an ordinary kind of pendulum, we have one made of plasticine and give it a tap it will probably swing once and then stop. To keep it swinging we should have to keep on giving it taps. Obviously, the longer we can cause the incoming oscillations in a wireless receiver to swing, as it were, the greater will be the amount of energy available for operating the telephones after rectification.

One of the chief effects of reaction is to cause the oscillations in the receiving circuit not only to increase in magnitude, but to persist for a longer period. This is, to a certain extent, a disadvantage, and a certain amount of distortion is very often obtained as a result of increasing the reaction effect too much.

A wireless receiving circuit in which reaction is introduced is very similar to a pendulum which is suspended on practically frictionless supports. A small amount of energy will set the pendulum swinging, whereas in the case of a pendulum suspended unscientifically we will require a considerable amount of energy to set it oscillating, and even then it will come to rest very soon after the initial energy has been expended in setting it in movement.

The effect of introducing reaction into a wireless receiving circuit is really to reduce the resistance of that circuit. Hence, we commonly speak of reaction as introducing a *negative resistance*, or something which is the very opposite of ordinary resistance, into the circuit. Now, resistance in a circuit has the effect of making that circuit less receptive to a particular wavelength. It would be almost impossible to tune accurately an aerial circuit if the inductance and aerial were made of resistance wire. The lower the resistance of the circuit, the finer tuning is it possible to obtain. It is therefore only natural that when reaction is introduced into a circuit it is possible to get very much finer tuning, and a slight variation of a tuning condenser will entirely cut out a station which, if there had been no reaction, could still have been heard, owing to the flat tuning.

Reaction has therefore two chief effects: It strengthens signals and it improves the tuning.

When reaction is being introduced into a circuit, it will often be found that it is much more difficult to tune-in a station accurately. It is therefore common practice to employ a

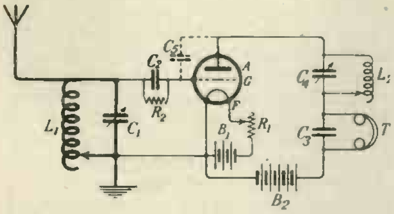


Fig. 10. A circuit which frequently oscillates without the intentional use of reaction. The dotted condenser C_5 represents the inter-electrode capacity of the valve.

very small capacity condenser in parallel with the ordinary tuning condenser. This small condenser is often called a "vernier" condenser, and its chief purpose is for obtaining the finer tuning which is necessitated by the use of reaction. When no reaction is employed and the wavelengths received are not very short, there is no need for a vernier condenser.

Another effect which will be noticed when reaction is employed, is that placing the hand near to different parts of the instrument will cause large changes in the strength of signals heard. This may either be due to a change in the amount of reaction applied, or more probably due to a change in wavelength of one of the circuits. The capacity, for example, across an inductance would be varied by placing the hand near the condenser. If no reaction were employed this slight change in frequency would not make any difference to the signal strength owing to the flat tuning.

Reaction and Loose-coupled Circuits

Circuits containing a large amount of resistance will need a greater amount of reaction to lessen the effect of that resistance to approximately zero. When the resistance is almost, but not quite, entirely neutralised, the loudest signals are heard. If the resistance is completely neutralised, self-oscillation sets in. It is to be noted that the resistance need not necessarily be in the oscillatory circuit itself. If another circuit containing resistance and capable of absorbing energy from the first circuit is brought near to it, the damping of the first circuit will be increased, and consequently more reaction will be necessary.

Let us study this in an actual example. Fig. 8 shows a very common receiving circuit in which the aerial circuit L_1C_1 is loosely coupled to the grid circuit L_2C_2, both circuits being tuned to the same frequency. A reaction coil L_3 is coupled to the closed circuit inductance L_2. Let us assume that the coupling between L_1 and L_2 is at a medium value and that the inductance coil L_3 has been coupled to L_2 in such a way that the loudest signal results are obtained. Under these conditions, it is to be noticed, not only does the circuit L_2C_2 have some of its resistance neutralised but the resistance of the circuit L_1C_1 is also, to a certain extent, neutralised owing to the coupling between L_1 and L_2. It is, therefore, not essential that there should be actual metallic contact between two circuits in order that one should receive the benefit of the reaction applied to the other.

It will be found, for example—and this is always a very good test to see whether a circuit is absorbing, as it were, the benefits of reaction—that when the inductance L_1 is coupled to L_2 the tuning on the aerial circuit will become very much sharper and a slight variation of the condenser C_1 will cut out the desired station.

When the conditions are as I have stated, what will be the effect of loosening the coupling between L_1 and L_2, and why? Many a student could not answer this question although the answer is very simple. Loosening the coupling between L_1 and L_2 means that the reaction effect on L_1C_1 will be lessened while the reaction effect on the circuit L_2C_2 will be increased, this being due to the fact that when the inductance L_1 is more tightly coupled to L_2 the damping of the circuit L_2C_2 is increased. If, on the other hand, we do what is proposed, *i.e.*, loosen the coupling between L_1 and L_2, the damping of the circuit L_2C_2 is lessened and the available reaction introduced by L_3 may now be even more than sufficient to overcome the resistance in the circuit L_2C_2. Put simply, the loosening of coupling between L_1 and L_2 will increase the reaction on the circuit L_2C_2 and probably cause self-oscillation of the valve.

If we tighten the coupling between L_1 and L_2, the available reaction effect introduced by L_3 will not be sufficient, as the damping of the circuit L_2C_2 has been increased because of the tighter coupling with the aerial circuit tuned to the same frequency. The result is that the tighter the coupling between L_1 and L_2, the tighter will have to be the coupling between the reaction coil of L_3 and the coil L_2 to obtain the same signal strength.

Single circuit tuners in which the grid circuit of the valve is directly in the aerial circuit, *i.e.*, a direct-coupled arrangement, tend to oscillate far less than loose-coupled arrangements, and the reason is simply this: That the resistance of the aerial circuit is permanently connected in the grid circuit and the reaction effect needs to be much greater to make the valve oscillate. In the loose-coupled arrangement, however, unless the aerial circuit is very tightly coupled to the grid circuit, the damping of the grid circuit is relatively small, and it only needs a little reaction to cause self-oscillation.

Before leaving this point, I would like to explain a phenomenon which often occurs when working a circuit of the Fig. 8 type. It will be found sometimes, especially when the coupling between L_1 and L_2 is fairly loose, that when the circuit L_1C_1 is tuned to a certain position, the valve does not oscillate, but if tuned to either side, the valve immediately begins to oscillate. The non-oscillating condition is obtained when the circuit L_1C_1 is tuned to the same frequency as the circuit L_2C_2. When this happens, the aerial circuit is really absorbing some of the reaction energy introduced into L_2C_2. Put in another way, the damping of the circuit L_2C_2 is increased. When, however, the circuit L_1C_1 is detuned to one side of the incoming frequency, the reaction effect is not absorbed by the aerial circuit and the circuit L_2C_2 has to stand the full effect and generally succumbs, with the result that self-oscillation sets in. Expressed other-

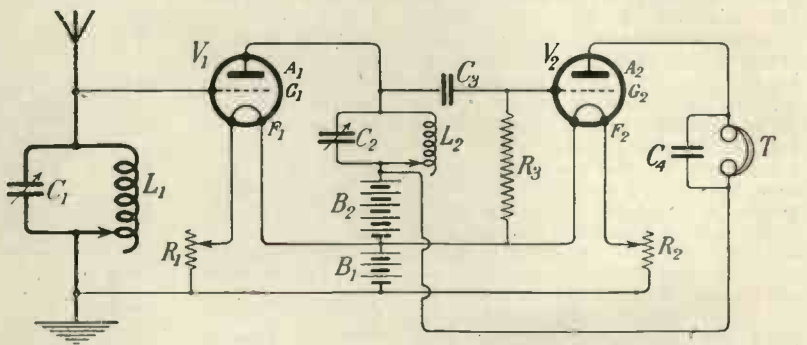


Fig. 11. A two-valve circuit in which undesired reaction may occur.

wise, we can say that when the circuit L_1C_1 is tuned to a frequency differing from that of L_2C_2, the damping of the circuit L_2C_2 is at once decreased and the reaction introduced by L_3 is more than sufficient to compensate for the resistance of the circuit.

Unintentional Reaction

We know only too well that unintentional reaction effects are frequently obtained in valve-receiving circuits; even though the circuit itself may be quite orthodox, yet in unskilful hands, or under certain circumstances, it may cause radiation of continuous waves from the aerial, these waves interfering with reception by neighbours.

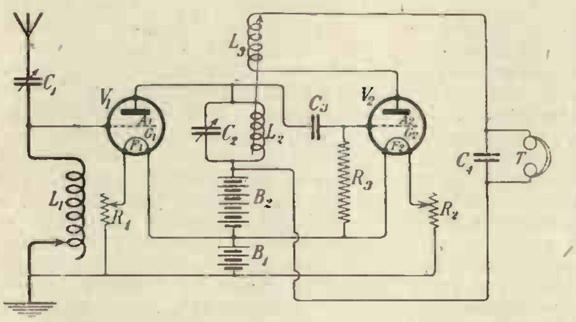


Fig. 12. *The best reaction circuit for broadcast reception.*

These undesirable oscillations are produced through some coupling between the anode circuit of a valve and the grid circuit of a valve—usually the same valve. We generally try and get reaction by means of a magnetic coupling between the anode and grid circuit. By magnetic coupling we imply that we have caused an inductance coil in the anode circuit to be brought close to an inductance coil in the grid circuit. This, however, is not the only means of coupling two circuits together and so transferring energy from one to the other.

A common method of coupling is by means of a condenser. Fig. 9 shows a typical circuit in which we can couple the ordinary circuit, L_1C_1, to another circuit, L_2C_2, tuned to the same wavelength, by the aid of a small fixed condenser, C_3, connected in the position shown. If such a circuit is arranged, the oscillations in the aerial circuit may be caused to produce oscillations in L_2C_2 just as well as if we left out the condenser C_3 and coupled the inductance L_2 to L_1 magnetically.

Now, in a valve circuit where there is high-frequency amplification, the anode circuit may be coupled to the grid circuit by some capacity such as a small condenser formed by the grid and anode inside the valve, or by wire leads to these electrodes.

Fig. 10 shows a receiving circuit which is really an ordinary detector circuit with the addition of a tuned anode circuit L_2C_4. To obtain reaction effects we would in the ordinary way couple the inductance L_2 to the inductance L_1, but these reaction effects are very frequently present, even though we do not directly couple these two inductances.

If you connect the circuit up as shown, you will very frequently find that signals are very much stronger when L_2C_4 is tuned to the incoming wavelength than when the circuit is left out altogether. This is because there is a certain natural coupling between L_2C_4 and L_1C_1, this coupling being chiefly effected by the small condenser formed by the grid G and anode A inside the valve. The presence of the grid leak and condenser C_2 need not here be considered as they do not materially affect the question of coupling and tuning.

The two circuits L_2C_4 and L_1C_1 are coupled together now in much the same way as the circuits L_2C_2 and L_1C_1 are coupled in Fig. 9. Unfortunately, they are coupled in such a manner that the magnified oscillations in L_2C_4 react on the grid circuit in a manner which strengthens the grid circuit oscillations, and frequently this type of circuit will oscillate of its own accord. Capacity between grid and anode circuit leads also helps to make sets oscillate of their own accord when it is not desired that they should do so.

Tuned reaction coils, therefore, are dangerous from the point of view of making the valve oscillate of its own accord.

A similar effect is obtained whenever the anode circuit of a high-frequency amplifier is tuned. Whether this takes place in a single valve or multi-valve circuit, a tuned anode circuit will always tend to cause trouble due to self-oscillation. When the tuned anode circuit is shunted by a crystal detector and telephones, or the primary of a low-frequency transformer, the damping introduced by the detector will, in practically all cases, prevent any tendency to oscillate. Also when a tuned anode circuit is used to couple the first and second valves of a receiver, the grid circuit damping of the second valve will lessen the tendency of the first valve to oscillate. If, however, the grid leak of the second valve is of too high a resistance, or is left out altogether, the tendency to oscillate will be greater.

By a tuned anode circuit, I do not simply mean one tuned by a condenser. If the natural frequency of a tuned anode coil corresponds to the frequency of the grid circuit, self-oscillation will be likely to arise and very often the tendency to self-oscillation is very much greater when either a variometer or an adjustable inductance is included in the anode circuit of a high-frequency amplifier. If the natural frequency, such as it is, of an anode coil is not the same as the grid circuit, then the tendency to oscillate is not great, but if it should coincide with the grid circuit frequency (and under these conditions the greatest amplification is obtained) there is always the danger of self-oscillation. The natural reaction effect due to the coupling through the valve may be highly beneficial in many cases, and it will be found that very loud results are sometimes obtainable without any *intentional* reaction whatever; if self-oscillation is obtained, however, the experimenter will now know why it is.

The greater the capacity across either the grid circuit or the anode circuit, or both, the less will be the tendency for the valve to generate oscillations of its own accord. If,

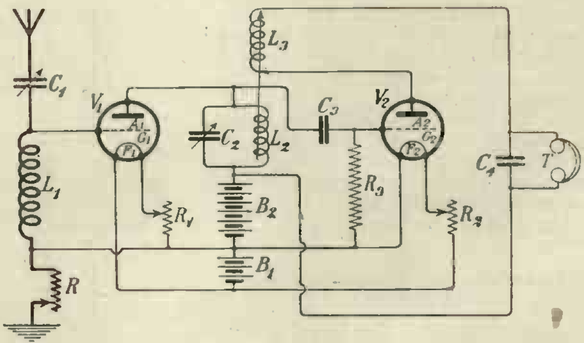


Fig. 13. *A method of preventing self-oscillation by the introduction of damping.*

then, your valve oscillates too readily it may be due to the fact that you are using too large an inductance and too small a capacity on your condenser. A decrease of one and an increase of the other will probably result in a decrease in the tendency to oscillate.

Multi-valve Circuits which Tend to Oscillate

Fig. 11 shows an excellent two-valve circuit which may be adapted to a three-valve or four-valve circuit by the addition of one or two low-frequency amplifying valves. We here have a tuned anode circuit, L_2C_2, which, when tuned to the incoming frequency, will act as a very efficient coupling between the first and second valves. This circuit is mentioned here because it ought, ordinarily, not to oscillate. If it does, the trouble is either that the valve filaments are too bright, the high-tension battery B_2 is of too high a value, or the condensers C_1 and C_2 are of too small a value. A condenser, C_4, having a capacity of 0·002 μF. will often stabilise the circuit considerably. Sometimes this circuit is reported upon very favourably. At others there are those who say that the efficiency is not nearly as great as when reaction is introduced into the circuit L_1C_1, either by coupling L_2 to L_1 or by inserting a reaction coil into the anode circuit of the second valve.

It is really a matter of personal experience with the apparatus in use. If very good results are obtained with this circuit, it is due to the inherent coupling between the circuit L_2C_2 and the circuit L_1C_1, which is producing a natural form of reaction which is just as good as a deliberate one, except that it is not under the same control. To test whether this reaction effect is being obtained, it is easy to note whether the tuning on the circuits L_1C_1 and L_2C_2 is very sharp. If not very sharp, much louder results may be obtained by either coupling L_2 to L_1, when there is a real danger of causing interference by self-oscillation, or by coupling an anode coil in the anode circuit of the second valve to the inductance L_2.

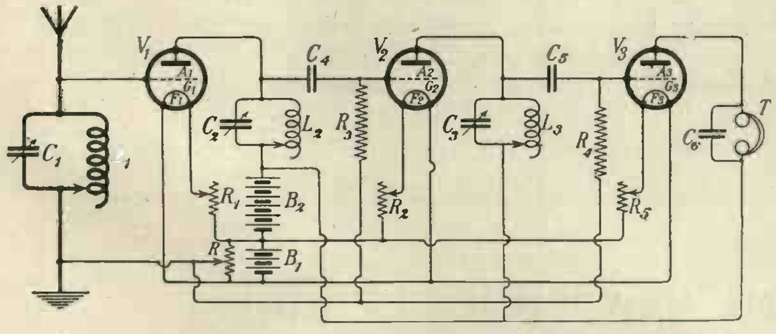


Fig. 14. Illustrating the use of a potentiometer to control reaction.

This latter type of circuit, which was first published by the writer in his book, "Thermionic Tubes in Radio Telegraphy and Telephony," is reproduced in Fig. 12. This is an excellent all-round circuit for the reception of broadcasting, and the dangers of self-oscillation are not very great. Oscillation of the second valve, of course, may be easily produced by tightening the coupling between the reaction coil L_3 and the coil L_2, but even if the second valve *does* oscillate the consequences are not quite as serious as if the first valve oscillated.

Sometimes the *first* valve oscillates on this kind of circuit, and this is then due to the natural coupling between the circuit L_2C_2 and the circuit L_1C_1. This tendency to self-oscillation is greater when a series condenser in the aerial circuit is employed in preference to a condenser in parallel with L_1.

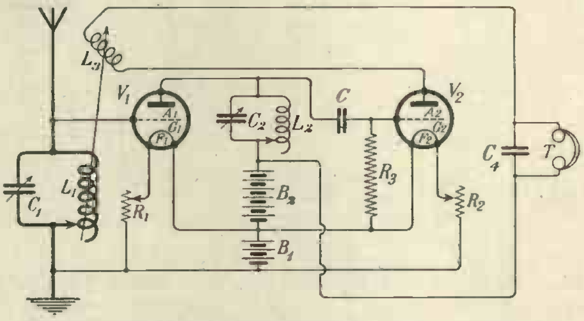


Fig. 15. A circuit which introduces reaction effects into both aerial and anode oscillatory circuits.

If the effect is very disturbing, it is easy to see whether the first valve is oscillating or not. If the condenser C_1 is varied, and the heterodyne note varies greatly with the slightest movement of C_1, the first valve is oscillating and something should be done at once to stop it. If, however, the variation in the capacity of C_1 only produces a very slow change in the heterodyne note, it is the second valve that is oscillating. If the first is oscillating, this may be often prevented by connecting the bottom side of the grid circuit to the positive side of the filament accumulator, instead of to the negative side. This introduces grid damping owing to the setting up of a grid current when positive oscillations make the grid positive. We have, in effect, done what is almost equivalent to connecting a high resistance across the inductance, and this, as a matter of fact, may be tried if no other remedy is found successful.

Fig. 13 shows another drastic remedy, and here we have a filament rheostat or other resistance, preferably of not less than 10 ohms resistance, included in the aerial circuit. This is for the purpose of introducing damping into the aerial circuit and so lessening the reaction effect on the grid circuit of the first valve.

Fig. 14 shows a three-valve high-frequency receiver in which the tendency to oscillate between the different valves is considerable. The only way to find out which valve is the culprit, if this set oscillates, is to test out each grid circuit separately in the manner indicated. Sometimes the whole chain is oscillating. A good all-round remedy in the case of trouble in a circuit of this sort is to connect all the grid circuits together and join them to the slider on a potentiometer resistance connected across the filament accumulator, as shown in Fig. 14.

Reaction from One Valve to a Preceding One

Fig. 15 shows a circuit which has been called by different names within the last year or so but which was also first published in my previously mentioned book. I mention these facts, not with the idea of attempting to gain any credit for them, as there are many who might consider that the design of these circuits involves no very great originality, but to indicate that there is no novelty regarding them.

The circuit of Fig. 15 is quite a useful one, and has the advantage that reaction is introduced, not only into the aerial circuit, but also into the tuned anode circuit L_2C_2; the reaction coil L_3 is coupled to the aerial inductance L_1, and therefore not only is reaction introduced into the aerial circuit, but into all the circuits of intermediate valves. In the present case, of course, there is only one intermediate valve, and we therefore get a reaction effect into L_1C_1 and L_2C_2. One of the advantages of the Fig. 15 circuit is that it particularly lends itself to apparatus using plug-in coils, and, owing to the two stages of amplification, it is not necessary to couple L_3 and L_1 closely. This circuit sometimes oscillates on the first valve, and previously mentioned methods may have to be adopted to prevent this happening. The first thing to try is to connect the bottom of the aerial circuit to the positive side of the filament accumulator instead of to the negative side as shown.

Damping introduced into the aerial circuit does not matter, as we can always balance it out by means of the reaction coil L_3.

A Useful Circuit

Those who, after reading this article, feel that they can experiment with circuits that tend to oscillate but need not do so in experienced hands, may care to try the Fig. 16 arrangement.

We here have a tuned anode circuit, L_2C_2, the inductance L_2 being coupled to L_1 so as to produce reaction effects. This circuit will give very good results and only necessitates two inductances.

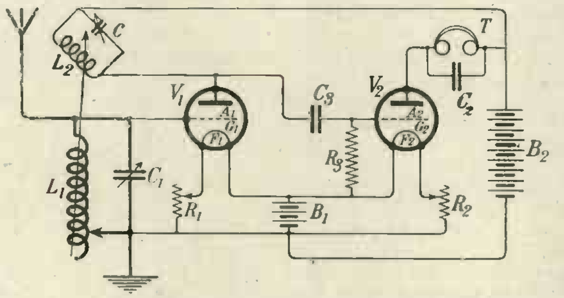


Fig. 16. *A circuit which demands great care in its operation.*

One or two low-frequency amplifying valves may be added to get greater signal strength. Great care must be taken to see that this circuit does not oscillate as, if it does, the aerial will be strongly energised and interference will be caused to hundreds of neighbours. Only the most experienced are advised to try Fig. 16, and many of these will find that the results obtainable are no better than those resulting from the use of Fig. 12. This circuit may not be used for the reception of British broadcasting.

Conclusion

In conclusion, I would like to express the hope that every Society and every experimenter will do his utmost, not to revile, but to *instruct* his less experienced friends. Only by instruction, combined with an attempt to inculcate a spirit of unselfishness amongst listeners-in, will it be possible to lessen the present evils of radiating receiving sets.

SHELLAC VARNISH

WHEN properly used, shellac varnish forms one of the most useful insulating compounds at the command of the wireless experimenter, but to secure the best results certain precautions must be observed in its preparation and application.

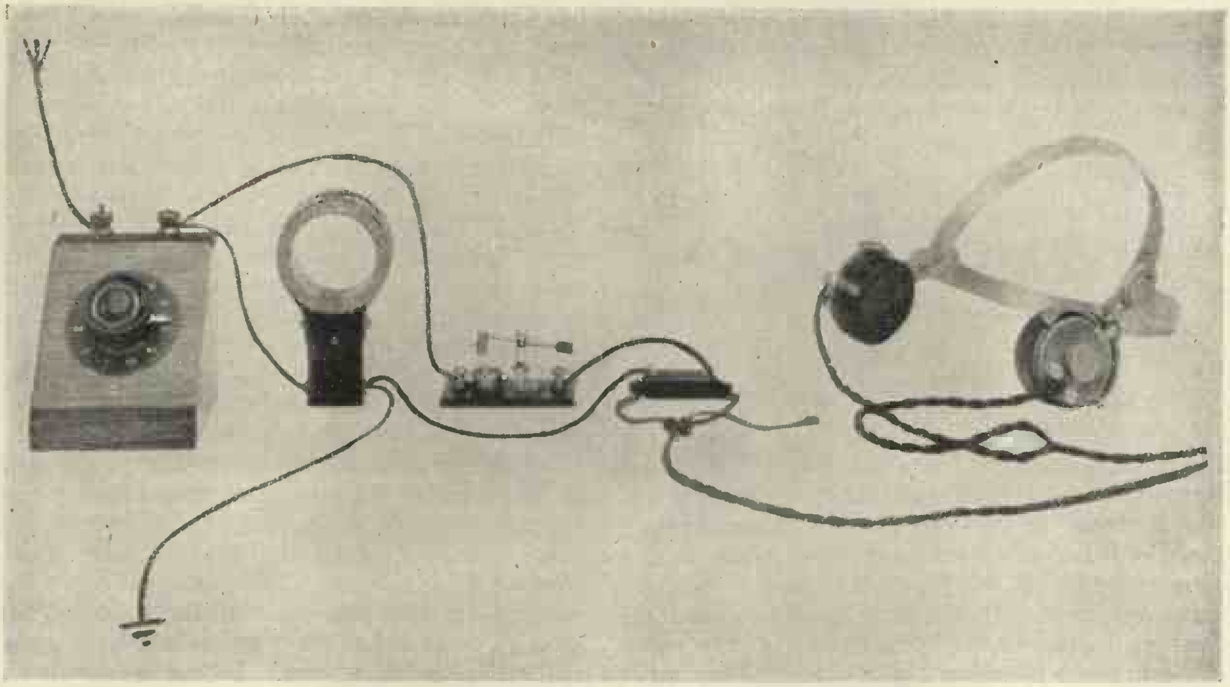
It should always be made up by the user himself, unless it can be bought from an electrical firm of assured repute, since much of the varnish sold is simply the product of the ordinary paint and colour manufacturer, which contains a number of ingredients that seriously impair its insulating properties.

The varnish should be made up by dissolving finely broken shellac in methylated spirit (or absolute alcohol if obtainable) *without* the application of heat; this takes some time and may be assisted by stirring.

The essential point to remember in using the varnish is that it is only a good insulator when thoroughly dry, and therefore it should be applied in *thin* coats, and dried by baking in a moderately hot oven. This last is especially important in the case of multi-layer coils which have been impregnated with shellac, since it is only possible to ensure complete drying of the varnish in their interstices by the application of a temperature higher than 100° C.

THE SIZE OF THE NEW "MODERN WIRELESS"

As announced upon another page, the June number of MODERN WIRELESS will be considerably increased in size. This increase will amount to an additional 30 pages of *text*.



A useful crystal set assembled from purchased components.

SOME SIMPLE SETS EMPLOYING CRYSTAL RECTIFICATION

By ALAN L. M. DOUGLAS, Associate Editor WIRELESS WEEKLY

An article giving detailed instructions for the assembly of some useful types of sets from purchased components.

Sets Employing a Crystal alone

MANY experimenters who do not care to go to the trouble of making all the component parts of a crystal receiver feel that the purchase price of the complete instrument is not at the same time fully justified, and so they elect to buy certain parts and piece them together. This practice has of late become very popular, and has much to recommend it, as not only is the complete apparatus sure to present a workmanlike aspect and to function well, but a much wider scope for design and general arrangement is presented, and is a direct incentive to ingenuity on the part of the builder—which it is one of the chief aims of this paper to stimulate. For a simple crystal receiver it is necessary to have (*a*) a tuning coil, or some device of a like nature and function ; (*b*) a crystal detector or rectifier ; (*c*) a pair of high-resistance telephones so as to make the detected wave-trains audible ; and (*d*) a fixed condenser of relatively large capacity forming a radio-frequency shunt to the telephone circuit so as to prevent damping and to sharpen the signals. All of these parts, with the exception of a telephone headgear, can be readily assembled by the experimenter without any other tools than a screw-driver, pliers, and possibly a small hand drill.

The Aerial Tuning Inductance

The first item to receive consideration will be the aerial tuning inductance. This is usually formed of a cardboard tube, which should be well impregnated with wax, or coated with shellac. It is surprising how few experimenters seem to realise that high-frequency currents are very prone to leak off the wire conveying them, and at the slightest chance will readily do so. High-frequency current travels upon the surface of a conductor and not *in* it, and therefore, within limits, the heavier gauge of wire we can employ the better. For short waves, let us say from 100 to 600 metres, No. 18 or 20 S.W.G.

enamelled or d.c.c. wire may be used, and although it makes rather an intermittent contact with the customary form of slider, it should not upset the latter's working if it is properly

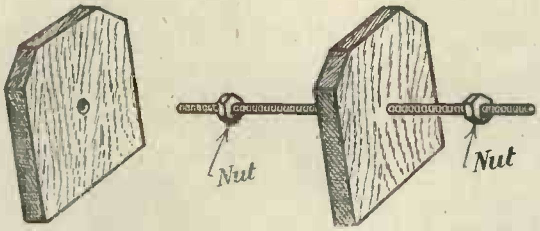


Fig. 1. *Method of assembling slider coil.*

designed. The inductance tube should be substantial and have thick walls, and it is necessary that it should be perfectly round. A moment's thought will confirm this statement, when it is remembered that we propose to use a sliding contact upon it. It will be necessary to mount the tube between end pieces, and a good method of doing this is shown in Fig. 1 (which shows the complete coil assembly). This method is simple, but too great a pressure must not be exerted on the tube by the sliding contact or it may tend to slip. The wavelength range over which it is required that electrical resonance be established will of course determine the size of tube and the number of turns of wire employed ; but a tube 4 in. in diameter by 7 in. long, wound full of No. 20 S.W.G. enamelled wire, will cover all the short-wave amateur working, British broadcasting and ship transmissions. This will be sufficient to satisfy the majority of elementary experimenters, for whom this article is chiefly written.

The Crystal Detector

The next item to claim attention should be the crystal detector this all-important device can be readily put together for a remarkably small sum if a set of parts, such as are shown in Fig. 2, are bought. It will be seen that these consist of : (*a*) two terminals ; (*b*) a crystal containing-cup with three screws for holding the crystal and an attachment to the base (*c*); (*d*) a small angle-piece of brass, suitably drilled, the purpose of which is to hold the rest of the search-point assembly to the base, and also to adjust the pressure on the ball. This is contained between the bearing plates, and has the search-point arrangement passing through it. To the latter is attached a small piece of brass wire, coiled up as indicated in the photograph. This is commonly known as a "cat-whisker," probably in deference to the American term. Suitable small screws and nuts hold the parts together, and the base may have a groove cut across it on the underside to carry the necessary short connecting wires which will run from (*b*) and (*d*) to the terminals. The method of assembling this should be evident to any experimenter however inexperienced, the more so as the base will probably be all drilled ready for the attachment of the various parts. The wiring-up, however, is effected by looping a small piece of bare copper wire round the shank of the screw holding the crystal cup in place, and taking this to the nearest terminal for attachment to it in a similar manner ; and in the case of the screws securing the brass angle-piece the same scheme is carried out with one of the screws holding it to the base. These small pieces of wire, which may be conveniently snipped off the bobbin used for winding the inductance (if it has been wound at home, so to speak), will be found to lie quite conveniently in the groove cut across the base. The crystal detector is now complete, and all that is necessary is to insert a small piece of mineral into the cup and it may be pressed into service. Until the

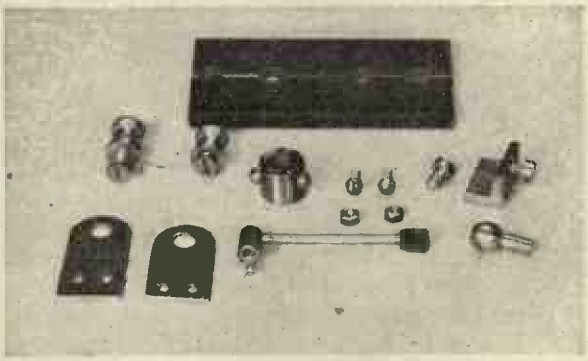


Fig. 2. *A set of parts for the assembly of a crystal detector.*

reader has had much experience with crystal combinations he is advised to use a piece of the specially treated galena or other synthetic substances now on the market under the name of "Hertzite," "Permanite," "Radiocite," etc.

The Telephone Condenser

There remains now but the question of the telephone shunt condenser. Whilst it is of course quite possible to dispense with this, its presence is desirable for the following reasons :

The crystal detector or rectifier does not entirely perform the duties of a complete cut-off to the return swing of a H.F. impulse ; a small amount of high-frequency current thus breaks past and if allowed to pass through the very highly-inductive windings of the telephones causes a slight damping in the circuit and thus reduces

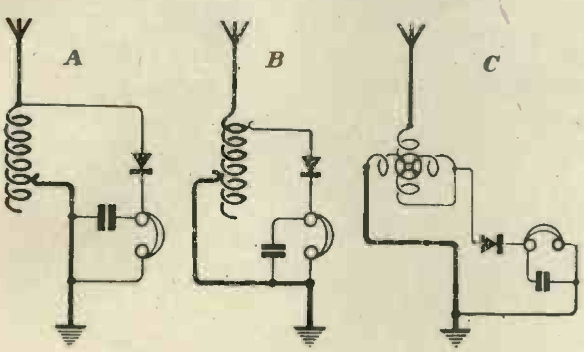


Fig. 3. Some useful crystal circuits.

signal strength. Whilst an inductance of such a nature offers but little impedance to low-frequency currents, a condenser offers practically an impenetrable path for them, but allows high-frequency current to pass readily, particularly if it is not too small. Hence we shunt the telephone windings with such a condenser knowing that the speech-frequency currents will not leak across it, but that strong high-frequency currents pass through it readily. It will thus be easily grasped that the signals will be somewhat sharpened by this method. A convenient value for this condenser is 0·002 μF., and it may be readily constructed as follows : An ebonite strip 3 in. by 1 in. by ¼ in. having been cut, two holes are drilled in it 9 cm. apart. These are to receive No. 4 BA. terminals, and may be tapped for this size so that no nuts will be necessary on the underside if desired. Sixteen sheets of thin copper-foil 8 cm. by 1½ cm. may be cut out, and a sufficient number of mica sheets 7 cm. by 2 cm. by 0·002 in. thick to interleave these will also be needed. A copper-foil is placed under a washer in such a manner that one of the terminals if screwed down will hold it fast and a sheet of mica laid upon that so that the edges project over the copper-foil as indicated. A copper-foil is then treated in a similar manner with the other terminal, but laid on top of the mica. Another mica is laid on that, then a foil as previously, and so on until the alternate terminal washers have each eight foils under them. The complete condenser may then be tightly wrapped with insulating tape, and connected across the telephone terminals. This completes the consideration of the various assemblies for a simple crystal set, and one or two circuit diagrams of a suitable type are indicated in Fig. 3. These will be of assistance to the beginner.

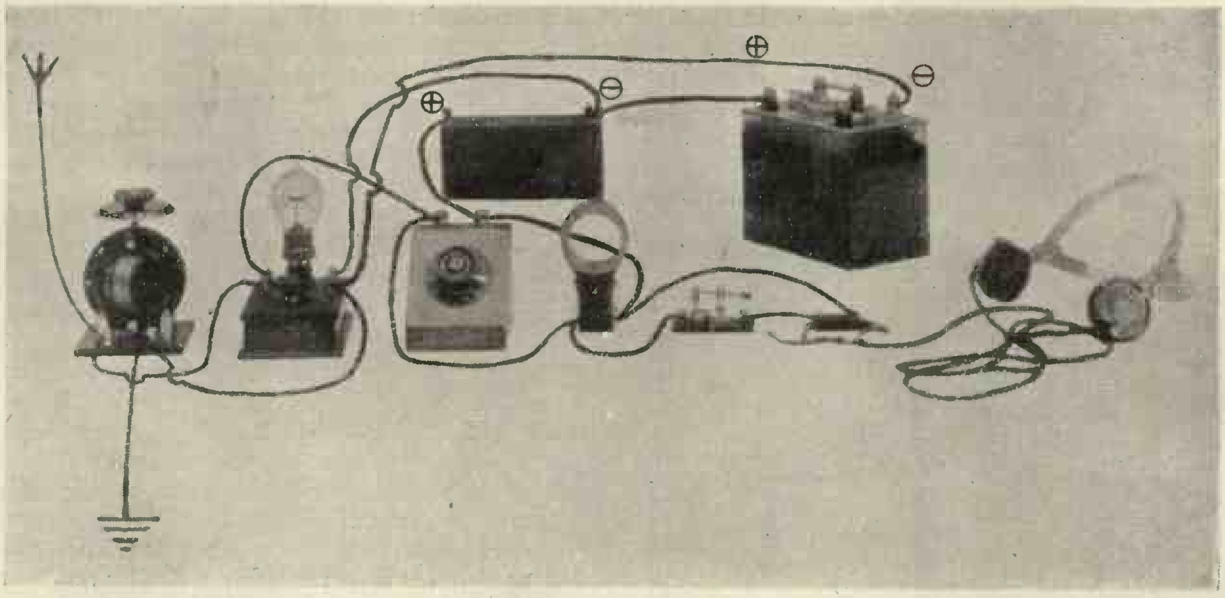
The Addition of Valve Amplification to the Simple Crystal Set

IT is surprising what a number of experimenters there are at the present day who consider that the one and only use for a crystal as a rectifier is in a standard crystal receiver. By this we mean what is generally regarded as the simplest type of apparatus that can possibly be used for the reception of wireless messages, yet which is complete in itself. It does not occur to many that their crystal could be made to yield greatly enhanced results if it were assisted by means of valve amplification.

There is no question that a good crystal or, in fact, any crystal, gives very much clearer reproduction than a valve. This is perhaps primarily due to the fact that the crystal rectifies efficiently over the whole range of audible frequencies, whereas unless a valve has its grid potential accurately adjusted for almost every class of frequency which it is desired to rectify, it does not do so properly, and in consequence creates overtones in places.

High-frequency Valve Amplification and Crystal Rectification

As an example of a simple valve and crystal circuit the reader should look at Fig. 4. In this case, the valve is so applied as to act as a magnifier of the incoming oscillations. That is, it acts as a high-frequency amplifier for the detector D. This circuit does not produce a great increase in signal strength, but undoubtedly increases the range of the crystal set. It is not, however, recommended as an ideal high-frequency amplifier for this purpose, but is a great improvement over the use of the crystal



A good set for long-distance reception which uses the valve as a high-frequency amplifier.

alone. The condenser C_3 should have a value of not less than 0·03 μF., whereas the circuit C_2L_2 should have values equivalent to those of C_1L_1. Depending largely on the type of valve used, there is sometimes a tendency for this circuit to set up oscillations of its own accord. This can be prevented by slightly detuning the circuit L_2C_2, which for this reason should be variable.

As crystal receivers are now almost exclusively used for the reception of British broadcasting, it is not permissible to use reaction of any kind upon the aerial circuit or any other circuit which may set up oscillations in the aerial, but as there

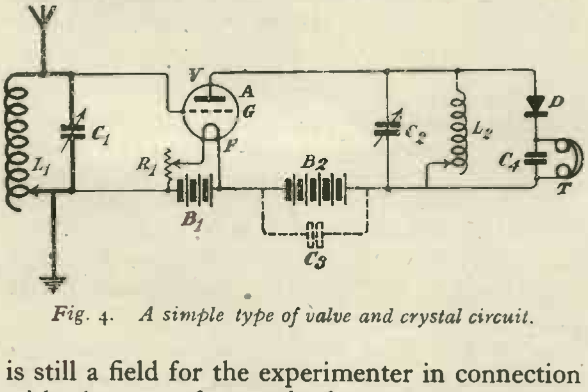


Fig. 4. *A simple type of valve and crystal circuit.*

is still a field for the experimenter in connection with the use of crystals for general reception purposes, a very useful type of circuit, which gives good amplification and has a considerable range, is shown in Fig. 5. This circuit reacts strongly, and for this reason should not be used, as before stated, for the reception of British broadcasting. It is very efficient, however, and the mounting of the coils L_1, L_2, may be easily accomplished by using a two-coil holder. The condenser C_1 may have a value of 0·0005 μF.; the condenser C_2 the same, and the condenser C_3 0·002 μF. The values of anode and filament batteries used here will again depend upon the type of valve, but a V 24, or a similar low-capacity valve, will give very good results in this circuit. The detector should preferably be one of the patent Galena crystals now on the market. The telephones must, of course, again be of high resistance. We will now pass to a consideration of slightly more complex circuits for the amplification of the incoming signals at radio frequency. Fig. 6 shows a very good arrangement for this purpose, in which the high-frequency amplifier takes the form of a tuned rejector circuit. For general working that shown in Fig. 5 is, of course, to be preferred, but for the reception of British broadcasting and short-wave working the latter arrangement—that is, the one shown in Fig. 6—will be the easier to operate. This latter arrangement also gives very sensitive control of reaction, and in this connection it should be noted that very strong signals can be obtained on British broadcasting without the actual setting up of oscillation to the aerial circuit. This is not to suggest, however, that the circuit cannot set up oscillations in the aerial, because it does so very strongly unless carefully handled. If, however, care is taken in its use, it is a very satisfactory form of high-frequency amplifier for a crystal rectifying circuit.

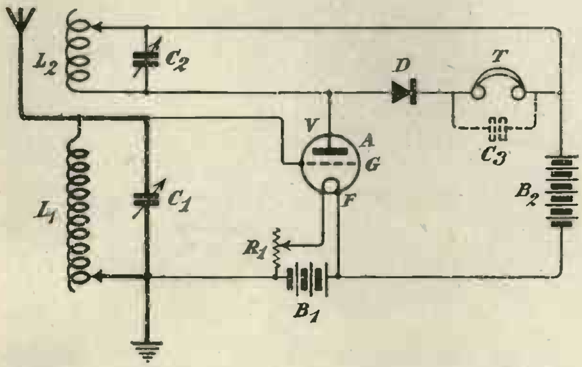


Fig. 5. A crystal and valve circuit employing reaction.

It is not, generally speaking, of much advantage to employ more than one or, at the outside, two high-frequency stages of amplification before a crystal. The reason for this is that the crystal as a rectifier has a distinct limit to the amount of current which it can carry whilst still rectifying efficiently, and, therefore, if we by too much high-frequency amplification supply it with a large amount of current, we shall get, it is true, a limiting action by the crystal, but at the expense of thorough rectification. The crystal is, however, the most economical form of detector where a portable set is concerned, or where the question of filament current for a valve supply is a serious one.

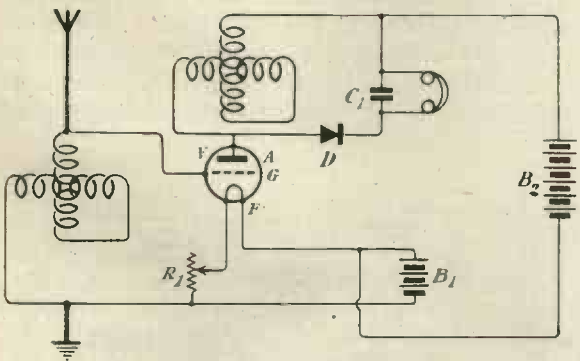


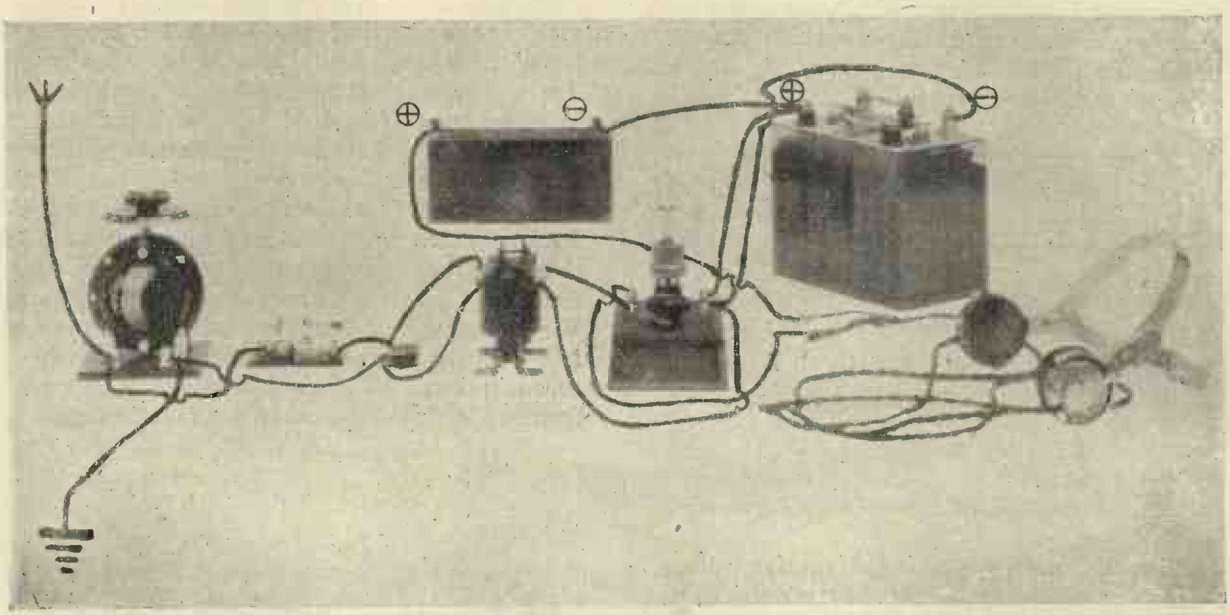
Fig. 6. H.F. amplifying circuit employing variometers.

Crystal Rectification and Low-frequency Valve Amplification

At a distance of from five to ten miles from a broadcasting centre there is no doubt that the low-frequency amplifier is more generally useful, as it will probably enable a loud-speaker to be worked directly from the crystal. If care is taken in the selection of a suitable low-frequency transformer, no trouble should be experienced due to distortion or noises in the loud-speaker or telephone. The reader is cautioned against buying cheap and shoddy transformers which are offered at an attractive price by unknown makers, as the manufacture of really good intervalve low-frequency transformers is a very special line, and there are only a few firms who can turn out a really lastingly satisfactory job in this respect. We illustrate here one very satisfactory type of low-frequency transformer, which is given rather as an indication of how a low-frequency transformer should be made than as a recommendation

Fig. 7. L.F. transformer used in the sets described in this article.

for any particular type. Where a crystal is concerned, of course, there is not very much current flowing through the transformer windings, and so it is possible to use a much greater ratio of magnification by the use of very much finer wire for winding the transformer than would be permissible in the case of a multi-valve receiver. If the experimenter wishes to obtain the maximum possible volume of sound from his receiver, he should search the market until he obtains a transformer with a ratio of 5 to 1 or 6 to 1. If, on the other hand, he is going to extend his low-frequency amplification to two or three stages, or



A crystal and valve set employing variometer tuning and low-frequency amplification.

at a later date to attach his amplifier to a valve detector, with possibly high-frequency stages preceding the rectifying valve, he should use

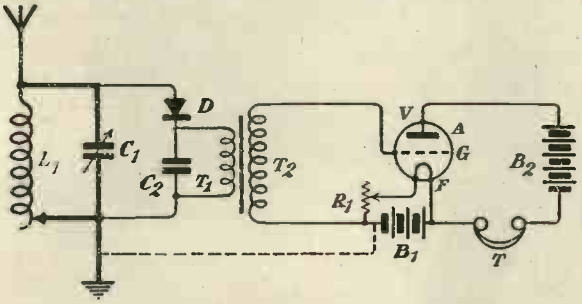


Fig. 8. A crystal and valve circuit using L.F. amplification.

more robust transformers than high ratio ones can possibly be. Low-frequency transformers wound on open iron cores—that is, a core consisting of iron wire left open at each end of the bobbin carrying the winding—are not to be recommended. There is not sufficient iron in the core to give the proper transformation ratio. The primary windings of these transformers should always be shunted by a fixed condenser of fairly high capacity, as indicated in the diagram, in order to by-pass any high-frequency current which may not have been completely rectified by the crystal.

Fig. 8 shows a very useful circuit for low-frequency amplification. An increase of strength of from three to six times is obtainable by the addition of a valve in this way. The actual tuning arrangements, of course, may be varied in many ways, but the arrangement of the note magnifier is standard. Improved results may sometimes be obtained by connecting the dotted line shown running from B_1 to earth. The condenser C_2 should have a value of not less than 0·001 μF., and preferably 0·002 μF. The valve V should be a hard one, that is, a valve requiring from 60 to 100 volts plate potential.

We will now examine a more complicated type of receiving circuit employing low-frequency amplification (Fig. 9). This is an exceedingly good

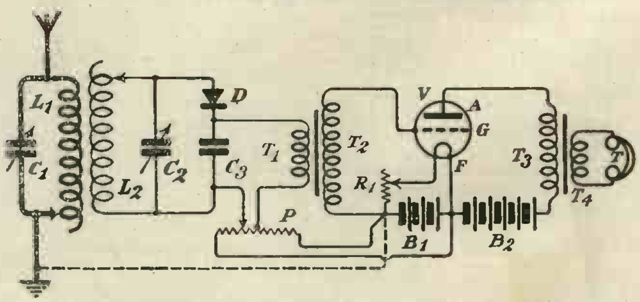


Fig. 9. A specially reliable type of low-frequency amplifying circuit.

arrangement for practical work, and is thoroughly recommended. It will be seen that the general arrangement consists of a loose-coupled crystal receiver followed by a single-valve low-frequency amplifier. A carborundum crystal, which is undoubtedly the most robust and reliable in action, is shown in use. A potentiometer, P, is connected across the accumulator battery B_1, in order to work the detector at its most efficient point. In operating this set the bottom end of the primary winding of the transformer T_1 should be connected first of all to one end of P and then the other, and after adjusting the slider in each case, see which connection gives the best results. An improvement in signal strength may also sometimes be obtained by connecting the negative end of the battery B_1 to earth by means of the dotted line as shown.

The valve should be a " hard " one. This will ensure the maximum magnification of signals. Dull emitter valves may be used for high- and low-frequency amplification with crystals, but are not in general very satisfactory for this work. At the present moment they have not been sufficiently fully developed to allow of a special type being available for each specific kind of amplification required, but where economy in filament current is an essential point, in spite of their initial high cost, they will be found a very considerable economy, as four of these valves take less current than one ordinary " R " type receiving valve.

This completes this brief article on the application of one valve to a crystal receiver as either a high-frequency amplifier or a low-frequency amplifier, and the experimenter will find that the value of his crystal is greatly enhanced if he takes the trouble to apply a valve in the manner indicated.

RADIO PRESS INFORMATION DEPARTMENT

THIS branch of Radio Press activities has now commenced operations and should prove of great use to our readers. The department is conducted by J. H. T. Roberts, D.Sc., assisted by A. L. M. Douglas, and deals with all queries regarding anything which appears in MODERN WIRELESS, WIRELESS WEEKLY, or Radio Press books. Questions must be enclosed in an envelope marked " Query," and addressed: Information Dept., Radio Press Ltd., Devereux Court, London, W.C. 2. Not more than three questions will be answered at once, and they must be accompanied by the coupon from the current issue. Postal replies will be sent if a stamped addressed envelope is enclosed.

"WIRELESS WEEKLY"

THE new Radio Press publication, WIRELESS WEEKLY, seems to be repeating the success of MODERN WIRELESS. It has had to overcome the very prevalent popular feeling that there are already so many weekly wireless journals that it is difficult for the enthusiast to make a choice. The merits of the new paper have already dissipated this feeling, and replaced it by the conviction that WIRELESS WEEKLY is a worthy companion of MODERN WIRELESS.

VALVE PANEL CONNECTIONS

THE connections of the valve panels used in the component sets described in this issue are as follows: the two terminals on the right are those for the filament positive and negative leads, while of the two on the left, that at the rear is the plate terminal, whilst that at the front is connected to the grid.

PATENTS OF THE MONTH

The following abstracts from patent specifications recently published have been specially compiled for MODERN WIRELESS by Mr. H. T. P. Gee, Patent Agent, Staple House, 51 and 52, Chancery Lane, London, W.C. 2.

189,955. British Thomson-Houston Co., Ltd. A condenser unit comprising a casing adapted to contain an insulating-medium, an insulating-cover for the casing, a conducting tube passing through the cover into the casing and communicating at the top and bottom with the interior of the casing, and conducting and insulating sheets wound around the tube, one of the conducting sheets being in electrical connection with the tube, and another being in electrical connection with the casing. The tube is closed by a screw-plug carrying a terminal. A number of condenser units connected in series or in parallel may be mounted in a rack, each unit being held by a clip from which it may be removed independently of the others. (October 31, 1921.)

190,177. Beauvais, G. A. The grid-filament circuit of a thermionic valve oscillation generator has two parallel branches, one including a condenser and a grid coupling coil in series, and carrying the oscillatory component of the grid current, the other branch including an H.F. choke-coil in series with a resistance or a modulating-valve and carrying the direct component of the grid current. The choke-coil is not coupled either to the grid coil or to the plate coil. (December 12, 1922. Convention date, December 12, 1921. Patent of addition to patent No. 131,018.)

190,280. British Thomson-Houston Co., Ltd. Horizontal aerials for directive signalling wherein signals coming from the opposite directions may be received simultaneously, and the invention consists in arranging the detecting-circuits for both sets of signals at one end or at one specific point of the aerial, and also in providing means for neutralising the effect of strays or of undesired signals. (October 5, 1921.)

190,489. British Thomson-Houston Co., Ltd. An amplifying system for varying electric currents, such as those flowing in the aerial circuit of a wireless receiving apparatus, comprises two or more magnetically-controlled thermionic valves connected in cascade and with electro-magnetic or electro-static reaction between the output side of one of the valves and the input side of the first valve. (December 14, 1922. Convention date, December 14, 1921.)

190,505. Ransford, R. B. In a receiver designed to prevent interference, a current limiter for reducing the strength of disturbances to that of signals is arranged between two groups of resonators, one of which is highly damped and the other slightly damped. The highly damped resonators are tuned circuits, the others may be tuned circuits of the wave or note frequency, or mechanically tuned devices capable of passing on signals. (June 24, 1921.)

190,532. Prangnell, J. P. An inductance coil, particularly for use in oscillatory circuits, is wound similarly to the weave of the sides of a cylindrical or taper-sided basket in order to reduce the capacity effect. The wire is wound upon a former consisting of rods mounted upon a base, and is zigzagged in and out around the rods. Tappings are provided for connecting sections of the winding to the stops of a selecting switch. A coil may be wound upon vertical rods, or the rods may be arranged so that the coil tapers to one end. The coil is preferably dipped in molten paraffin wax before removal from the former. (September 21, 1921.)

190,577. Habann, W. E. E. In a system for producing H.F. electric oscillations, particularly for transmitting messages, air waves of a frequency exceeding 4,000 are caused to act on a microphone or other vibratory body which is arranged to excite an electric oscillation circuit. The air waves are produced by a Galton whistle. The contact-pin resting against the diaphragm may be rendered incandescent, or the contact surface may be ionized by radium preparations. For multiple transmission, a siren with concentric rows of perforations co-operating with a series of microphones may be used. Low-frequency speaking currents are led to the microphone circuit by a transformer and are there divided into high-frequency impulses adapted to be transmitted through the oscillating circuit to a long distance telephone line or to an antenna. The invention is also applicable as a high-frequency generator for heterodyne reception. (October 15, 1921.)

190,699. Ges. Für Drahtlose Telegraphie. In order to permit of transmission and reception on the same carrier wavelength in a high-frequency telephony system, the thermionic generator of the carrier wave is interrupted at super-audible frequency. During the periods of self-oscillation, the tube is used for transmission, whilst it acts as a receiver during the intervals of interruption or non-oscillation. In a two-grid generator, the space-charge grid is connected to an ohmic resistance in the anode circuit of a second valve energised by an oscillator, so that an alternating potential is imposed upon the grid. During periods of high potential, carrier-wave oscillations are created in the anode circuit, and may be modulated by a microphone. When the charge on the grid is relatively negative, the tube does not generate, but acts as a receiver of incoming signals. (September 26, 1922. Convention date, December 20, 1921.)

190,777. Prangnell, J. P. A five electrode thermionic valve, comprising a cathode, two anodes of approximately semi-cylindrical form, and two grids curved to enclose a cylindrical space, the electrodes being arranged coaxially. The grids may be in the form of helices, preferably coiled in opposite directions, or may consist of mesh cylinders. (September 21, 1921.)

190,778. Mansbridge, G. F. Means for making an air-tight and moisture-tight joint around wires leading out of a case adapted to contain electrical apparatus such as a condenser or coil, comprising a carrying plate with openings and insulating material interposed between and connected directly to the plate and the wires so as to overlap the marginal portion of the holes on both faces of the plate, the whole being vulcanised together under pressure. (September 22, 1921.)

190,790. Wilson, F., and Robertson, H. S. In an electromagnetic relay particularly for receiving wireless signals and having the armature carried by a reed or diaphragm tuned to make the relay selectively responsive, two means are provided for tuning the reed, etc., and an amplitude increasing device is introduced between the reed, etc., and the controlled contacts to give greater make-and-break movement. (September 26, 1921.)

190,840. Sykes, A. F. An iron-cored intervalve transformer for acoustic frequencies is provided with a tertiary winding, the circuit of which is closed through resistance, inductance, or capacity, either singly or in combination. The tertiary circuit may have a natural frequency of approximately the same value as the frequency at which the transformer would be most efficient in the absence of the tertiary winding, for the purpose of improving the characteristics of the transformer. The invention is particularly applicable to the system of recording sound described in Specification No.160,223. (October 15, 1921.)

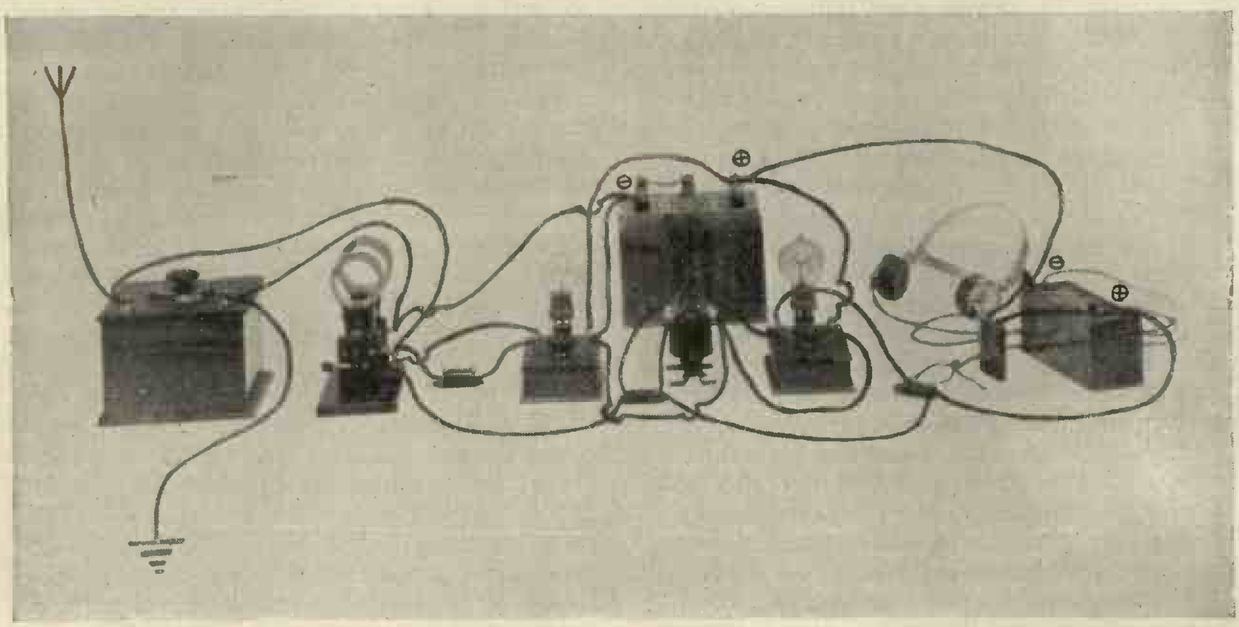
190,953. Pellant, F. W. A plug for a thermionic valve or a single- or multiple-pin coupling consisting of two wire loops of hairpin or U-shape, crossed at the centre, one inside the other. The free ends of the loops are fixed to a metal rod or tube which is screw-threaded or otherwise shaped for moulding into an insulating base. The wire may be of semi-circular, circular, or square section. (March 11, 1922.)

191,038. British Thomson-Houston Co., Ltd. A four-electrode thermionic valve comprises the usual cathode, grid, and anode, and a slat electrode interposed between the grid and anode, adapted to receive electrons from the cathode and to emit impact or secondary electrons which are attracted to the more positive anode. The input potentials are impressed on the grid circuit, and the amplified output current flows through an indicator in the anode circuit. The electron stream may be caused to travel in a curved path by providing a steady axial magnetic field within the valve. (December 23, 1922. Convention date December 28, 1921.)

191,125. British Thomson-Houston Co., Ltd. Horizontal directional aerials adapted for the simultaneous reception of a number of signals of different wavelengths. In order to neutralise the effect of strays, or of imperfect balance for desired signals of widely different wavelengths, or of undesired signals coming from the wrong direction, means are provided for impressing upon each separate detecting circuit current derived from another point in the aerial and adjusted so as to have the proper intensity and phase to neutralise the disturbing factors. (September 30, 1921. Cognate application with 26431/21.)

191,159. Smith, R. T. A variable inductance, coupling-device, or aerial, comprises one or more single-handed windings around a closed or polygonal frame which is collapsible and expansible to vary the cross-sectional area of each convolution. The frame may be mounted adjustably upon a stand. (October 6, 1921.)

191,228. Brown, S. G. In relays in which a microphone is operated by an armature in the form of a vibratory reed fixed at one end and vibrated by a receiving electromagnet, the reed operates towards its free end a differential microphone. The differential microphone may, for loud speaking, comprise two or more microphones arranged in series. (November 11, 1921.)



A two-valve set employing low-frequency amplification and reaction upon the aerial circuit. This arrangement is only permitted upon other than the broadcasting wavelengths.

TWO USEFUL SETS EMPLOYING TWO VALVES

An article specially written for the experimenter who wishes to build up his set from ready-made components.

WHATEVER the particular work which claims the attention of each individual experimenter, whether it be the reception of amateur transmissions, aircraft telephony, or long-distance reception from the high-power commercial stations, it is only by the actual trial of various circuits that real knowledge is to be gained. Of almost equal importance to the serious radio worker is the ability to " try out " new circuits or components, either those which he may have evolved himself or seen descriptions of, without being under the necessity of scrapping expensive apparatus which is still capable of useful work. If his existing set or panels are contained in boxes, for instance, any radical change is almost impossible, not only from the fact that to do so entails considerable time and trouble in taking down the wiring, but also the fact that in nine cases out of ten this alteration and rewiring makes it almost impossible to utilise, in their new capacity, *all* the various parts which were comprised in the set in its original and very probably expensive state.

Now the moral of this is that a true radio experimenter's set should be capable of rapid change over from one circuit to another with the least possible expenditure of time and trouble, bearing in mind that as many as possible of the parts should be capable of being used in its new form. Many experimenters for various reasons, usually lack of suitable tools and appliances, prefer to purchase their component parts ready made, and it is hoped that this article, which describes briefly several simple yet efficient two-valve receivers built up from bought components, will prove helpful, and may act as a stepping-stone to more advanced experimental work.

Let us first consider *what* we wish to receive; that is to say, do we wish to have a receiver for one special class of transmission, or do we wish to have one which will give efficient results on all general wavelengths. Looking at this question from the point of view of the beginner in experimental wireless work, in nearly all cases the answer will be the latter, and therefore we will deal with this first. For efficient all-round reception, where extreme range is not the primary object, there are few circuits to equal that comprising a valve detector followed by one stage of low frequency, or, as it is also

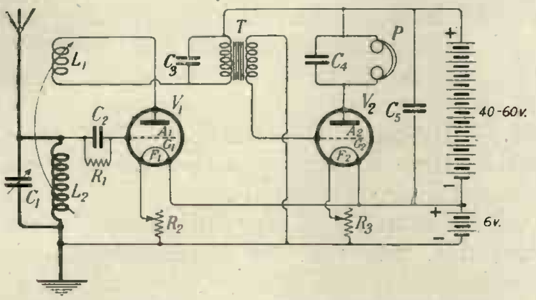


Fig. 1. Circuit of the low-frequency amplifying set.

called, " note " magnification, such as is shown in Fig. 1. To build up this set we shall require the following parts :

One two-coil holder.
One set of coils to cover the range of wavelengths we wish to receive.
One variable condenser with a capacity of 0·001 μF.
One variable condenser with a capacity of 0·0005 μF.
One grid condenser of a capacity of approximately 0·0003 μF. with a 2 megohm leak.
One pair of high-resistance telephones, say of 4,000 ohms resistance.
One telephone condenser, capacity 0·001 μF.
One high-tension battery, 60 volts.
One high-tension battery by-pass condenser with a capacity of 0·01 μF.
One 6-volt 60-amp. hour filament accumulator.
Two valves.

At the present time there are on the market many excellent components, such as we shall require, at a price well within the pockets of most experimenters, and it only needs a perusal of the advertisement pages of MODERN WIRELESS for the experimenter to find those which are suited to his own particular case.

Referring to Fig. 1, the first valve (V_1) functions as a detector of the radio-frequency oscillations impressed on its grid through the medium of the circuit C_1L_2, passing on this rectified current through the iron-cored transformer (T) to the grid of the second valve (V_2), in the plate circuit of which are the telephones (P). Let us now consider the various parts of the circuit, their functions, and any points of interest which may help the experimenter in the choice of his parts.

Tuner.—Modern practice is to use separate coils for different wavelength ranges, and to tune the coils by means of a variable condenser, which may be either in parallel or series.

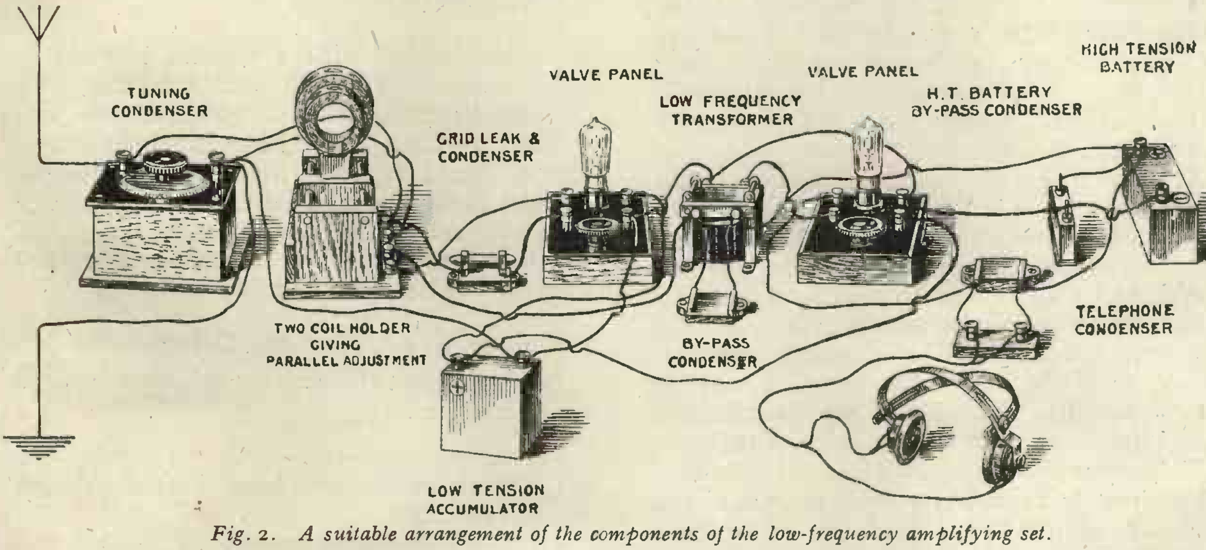


Fig. 2. A suitable arrangement of the components of the low-frequency amplifying set.

Two valve panels with filament resistances.
One low-frequency transformer.
One transformer by-pass condenser, capacity 0·002 μF.

Generally speaking, for short waves a variable condenser of 0·001 μF. capacity is suitable in series with the aerial, and for long waves one of 0·0005 μF. in parallel. For the actual coils, the experimenter cannot do better than to use those of the " duo-lateral " type.

Coil Holder.—Many good and inexpensive ones are now procurable, but the amateur should choose one the mechanical design of which is such that continuous working will not tend to work loose the spindles carrying the rotating holder. One make in particular is to be recommended, in which the moving coil is brought near to, or farther away from, the fixed one by means of an ingenious device, whereby the vertical axes of the coils remain parallel even in the position of minimum coupling. In the circuit shown in Fig. 1 the coil L_2 is the tuning coil, and should be placed in the fixed holder, while the reaction coil is the movable one, thus permitting the " boosting " up of spark signals, or, by increasing the coupling between it and L_2, the circuit may be thrown into oscillation, thus giving the autodyne method of receiving continuous wave signals. If, however, this circuit is used on broadcast wavelengths, it is essential that this reaction coil should be removed from its holder, and a dummy short-circuiting plug put in its place.

Grid Condenser and Leak (C_2) and (R_1).—This condenser should be well insulated, and a very efficient type of self-contained grid condenser and leak is shown in Fig. 2, which also has the merits of being small in dimensions and reasonable in price.

Low-frequency Transformer.—A poor transformer will reduce the efficiency of the set by quite 50 per cent., therefore it will pay the experimenter to choose one with care. Points to be noted are that the iron circuit is of good design, and that the windings are of a robust gauge of wire.

Transformer By-pass Condenser.—This is necessary in order that any radio-frequency component in the plate circuit of the detecting valve may pass the primary winding of the transformer without actually flowing through it. A suitable type of condenser is that described for the grid condenser. The capacity, however, should be of the order of 0·002 μF., and this can be obtained without the clips for the grid leak, these being replaced by soldering tags.

Telephone Receivers.—These should be of approximately 2,000–4,000 ohms resistance, and should be shunted by a condenser of the same type as that used for the grid condenser, but with a capacity of about 0·001 μF.

High-tension Battery.—In these days of hard valves, a critical high-tension voltage is very rarely necessary, so that the experimenter may obtain either a 60-volt, 30-volt or 15-volt unit, most makes of which have plugs and sockets to give steps of 3 volts. A very useful size for the experimenter is the 15-volt unit which one maker is now putting up with spring clips, thus doing away with the necessity of soldered leads, which do the cells no good, or of drilling the brass tags and bolting together, which will be found a somewhat lengthy job.

H.T. By-pass Condenser.—This should have as large a capacity as possible ; a good all-round figure is 0·01 μF.

Valve Panel.—Very little need be said about this, save that the buyer should satisfy himself that it is simply a valve-holder, with the plate and grid leads brought straight out

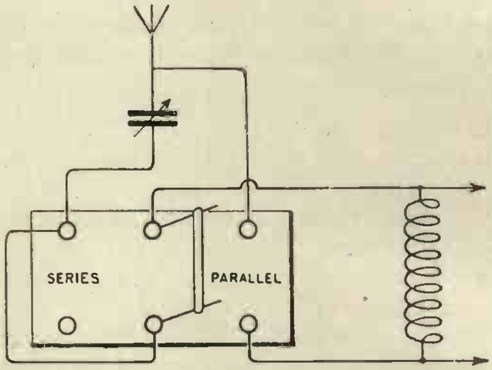


Fig. 3. Connections of the series-parallel switch for the aerial tuning condenser. The arrows represent leads to the aerial and earth terminals of the set.

to terminals, and with a filament rheostat in series with one of the filament leads, and not a complete detecting unit with grid condenser, etc.

Valves.—Little need be said about these, except that a type which is designed as an efficient rectifier should be used as the first or detecting valve, the second valve being one which has a fairly straight characteristic, and so gives freedom from distortion.

How to Lay Out the Components

For laying out the set the main points to be considered are :

(1) Ease of operation.
(2) Parts should be placed in their proper sequence.
(3) Leads should be as short as possible.

Looking at (1) " Ease of operation " in more detail, the experimenter should aim at placing his various components in line ; that is to say, two or more parts should not be situated one behind each other. If he arranges his set in such a way that all the various components are in line, he will find that practically all adjusting points are easily accessible, thus giving more speed in changing wavelengths, adjusting re-

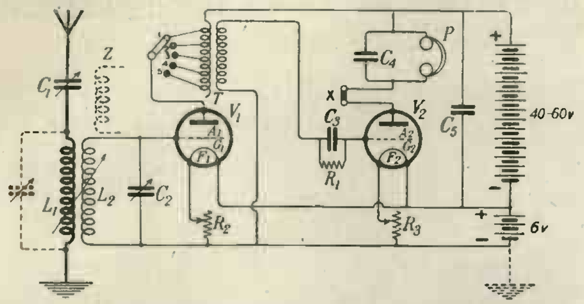


Fig. 4. A two-valve circuit employing H.F. amplification; x, shorting plug for reaction coil; z, optional reaction coil.

action, etc. If this method be adopted then (2) will almost automatically follow.

(3) The leads throughout the set should be as short as possible, in order that stray capacity effects may be minimised.

Fig. 2 suggests a method of arranging the components on the bench, and in passing it should be noted that several of the leads shown in the drawing are longer than is the actual case when wired up. They are shown thus in order to simplify the drawing. Finally, the wiring itself; various experimenters employ various methods—some use bare wire covered with insulated sleeving, some bare wire only, and some untwisted flex. The first method—namely, bare copper wire covered with insulated sleeving—has much to commend it, especially as the sleeving can be obtained in a variety of colours, thus enabling each circuit to have its own colour, which makes it easily distinguished.

Before we proceed to consider the second circuit, comprising a radio-frequency amplifying stage, a useful refinement, which can be added easily to both circuits, is a series-parallel switch for putting the aerial tuning condenser either in series or parallel with the tuning coil. Such a switch may be made from an ordinary double-pole change-over switch, and connected as shown in Fig. 3.

If it be desired to increase the range of the station, the circuit shown in Fig. 4 can be used. Now in this circuit the first valve (V_1) functions as an amplifier of the incoming radio-frequency signals, and passes this amplified current through the high-frequency transformer (T), from whence it is impressed on the grid of the second valve (V_2), which rectifies it and makes the signals audible in the telephones (P). This circuit will give a very much longer range than that which has already been described, because signals which are too weak initially to operate the detecting valve in Fig. 1 are now amplified *before* detection and thus become audible.

Now the chief differences to be observed between the two circuits are: firstly, that in the high-frequency-detector two-valve set shown in Fig. 4 we shall need an air-cored radio-frequency transformer instead of the iron-cored audio-frequency one shown in Fig. 2; secondly, we can now use the two-coil holder for a double circuit tuner—that is to say, one which employs an aerial circuit inductively coupled to a closed secondary circuit, thus obtaining greater selectivity. Should the experimenter desire to use reaction on this circuit, a three-coil holder must be used, the arrangement being that the centre fixed coil is the secondary tuning coil, whilst

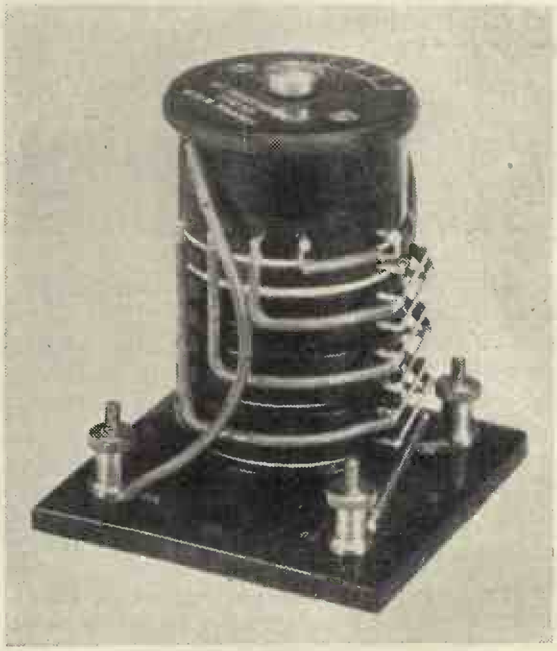
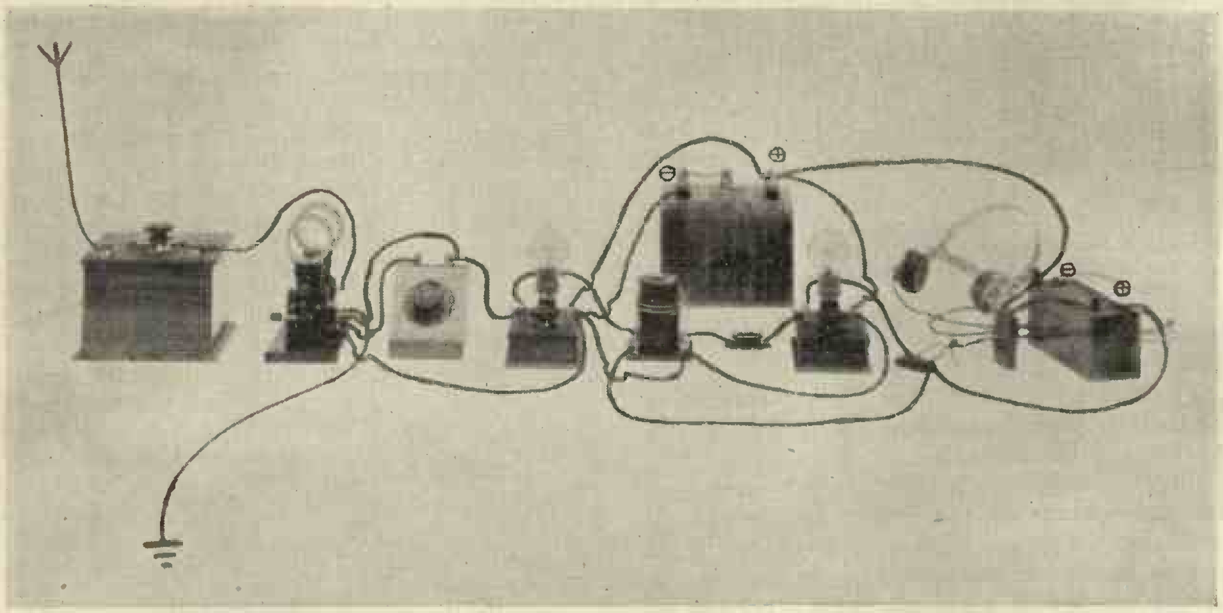


Fig. 5. The type of H.F. transformer used in the set illustrated.

the two outside adjustable coils are respectively primary (or aerial) and reaction. In this case the reaction coil is placed in series with the plate of the valve V_2. Here, again, if it be desired to operate the set on broadcast wavelengths, the reaction coil must be removed, and a dummy short-circuiting plug inserted in its place.

It will not be necessary to consider this circuit in such full detail as the previous one, as, with the two exceptions mentioned above, the actual components are the same in both cases; that is to say, the same grid condenser and by-pass condensers are used in both circuits, and it is recommended that the same scheme of laying out the components be adopted also.

When using a copper-wound transformer for falls off very rapidly. By bringing out tappings on the primary windings and thus altering the number of turns in circuit, this disadvantage can be overcome. A good form of transformer embodying this method is shown in Fig. 5, from which it will be seen that the leads are brought out to four terminals.



The high-frequency amplifying set with loose-coupled tuning. Note that the aerial tuning condenser is in series with the primary coil.

amplification at radio-frequencies we have one disadvantage to contend with. This is that such a transformer has a definite optimum resonance point or wavelength dependent on the nature of the winding. This gives high magnification over a very small band of wavelengths, below and above which its efficiency

Finally, it is hoped that the experimenter will not remain satisfied with the two circuits described in this article, but will aspire to more advanced work, as, for example, combining the two and thus obtaining a three-valve set.

G. L. M.

"S.T. 100"

As announced upon another page, next month's MODERN WIRELESS will contain the first published description of the remarkable new two-valve circuit devised by the Editor, which will be known as "S.T. 100." Lest our readers should be inclined to complain at having their curiosity further whetted by this second reference to the new development, we offer them as consolation the information that the editorial staff are equally in the dark and even more impatient!

Incidentally, No. 5 will be a great improvement upon all the preceding issues. Entirely new attractive features are being introduced, the type and arrangement are being improved, and thirty extra pages of TEXT are being provided. Tell your friends about it. G. P. K.

QUESTIONS AND ANSWERS

We invite readers to write to us when any technical difficulties in connection with wireless are encountered. All letters must be addressed to "The Editor, MODERN WIRELESS, Devereux Court, Strand, W.C.2," and envelopes are to be marked "Query" on the top left-hand corner. Not more than three questions are to be asked in each letter, which should be typewritten or clearly written in ink upon one side of the paper only, and must be accompanied by a "Query" coupon cut from the current issue. Sketches or diagrams should be supplied whenever possible, and should be clearly drawn in ink upon a separate sheet and be attached to the letter.

W. W. A. asks (1) for a diagram of a single-valve set using reaction. (2) I have made a variometer according to pages 14 to 18 of the February issue of "Modern Wireless," but with a stator 4½ in. in diameter instead of 4. Does the difference in the diameter matter?

(3) Would it be an improvement to wind the variometer with No. 36 double cotton-covered wire instead of No. 26 as specified, and to reduce the dimensions of the stator and rotor to 2¼ in. and 2 in. instead of the dimensions given in the previous question?

(1) You will find a suitable circuit in "Practical Wireless Valve Circuits," No. S.T. 17. We should remind you, however, that this circuit, or any single-valve circuit employing adjustable reaction, is not permitted for broadcast reception.

(2) The effect of the difference in diameter will be to cause the variometer to tune to a slightly longer wavelength.

(3) The effect of using No. 36 wire instead of No. 26 would be to introduce a good deal of resistance in the circuit with consequent weakening of signals. We do not recommend alterations in the dimensions.

N. B. refers to the two-valve broadcast receiver described in "Modern Wireless" for February, and asks (1) Whether the addition of an extra coil wound with No. 28 enamelled wire 8 in. long and 5 in. in diameter, connected in series with one of the variometers, will serve to increase the wavelength range of the set. (2) Over what distance broadcasting can be heard in the telephones? (3) If the set complies with the Postmaster-General's regulations?

(1) The proposed arrangement is not sufficient to increase the wavelength range of the set. Two coils, such as that specified, will be needed, one placed in series with the aerial variometer and the other in series with the plate circuit variometer. You should then be able to receive up to about 3,000 metres.

(2) This depends so much on local conditions, such as height and size of aerial, that it is impossible to give an answer of much use. A range of some 50 miles may, however, be confidently expected.

(3) This set complies with the Post Office regulations, provided that the user holds an experimental licence.

R. T. (Leytonstone) refers to the article on dual amplification in No. 1 of "Modern Wireless" and asks whether a high- or low-frequency transformer is used.

A high-frequency transformer is used, as stated in the article.

G. W. G. (Earlsfield) refers to the two-valve broadcast receiver described in the first number of "Modern Wireless" and asks how he can add reaction to this set so as to comply with the regulations of the Post Office.

This set is not a very easy one, or a very suitable one, to which to add reaction, but it can be done after a fashion by connecting in series with the second variometer a small basket coil of, say, 40 turns, and in series with the plate circuit of the rectifying valve another basket coil, somewhat larger, and obtaining reaction effects by coupling these two coils together. It should be added that the best sizes of these two coils must generally be found by experiment for any given set.

K. E. (Clapham) refers to the two-valve broadcast receiver and asks (1) How can the wavelength of the set be increased to, say, 3,000 metres? Would plugging-in appropriate honeycomb or basket coils in series with the aerial variometer effect this?

(2) How can this set be converted into a non-radiating valve-crystal-valve circuit with range of 3,000 metres?

(1) One method which gives fair results is to connect with each variometer a slider coil of the following dimensions: Length, 12 in.; diameter, 4 in. Aerial coil to be wound with No. 26 enamelled wire. Plate coil to be wound with No. 30 enamelled wire. Basket or other plug-in coils could be used, but it would involve making a complete set of these coils and mounting them on plugs, which would probably be more troublesome than making the sliders.

(2) The alterations involved would be so great as to mean practically making a new set, and we do not recommend this conversion.

H. G. O. (Wimbledon) asks whether it matters in which direction the windings of a low-frequency transformer are connected.

There is no very great difference noticeable upon reversing the direction of the windings, although if one can get the connection so arranged that the capacity coupling through the transformer acts in the same direction as the magnetic coupling, there is a slight increase in signal strength. A more important aspect of this question, however, arises out of the use of several transformers in a two- or three-valve low-frequency amplifier when it is often found necessary to try reversing the connections of the primaries of the transformers to stop the set from howling.

A. C. (Kirriemuir) asks (1) Why has he blown eight valves within one month, although the valves never blow twice in the same holder, and to look at the filament seems intact.

(2) Is it possible by using excessive high-tension voltage to break down the plate insulation of the valve?

(1) The reason for the blowing of your valves is by no means obvious from the information given. We would suggest that you inquire first of all as to the previous history of your valves, also that you ascertain whether the pins of the valves are making proper contact in the holders. We presume that you are giving the valves correct treatment in the matter of filament current —that is, that you are not running 4-volt valves from a 6-volt accumulator without a resistance, which of course would account for their short life.

(2) With normal valves and reasonable plate voltages, say below 150 volts, there is no risk of injuring the valve.

Beginner (Wrexham) refers to a four-valve receiver made as per instructions in the February and March issues of "Modern Wireless," and complains of flatness of tuning and weak signals. He asks (1) Would the introduction of reaction improve the results? (2) If so, how can this be done to the best advantage? (3) Would a variable condenser improve the sharpness of tuning?

(1) Reaction would probably remedy the troubles of which you complain, since besides improving signal strength, it also greatly increases the selectivity of a receiver. (2) See reply to G. W. G. of Earlsfield. (3) We do not think a variable condenser would be of much advantage.

J. B. (Motherwell) asks with reference to a loose coupled receiver, should the end of the first coil (primary) be joined to the beginning of the second coil (secondary) and then to earth as in a variometer, or ought the secondary coil to be just pushed inside the primary coil without joining?

These coils need not be connected in any way except by the inductive coupling between them. One sometimes sees the end of the primary and secondary joined together and to earth, but this is not necessary for the working of the set, being merely done to connect to earth certain other parts of the circuit.

H. J. R. (H.M.T. "Huntsend") states that he has found it possible to receive continuous waves at short distances with a crystal detector, and asks for the explanation of this phenomenon.

The reception of continuous waves with a crystal set may be due to any one of several circumstances. For example, the C.W. station may be using rectified alternating current to feed the plates of the transmitting valves, and this alternating current very commonly produces a considerable ripple upon the transmitted wave, which is sufficiently strong to cause the signal to be audible rather after the manner of tonic tra n at short distances. Again, the C.W. signals may be heterodyned by the radiation from some other station using C.W. It is also possible to read continuous wave signals at short distances by the clicks which are produced at the beginning and end of each dot and dash, the effect rather resembling the signals of a P.O. sounder. The note of the received signals will obviously depend upon what is producing the reception by the crystal set. For example, in the first case the note will depend upon the frequency of the alternating current used by the transmitting station.

F. C. P. (King's Lynn) asks for a complete design and specification of a six-valve broadcast receiver (2 H.F. valves, 2 detector and 2 L.F. valves) and sends a list of the components which he already possesses.

The design of so ambitious a set is beyond the scope of these columns. We think that if you refer to "Practical Wireless Valve Circuits," by John Scott-Taggart, F.Inst.P., you will find in diagram No. ST 51 sufficient guidance to assemble a set such as you require from the components which you specify. The tapped transformers which you have will be quite suitable for this circuit, or, if you prefer, you may use the ordinary plug-in type of transformer.

W. M. M. (Anerley) says that he has a good high aerial of the full hundred feet, but complains of the weakness of his signals, adding that his down-lead from the aerial is taken from a point about one-third of the distance from the highest end of the horizontal span.

We think that the probable cause of your trouble is the fact that you have not taken the down-lead from the exact centre of the horizontal span. Would it not be possible to take the down-lead from one end of the aerial, thus converting it into what is known as an inverted L type?

E. B. le B. (West Hampstead) asks whether by using one high-frequency valve and two low-frequency valves with a crystal rectifier he could get long-distance stations, and also whether it is possible to cut out the London station so as to be able to receive Birmingham.

The combination of valves and crystal which you describe is quite a good one and should meet your requirements. To eliminate the local station we think that you will find it necessary to use a loose coupled tuner.

W. O. V. (County Meath) refers to the two-valve and crystal circuit illustrated on page 89 of "Modern Wireless" for March, and asks several questions as to capacity of condensers, size of tuning coils, type of crystal to use, and the proper connections of the low-frequency transformer. In particular, Which is the in-put side and which is the out-put?

Since it would appear from your letter that you are quite a beginner, we can only say that we strongly advise you not to commence with this circuit, but to start with some simpler standard type. These dual amplification circuits are distinctly difficult to work and require considerable experience to obtain satisfactory results.

J. L. (Forest Gate) refers to the broadcast receiver No. 3 described in "How to Make Your Own Broadcast Receiver," and says that he wishes to purchase a ready-made telephone condenser, and asks what should be its capacity.

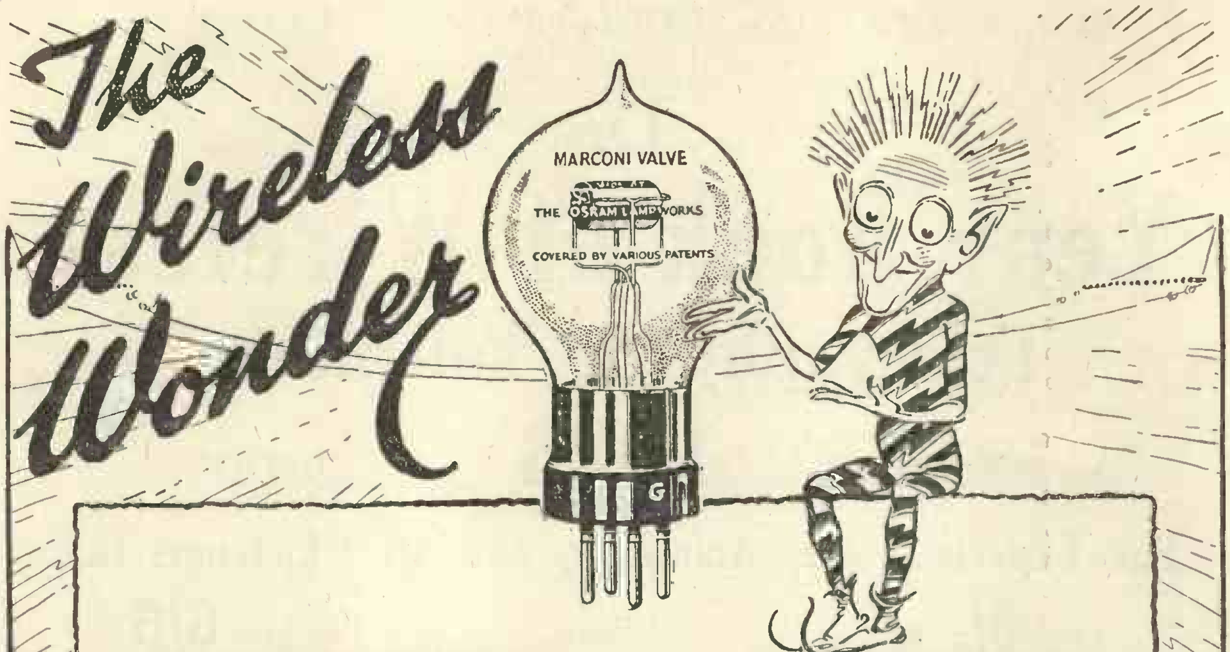
0·002 μF. is a suitable value.

L. G. H. (Johannesburg) asks (1) For a suitable diagram of connections for a four-valve set employing one high-frequency valve, one detector, and two low-frequency valves (the H.F. to be transformer coupled). (2) How many turns should be wound upon a set of transformers of the plug-in type to cover wavelengths of 150 to 30,000 metres and what gauge of wire to use. (3) What type of valve would be suitable to use in the valve transmitter described in the February number of "Modern Wireless." (4) Would 200 volts D.C. be suitable for transmission (supplied by lighting mains)?

(1) Being dealt with by postal replies department of *Wireless Weekly*. (2) Plug-in type intervalve high-frequency transformers may be made by winding the following numbers of turns upon disc type formers having a diameter of 2 inches: 80, 100, 125, 160, 200, 250, 300, 450, 600, 1,000, 1,200. A suitable gauge of wire to use is No. 40 single silk covered. (3) For a low power transmitter of this type you might use a good hard receiving valve of a type capable of working with a fairly high plate voltage. If you wish to obtain higher power it will be necessary to use a higher plate voltage and a small transmitting valve, details of which you may obtain from one of the manufacturing firms. (4) 200 volts obtained in the manner which you suggest will be sufficient for the small valve referred to.

J. E. (Urpeth) submits a diagram of a proposed microphone amplifier which he desires to make to work with a large size Brown's loud-speaker of 120 ohms resistance, and asks for constructional details, including size and quantity of wire to use for the various windings, size of formers, etc.

The sketch which you submit is quite correct, but we can only say that we should strongly advise you not to attempt to construct one of these instruments, since it is really a job beyond the powers of the average amateur, and, moreover, the instrument would probably be far from satisfactory in use when made. We think you would get much better results from the use of a two- or three-valve low-frequency amplifier.


The Wireless Wonder
MARCONI VALVE
THE OSRAM LAMP WORKS
COVERED BY VARIOUS PATENTS

"Listen in" with a GECoPHONE

for best possible broadcasting results

Simplicity is the keynote of all GECoPHONE "Listening-in" Sets. They are noticeably devoid of all technical complications and can be installed and operated with the utmost ease.

A Derbyshire user, in one of thousands of similar letters of unsolicited testimony, tells how he "was able to get the opera at Covent Garden with a 2-valve GECoPHONE Set. All the instruments could be plainly heard. Also the applause. We were, so to speak, actually at the opera."

Fully approved by H.M. Postmaster-General.

Complies in all respects with Broadcasting Regulations.

GECoPHONE CRYSTAL SET No. 1.
Approximate range, 25 miles. Price complete, **£5 10 0.**

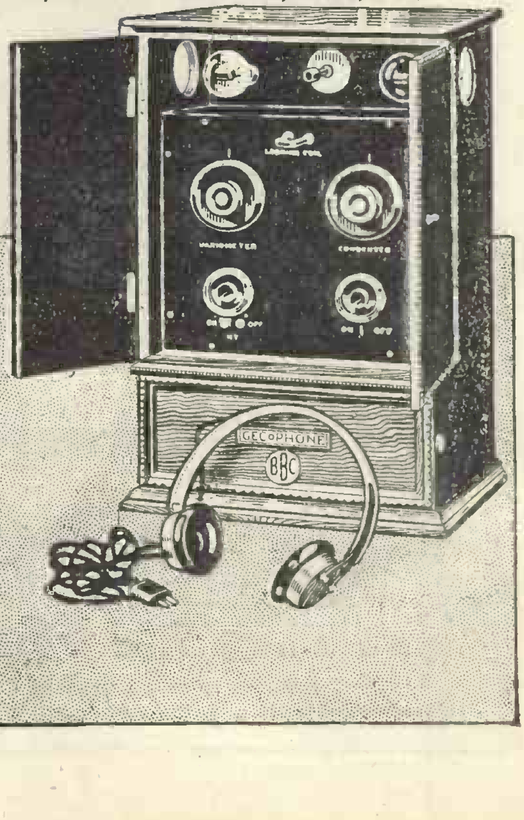
GECoPHONE CRYSTAL SET No. 2.
Approximate range, 30 miles. Price complete, **£9 15 0.**

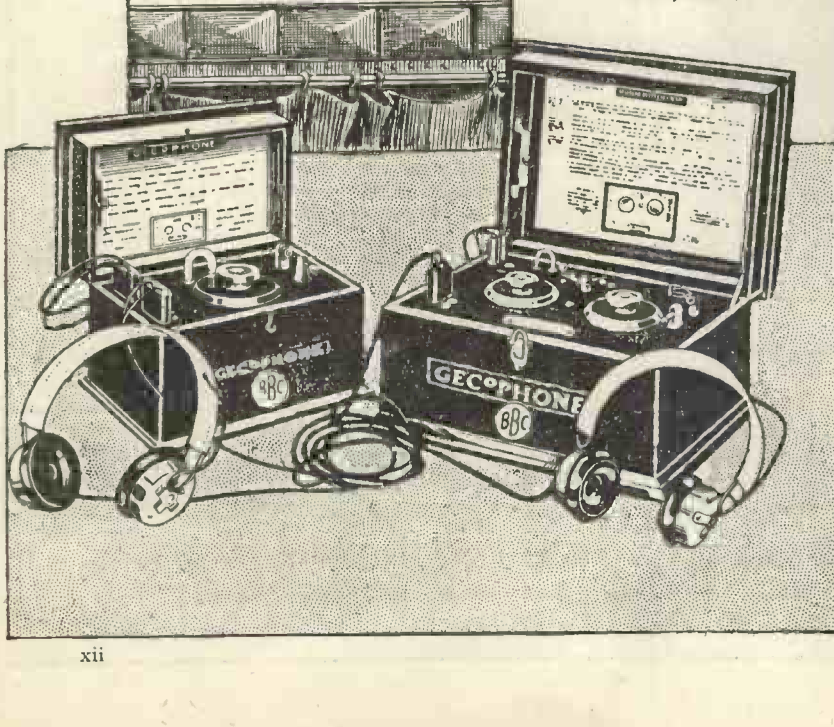
GECoPHONE TWO-VALVE SET.
Approximate range, 100 miles. Price complete, **£25 0 0.**

Sold by Principal Electricians, Stores and Wireless Dealers.

Sole Selling Agents for the Music Trades in Great Britain and Ireland:
Columbia Graphophone Co., Ltd., 102-108 Clerkenwell Road, London, E.C. 1.

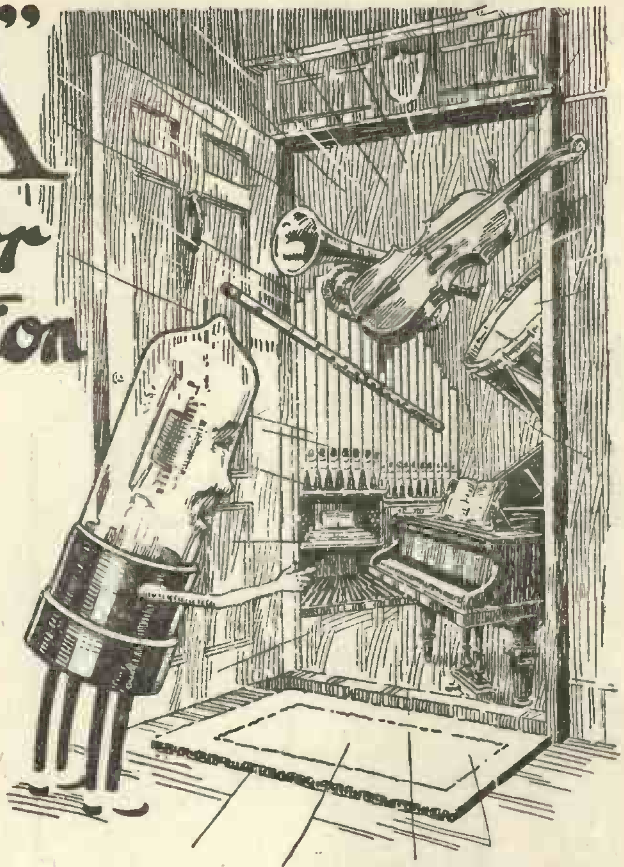
(Manufacturers and Wholesale only):
The General Electric Co., Ltd.,
Magnet House, Kingsway,
London, W.C. 1.





"ORA"

The Valve for perfect reception



A CONVINCING STATEMENT.

The International Meteorological Expedition operating in the North West district of West Australia, and using a portable wireless equipment, consisting of a 3-valve receiver with small portable aerial, received quite easily the time signals from all the high-power stations in the world.

They reported very satisfactory results despite the fact that conditions were very unfavourable indeed.

Needless to say, Mullard "ORA" valves were used.

The admirable manner in which these valves sustained several trans-shipments, submersion in water during landing, and severe rough handling generally, is the subject of a very interesting letter sent to us recently by Mr. John Wishaw of Mount Lawley, Western Australia.

For receiving vocal and instrumental items you must have

MULLARD "ORA" VALVES

to get the best results

Oscillates Rectifies Amplifies

See that you get "ORA" valves

For efficient results the "Ora" Valve requires 3·6 to 4 volts on the filament and 30 volts or over between the anode and filament.

Standard Price 15/- each.

THE MULLARD "R" VALVE is now reduced in price from 22s. 6d. to **17s. 6d.**

The Mullard Radio Valve Co., Ltd.

(Department M.W.)

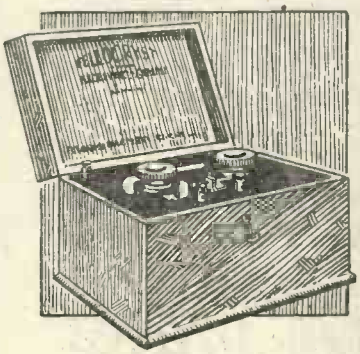
45, Nightingale Lane, Balham, S.W. 12

Contractors to H.M. Admiralty, War Office, Royal Air Force, and Post Office.

Telephone :	Codes :	Telegrams :
BATTERSEA 1068.	ABC (6th Ed.) BENTLEY'S.	RADIOVALVE, WANDSCOM, LONDON.

BROADCASTING

The FELLOCRYST SUPER



THIS is a high-grade Crystal Detector especially designed for receiving broadcasting, and complies with all regulations. Beautifully pure clear speech and music are received, and as many as 3 pairs of Fellows 4,000 ohms double headphones can be simultaneously used.

The "FELLOCRYST SUPER" is mounted in a highly polished oak cabinet and is sent out complete with a 100 ft. coil of 7/22 stranded copper aerial wire, two shell insulators, and one pair 4,000 ohms double headphones, and is BRITISH MADE Throughout. Fully approved by the Postmaster-General and the British Broadcasting Company.

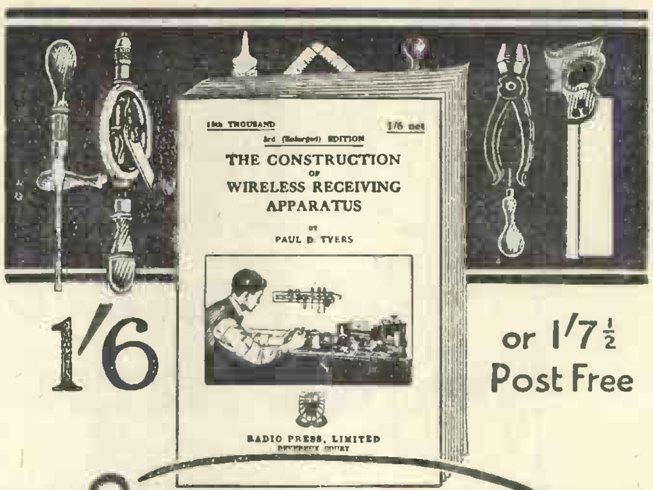
PRICE COMPLETE inclusive of all taxes. **£4 - 15 - 6** POSTAGE 2/- EACH.

Additional Double Headphones. (4,000 ohms) inclusive of all taxes. **21/6** POSTAGE 1/-.

FELLOWS MAGNETO CO., LTD.
LONDON, N.W. 10.

Telephone: WILLESDEN 1560-1 Telegrams: "QUIXMAG," 'PHONE, LONDON."

For they are jolly good Fellows



Saves its cost on the first piece of apparatus

HERE, for the first time, is a collection of constructive articles giving full details for making almost every piece of apparatus required in the building up of a complete Receiving Set. Essentially practical, well written, and illustrated with working diagrams, this is a book which every experimenter must have—whether he does much constructional work or little.

Get a copy to-day—you will certainly save its cost on the very first piece of apparatus you make.

The Construction of Wireless Receiving Apparatus
By Paul D. Tyers

Shows how to build the following apparatus

Anode and Grid Resistances, Filament Rheostats, Potentiometers, Basket Coils, Slab Coils, Solenoid Coils, Loose Couplers, Honeycomb Coils, Duolateral Coils, H.T. Batteries, Condensers, Crystal Detectors, L.F. Transformers, H.F. Transformers, etc.

1/6

From all Booksellers and Newsagents, or 1/7½ post free direct from Publishers.

Radio Press, Ltd.
PUBLISHERS OF AUTHORITATIVE WIRELESS LITERATURE
DEVEREUX COURT. STRAND. W.C.2.

DIRECTORY OF SUPPLIERS

"TO WIRELESS SUPPLIERS."—Half inch in column spaces for names and addresses and particulars of apparatus supplied in the districts of this Directory are offered at the rate of 10/- per insertion, or 12 Insertions £5 5s. od. prepaid. Communications with remittance should be sent to, Scheff Publicity Organisation Ltd., 125, Pall Mall, London, S.W.1. Advertisers are included under one district without charge.

LONDON.

RADIO SOCIETY OF GREAT BRITAIN.

Hon. Sec.: 32, Quex Road, West Hampstead, N.W.6.

SUPPLIERS:

American Hard Rubber Co. (Britain) Ltd., 13a, Fore Street, E.C.2.

Ashley, J. &. E., 5, New Oxford Street, W.C.1.

Autoveyors Ltd., 84, Victoria Street, S.W.1.

G. Z. Auckland & Son, 395, St. John St., E.C.1.

Bower Electric; Ltd., 15, Grape Street, W.C.2.

British L.-M. Ericsson Manufacturing Co., Ltd., 63, International Buildings, Kingsway, W.C.2.

Burndept Ltd., 16, Bedford Street, Strand, W.C.2. (Phone Gerrard 7794.)

Buss, T. O., 77, Clerkenwell Rd., E.C.1.

City Accumulator Co., 79, Mark Lane, E.C.3.

The Dubilier Condenser Co. (1921) Ltd., Ducon Works, Goldhawk Rd., Hammersmith, W.12.

Economic Electric Ltd., 10, Fitzroy Square, W.1.

Edison Swan Electric Co., Ltd., 123, Queen Victoria Street, E.C.4.

Green (Egerton) & Co., 22, Dyott Street, W.C.1.

C. F. Elwell, Ltd., Craven House, Kingsway, W.C.2.

Fallon Condenser Co., 230A, Hermitage Road, N.4.

Fellows Magneto Co., Ltd., Cumberland Avenue, N.W.10.

Gambrell Brothers, Ltd., Merton Road, Southfields, S.W.18.

General Radio Co., 105, Gt. Portland Street, W.1.

General Electric Co., Ltd., Magnet House, Kingsway, W.C.2.

Alfred Graham & Co., St. Andrew's Works, Crofton Park, S.E.4.

Gredmy Radio Co., 128–132, Shaftesbury Avenue, W.1.

Hestia Engineering Co., 32, Palmerston Road, W.3.

Holborn Radio Co., Ltd., 267, High Holborn, W.C.1.

Igranic Electric Co., Ltd., 147, Queen Victoria Street, E.C.4.

Joanes, W., 42, Jenner Road, Stoke Newington, N.16.

L.E.B. Engineering Co., 68, Pentonville Road, N.1.

LONDON—(continued)

WIRELESS INVENTORS.
Advice Handbook on Patents and Trade Marks. Consultations free.—B. T. King, Regd. Patent Agent, 146a, Queen Victoria St., E.C.4. 'Phone: Central 682. 36 yrs. refs.

Leslie McMichael, Radio Corner, Strand, W.C.2.

Longton, H., 43, Johnson Street, Westminster, S.W.1.

Marconi Wireless Telephone Co., Ltd., Marconi House, Strand, W.C.2.

Mullard Radio Valve Co., Ltd., 45, Nightingale Lane, Balham, S.W.12.

Negretti & Zambra, 38, Holborn Viaduct, E.C.1.

Peto-Scott Co., Featherstone House, 64, High Holborn, W.C.1.

Radio Communication Co., Ltd., 34–35, Norfolk Street, Strand, W.C.2.

Radio Components Ltd., 12–13, Henrietta Street, Strand, W.C.2.

Radio Instruments Ltd., 12, Hyde Street, W.C.1.

Radiophones, Ltd., 1B, Granville Place, Marble Arch, W.C.1.

M. Raymond, 27, Lisle Street, W.C.2.

Richford & Co., 153 Fleet Street, E.C.4.

"WIRELESS APPARATUS AND ITS UPKEEP."
A book that will enable you to get the most out of your receiver or will guide you if you contemplate installing a Broadcast receiver. 1s. Post free. Every reader should have one. Trade 8/- per doz. post free.
C. ROEBUCK'S ADVERTISING SERVICE, Craven House, Kingsway, London, W.C.2.

Rose Bros. Electric Co., 25, Milton Street, E.C.3.

Rowley & Louis, 12, The Broadway, Muswell Hill, N.

Firm of Telephone and Radio Instrument Manufacturers would be glad of quotations and particulars of material used for making Mouldings for the various parts. Manufacturers of raw material suitable for making mouldings kindly get into communication, giving particulars, to Box 1476, Sells Advertising Offices, Fleet St., E.C. 4.

Simpson & Blyth, 8, Sherwood Street, W.1.

Sterling Telephone & Electric Co., 210, Tottenham Court Road, W.1.

Tingey Wireless Ltd., 92, Queen Street, W.6.

Waterloo Electric Co., 129, Waterloo Road, S.E.1.

LONDON—(continued)

Wates Brothers, 13–14, Great Queen Street, Kingsway, W.C.2.

Western Electric Co., Ltd., Connaught House, Aldwych, W.C.

Whale & Co., 321, Vauxhall Bridge Road, S.W.1.

The Wilkinson Motor and Engineering Co., 10–14 and 29–33, Lonsdale Road, Kilburn, London, W.C.10.

Wilton Wireless Co., Ltd., 120–124, High Street, Tooting, S.W.17.

BELFAST.

SUPPLIERS:

The Electrical Installation & Repairing Co., 40, Berry St., Belfast. Phone: Belfast 3659

BIRMINGHAM.

BIRMINGHAM EXPERIMENTAL WIRELESS CLUB.

Hon. Sec.: 110, Ivor Road, Sparkhill.

SUPPLIERS:

Burndept Ltd., 133, New Street, Birmingham.

Cable Accessories Co., Ltd., Tipton, Staffs.

Electric Depot, The, 222, Corporation Street.

Rogers, Foster & Howell, Ltd., Edward Road, Balsall Heath.

BRIGHTON.

BRIGHTON AND HOVE RADIO SOCIETY.

Hon. Sec.: 68, Southdown Ave., Brighton. Sussex.

SUPPLIERS:

H. J. Galliers, 32, St. James's Street, Brighton. Agent for Burndept Ltd.

CONGLETON.

SUPPLIERS:

W. P. ALCOCK, Mill Street, Congleton.
Complete sets by leading makers. Complete stocks of accessories for amateurs.

DORSET.

EAST DORSETSHIRE WIRELESS SOCIETY.

Hon. Sec: "Hillmorton," Ringwood Road, Newtown, Parkstone.

SUPPLIERS:

E. T. Chapman, A.M.I.R.E., Wireless and Electrical Engineers, Ringwood Road, Newtown, Dorset. Agent for Burndept Ltd.

EDINBURGH.

EDINBURGH AND DISTRICT RADIO SOCIETY.

Hon. Sec. : 9, Ettrick Road, Edinburgh.

SUPPLIERS :

GLASGOW.

SUPPLIERS :

Clyde Electrical Co., Palm Street, N.W.

GUILDFORD.

SUPPLIERS :

Drummond Brothers, Guildford.

HALIFAX.

HALIFAX WIRELESS CLUB AND RADIO SCIENTIFIC SOCIETY.

Hon. Sec. : Clare Hall, Halifax.

SUPPLIERS :

Electrical Supply Stores, King's Cross.

ILFORD.

ILFORD AND DISTRICT RADIO SOCIETY.

Hon. Sec. : 77, Khedive Road, Forest Gate.

SUPPLIERS :

LEEDS.

LEEDS & DISTRICT AMATEUR WIRELESS SOCIETY.

Hon. Sec. : 37, Mexborough Avenue, Chapeltown Road, Leeds.

LEEDS—(continued).

SUPPLIERS :

British Wireless Supply Co., Ltd., 6, Blenheim Terrace.

LEICESTER.

LEICESTERSHIRE RADIO AND SCIENTIFIC SOCIETY.

Hon. Sec. : 269, Mere Road, Leicester.

SUPPLIERS :

LIVERPOOL.

LIVERPOOL WIRELESS SOCIETY.

Hon. Sec. No Secretary for Liverpool W.S.

SUPPLIERS :

Ashley Wireless Telephone Co., Ltd., 69, Renshaw Street, Liverpool.

MANCHESTER.

MANCHESTER RADIO SCIENTIFIC SOCIETY.

Hon. Sec. : 16, Todd Street, Manchester.

SUPPLIERS :

Victoria Electrical (Manchester) Ltd., 1–5, Chapel Street, Manchester.

Ward & Goldstone, Ltd., Frederick Road, Pendleton.

NEWCASTLE-ON-TYNE.

NEWCASTLE & DISTRICT AMATEUR WIRELESS ASSOCIATION.

Hon. Sec. : 51, Grainger St., Newcastle-on-Tyne.

SUPPLIERS :

NOTTINGHAM.

NOTTINGHAM AND DISTRICT RADIO EX. ASSCN.

Hon. Sec. : 99, Musters Road, W. Bridgford, Nottingham.

SUPPLIERS :

POOLE.

EAST DORSETSHIRE WIRELESS SOCIETY.

Hon. Sec. : Abbotsford, Serpentine Road, Poole.

SUPPLIERS :

PRESTON.

SUPPLIERS :

SPALDING (Lincs.)

SUPPLIERS :

TUNBRIDGE WELLS.

SUPPLIERS :

TORQUAY.

SUPPLIERS :

WANSTEAD.

SUPPLIERS :

YEOVIL.

SUPPLIERS :

WESTON ELECTRICAL MEASURING INSTRUMENTS

The WESTON

Model 280 VOLT-AMMETER

Triple Range. 150/15/3 volts. 15/1·5/0·15 amps.

This Precision Instrument is especially suitable for Wireless Research Work, *i.e.*
3 Volt Range.—Testing accumulator cells, dry batteries, measuring fall of potential across potentiometers.
15 Volt Range.—Testing 6 or 12 volt accumulator supplying voltage to valves, etc.
150 Volt Range.—Testing H.T. Batteries, etc.
0·15 Amp. Range (150 M.A.).—Measuring H.T. Current to transmitting valves, determining resistance of transformers, chokes, telephones, rheostats, etc.
1·5 Amp. Range.—Adjusting filament currents, etc.
15 Amp. Range.—Measuring output or charging current of accumulators, etc.
NOTE.—The 3 volt range may be used as a sensitive low range Milli-Ammeter.

SEVEN INSTRUMENTS IN ONE CASE.

PRICE £10. **Leather Case 15/-**

Write for further particulars.

WESTON ELECTRICAL INSTRUMENT CO., LTD.
Audrey House, Ely Place, Holborn, E.C. 1.
Telephone: *Holborn 2029.* *Telegrams*: *"Pivoted, Smith, London."*

MODEL 280

It answers your queries

IF you are at all keen and enthusiastic, you will continually find little queries which will puzzle you. Exactly what is Reaction? How does a Valve oscillate? What is Tuning?

These are the sort of questions answered in this new Book by the Editor of *Modern Wireless*. Get a copy to-day—master its contents—and you will begin to make *real progress* at once.

2/6

From all Booksellers, or 2/8 post free.

RADIO PRESS LTD.,
Devereux Court, Strand, W.C 2

Wireless Valves simply explained
By John Scott-Taggart F. Inst.P.

PHONES!! PHONES!!

Note the Prices

List No.	Make	Total Res. in ohms	Price	Post-age
201	Picard	4,000	21/-	9d.
202	Picard	8,000	22/6	9d.

Moulded ebonite receivers, double duralumin straps fully adjustable.

List No.	Make	Total Res. in ohms	Price	Post-age
203	Picard	2,000	8/-	5d.

Single receivers only, complete with cords.

List No.	Make	Total Res. in ohms	Price	Post-age
208	Thomson-Houston	4,000	25/6	9d.

Highly polished detachable receivers, double nickel-plated light steel spring straps.

List No.	Make	Total Res. in ohms	Price	Post-age
210	Thomson-Houston	4,000	27/6	9d.

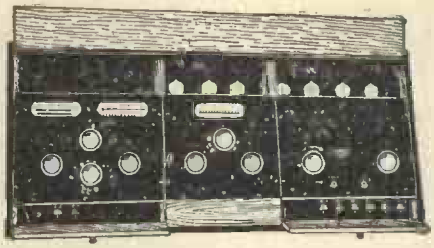
As above, with double imitation tortoiseshell straps. Very attractive.

TRADE SUPPLIED. Full List of Headphones Sent Post Free.

W. JOANES, *SOLE AGENTS.*
42, Jenner Road, Stoke Newington, London, N.16.
Telephone: Dalston 4741.

"POLAR"

THE FAMOUS 7-VALVE "POLAR" RADIOPHONE TYPE R.A. 33, 34, 35. DESIGNED FOR LONG RANGE AND PURE ARTICULATION.



Price, without accessories £58

SETS. The above instruments have established a wonderful reputation for loud-speaker reception on London and Paris all over the British Isles.

Using 4 valves, only short range loud-speaker reception can be obtained from your local broadcasting station.

With all 7 valves loud-speaker reception is available on practically all the broadcasting stations under normal conditions, and with an efficient aerial.

SERVICE. Every purchaser of a "Polar" Radiophone combination is entitled to a visit from one of our engineers after the instrument has been installed, when a demonstration of the evening's broadcasting will be given.

This service ensures that everything is in correct working order, and that the user is made familiar with the extremely simple manipulation of these powerful sets.

SIGNALS. "Polar" Radiophones are not simply built to a circuit diagram. Even the most minute details have been the subject of study and experiment in the perfecting of their design, and the most exacting attention has been paid to articulation. Purity of articulation involves perfection in the parts employed, and more particularly still, in the method of their mutual arrangement.

"Polar" design is the work of engineers who have made wireless their life's business, and who have graduated in the exacting school of commercial wireless design and manufacture. In the instrument illustrated, they have produced the most powerful set available to the holder of a Broadcasting licence.

Sets
Service
Signals

Ask your local agent to arrange for a demonstration or write for new leaflet describing this set.

THE

RADIO COMMUNICATION CO., LTD.,

OSWALDESTRE HOUSE, NORFOLK STREET, LONDON, W.C. 2.

BRANCHES:

NEWCASTLE: 17 SANDHILL. SOUTHAMPTON: 19 QUEEN'S TERRACE. CARDIFF: ATLAS CHAMBERS, JAMES STREET. LIVERPOOL: 67 DALE STREET. GLASGOW: 116 HOPE STREET.

WARRINGTON: 37 BRIDGE STREET ABERDEEN: 9 HADDEN STREET.

68

We can meet *your* Wireless Requirements at a Price to suit your Pocket

Complete Sets of every description and all accessories

We invite you to call at our Showrooms, where demonstrations will be gladly given. Illustrated lists free on request.

CRYSTAL RECEIVING SET

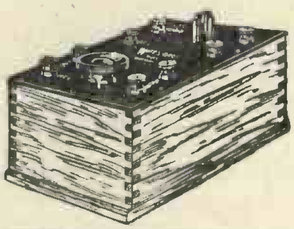
Receives Broadcasting music for thirty miles, is exceptionally easy to adjust, the movement of one switch arm being all that is necessary to adjust to any wavelength. The crystal is enclosed in a glass case, one adjustment being almost permanent.

Price £5 : 0 : 0
complete, and all ready for fixing.
No extras. No upkeep costs.

This Set can be adapted to take a Loud-Speaker by the use of our unit system of Note Magnifiers.

IMPROVE YOUR SET

The Wates Unit System of Note Magnifiers enables you to build up your Set step by step. The amplification is remarkable. One, two or three of these units will permit you to use a Loud-Speaker, according to the distance from the Broadcasting Station.



Price for 1-Valve Unit £3 : 10 : 0

Price for 2 Valves in one Unit £6 : 0 : 0

3-COIL HOLDER COMPLETE UNIT

Can be used with any standard coil, is mounted on mahogany base with ebonite top and well-lacquered brass parts. The levers at the side make possible the most critical adjustment with the minimum of friction. **Price 20/-**

Filament Resistances	**3/9**
Fixed Condensers	from **2/6**
Variable Condensers (of various capacities)	from **6/-**

PYRAMID H.T. BATTERIES

Supply that consistent flow through the grid, so necessary to ensure perfect reception. It has forty years' manufacturing experience behind it. Read this enthusiastic letter from a user:—" I feel it my duty to let you know that your batteries are worth recommendation. I have put them to exhaustive trials in many ways and find that they are very constant and lasting."—He ordered some more.

15 volt 3/6
30 volt (with Variable Plug Connection and 2 Wander Plugs)............ 7/-
66 volts (Tapped each 3 volts) 12/6

THE "IDEAL" VALVE ACCUMULATOR

Twenty-five hours continuous on one charge. Soundly constructed of the best materials. The numerous letters of appreciation we have received giving evidence of the remarkable service given by this type of accumulator, are sufficient evidence of long life and reliability. It has no rivals for valve work.

Rating: 50 hours intermittent; 25 hours continuous.

4 volt, in wooden case with carrying handle, 24/-
(Carriage, 2/-)

6 volt, in wooden case with carrying handle, 35/-
Carriage, 3/-

VALVES

Ora	**15/-**
M.O. " R."	**17/6**
Cossar	**15/-**
Ediswan	**15/-**

WATES BROS.

13/14, GREAT QUEEN STREET, KINGSWAY, LONDON, W.C. 2. Phone: Gerrard 575. Grams: Zywateseng, Westcent

Tone

THE ATM CLARITONE

The Loud Speaker that is acknowledged by the leading wireless Manufacturers to be the BEST IN THE WORLD
Excelling in CLARITY AND VOLUME.

Price: 2000 ohms £6 2 6 120 ohms £6 0 0

ASHLEY 3 Valve RECEIVING SET

Embodying 2 High Frequency Amplifying Valves and 1 Detector Valve.

Simple to control and suitable for long range work; adapted for direct coupling to the Ashley 2-Stage Low Frequency Amplifier. This outfit will not only receive all British broadcasting stations but brings in The Hague, Paris, etc.

Price: 3 Valve Set, £27 2-Stage Amplifier, £10
Valves, Batteries, etc., extra.

ASHLEY WIRELESS TEL. CO. LTD.

69 RENSHAW ST., LIVERPOOL Telephone 4628 ROYAL

DISTRIBUTING AGENTS—

London, Cardiff, Birmingham and Southern Counties—Pettigrew & Merriman Ltd., 122/124, Tooley St., London, S.E. 1.

Yorkshire—Carr & Childe, 38, Park Row, Leeds.

Nottingham—Gillott & Son.

Staffordshire—D. Shannon, Wyvern Grange, Sutton Coldfield.

North Wales—Thornton & Evans, 37, Regent St., Wrexham

Derbyshire—Clive & Co. Derby.

Westmorland—J. K. Thornborough & Co., Crescent Rd., Windermere.

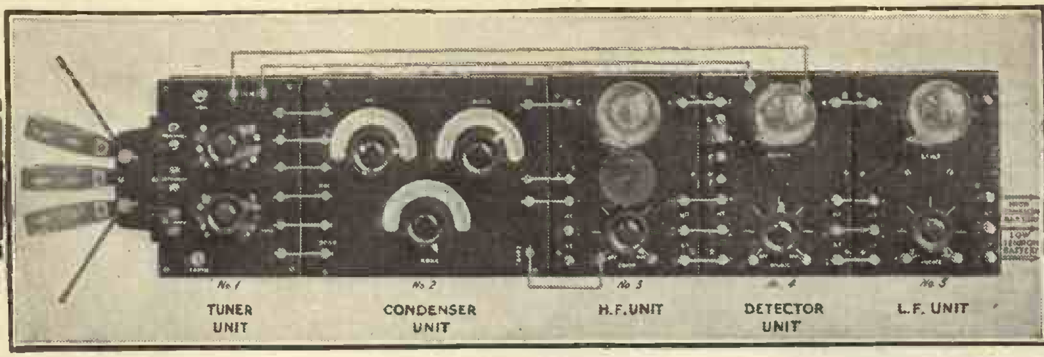
Northumberland—Wilson & Ridley 161, Northumberland St., Newcastle-on-Tyne.

Shropshire—J. Hopley & Son, Dodrington, Whitchurch

Isle of Man—Ramsey Power Co., Ramsey.

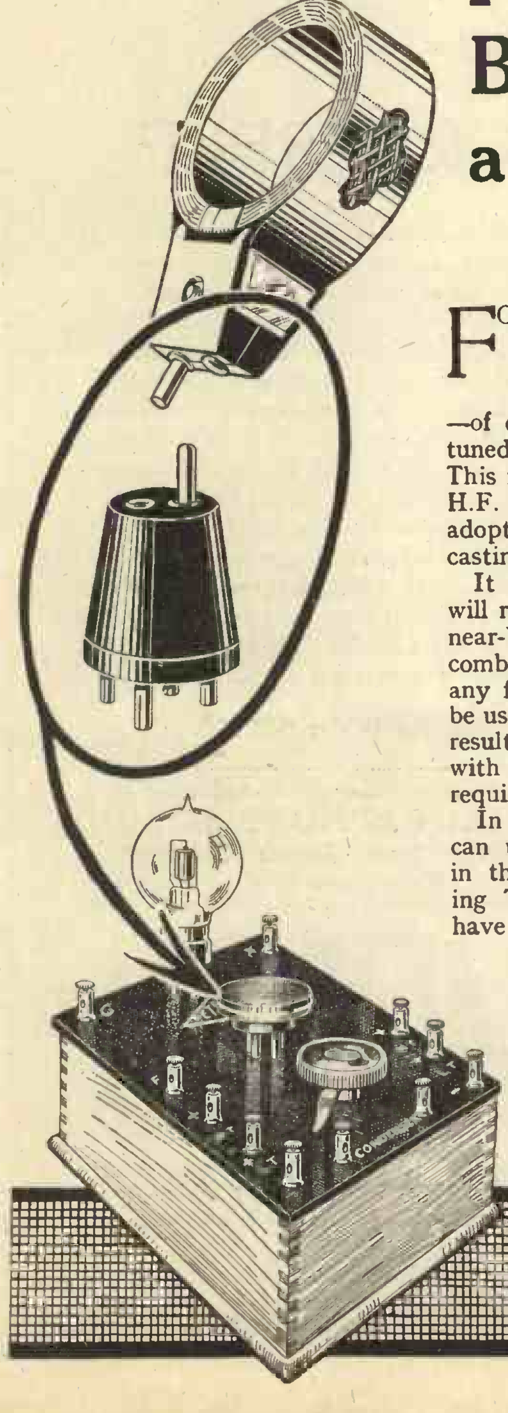
Glasgow and South Scotland—Fraser & Borthwick, Delta Electric Works, 53, Pitt St., Glasgow.

Aberdeen and North Scotland—Lawson, Turnbull & Co. Ltd., 8/18 Mealmarket St., Aberdeen.



For those long-distance Broadcasting stations use a tuned Anode Circuit

—— here is a way to use it without altering your set



FOR long-distance work, you must use high-frequency amplification, and the most efficient method—as well as the most economical—of doing this is to use a plug-in Coil tuned by a small variable Condenser. This method gives louder signals than H.F. Transformers, and is usually adopted in Circuits used in Broadcasting Receiving Sets.

It is also much more selective and will readily tune out interference from near-by Broadcasting Stations. Honeycomb, Basket, Duo-lateral—in fact, any form of coil may be used with excellent results, the size varying with the wavelength required.

In order that you can use plug-in Coils in the place of existing Transformers, we have designed this ***TUNODE PLUG*** (registered design).

To use it, merely remove Transformer and insert ***TUNODE PLUG*** and a Coil, and you are ready to receive. There is no alteration to any of the wiring of the Circuit.

This is just another example of the wonderful adaptability of the Peto-Scott Standardised Radio Units. Valves can be added at any time at ridiculously low cost—but from the first Valve the Set is quite complete.

If you would know more of this *perfected* Unit System—on which thousands of amateurs obtained the knowledge which qualified them for their Experimenters' Licences—send 6d. for a copy of "Radio," a 24 pp. Booklet showing how each Unit is constructed.

Price List of Sets of Parts

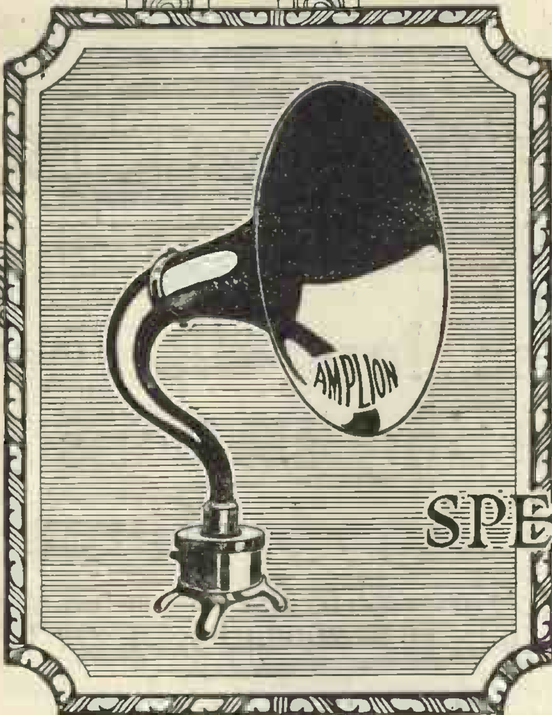
No. 1 Tuner Unit	27/6
No. 2 Condenser Unit	42/-
No. 3 H.F. Amplifying Unit	13/6
No. 4 Detector Unit	17/6
No. 5 L.F. Amplifying Unit	33/6
Cabinets for 1, 3, 4, and 5	3/6
Cabinets for No. 2	7/-
TUNODE PLUG	3/6
Catalogue of all Radio Components, 32 pp.	3d.

PETO-SCOTT CO., LTD.,

Featherstone House,

64, HIGH HOLBORN, W.C. 1.

THE PETO-SCOTT CO LTD



SPEAKS FOR ITSELF

AMPLION RECEIVERS are designed and produced by the world's original and largest manufacturers of Loud-speaking Telephones.

First demonstrated in 1887, commercially introduced in 1893, adopted by the British Admiralty in 1894, and by Foreign Governments and the leading Steamship Lines in the following years, no less than 12,000 vessels were fitted with Graham's instruments by the end of the year 1919, besides installations in numerous power stations and for other purposes. To-day the number of Graham Loud-speakers in use exceeds that of all other makes combined.

More Loud-speakers than ever are now produced in the Graham Factories or under licence, and in the Wireless field the Graham Amplion represents the utmost technical efficiency and unequalled commercial value.

Ask for Folder "M.W."

Daily Demonstrations at our Showrooms:
THE ALGRAPHONE SALON,
25-26, Savile Row, Regent Street, W.1.
'Phone Regent 1075.

AMPLION

ALFRED GRAHAM & CO.,
St. Andrew's Works, Crofton Park, London, S.E.4.
'Phone: Sydenham 2820-1-2.
'Grams: "Navalhada, Brock, London.
SCOTLAND—Mr. F. M. Milligan, 25, Renfrew Street, Glasgow.
IRELAND—Mr. Alex. R. Munday, 41, Chichester Street, Belfast.

T. O. BUSS, SCIENTIFIC INSTRUMENT MAKER

77, Clerkenwell Road, London, E.C. 1. *Estd. 1850.*

EXHIBITION AWARDS: London, 1862. Sydney, 1879. Melbourne, 1880.

HEADPHONES 19/6

Genuine French Telephones, most sensitive obtainable, 6 Tungsten poles in each earpiece. 4,000 ohms with cords (Double Receivers). Post free.

French "Brunet" Headphones
4,000 ohms **22/6** POSTAGE 9d.

French "Sidep" Headphones
4,000 ohms **21/-** POSTAGE 9d.

VARIABLE CONDENSERS

CONDENSERS. Complete Sets of Parts.			Assembled Complete for Cabinet Mounting.	
Approx. Capacity Microfarads.	No. of Plates	Price	Approx. Capacity Microfarads.	Price
·001	57	7/6	·001	16/-
·00075	43	6/9		
·0005	29	5/6	·0005	12/6
·0003	19	4/6	·0003	11/6
·0002	13	3/6		
·0001	7	3/-	·00005	5 6

Postage 1/- per set extra.

FIXED CONDENSERS

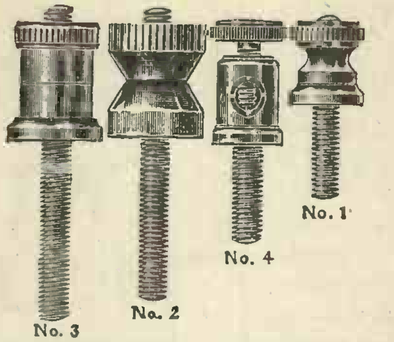
Fixed Condensers, with terminals on ebonite, ·0003, ·0005, ·001, ·002, ·003, 1/6; by post, 1/9; ·004, 1/9; by post, 2/-.
Variable Grid Leak for thermionic valves, 6/- each, composed of a special compound to vary the grid.

Wireless Parts and Accessories.

Aerial Wire, 7/22 bare copper, stranded. Price per 100 ft. 2/9. By post, 4/3.
Aluminium Vanes, 2 doz., 1/-. By post, 1/6. 5/- gross; by post, 6/-.
Basket Coils, 7 in set, 5/- set. By post, 5/6.
Brass Washers, 2, 3, 4 or 5 B.A. .. .. dozen 2d.
„ **Nuts,** 2, 3, 4 or 5 B.A. .. .. dozen 4d.
Brass Rod (screwed)—
2 B.A., in 12-in. lengths .. .. each 5d.
3 B.A., in 12-in. lengths .. .. each 4½d.
4 B.A., in 12-in. lengths .. .. each 4d.
5 B.A., in 12-in. lengths .. .. each 3½d.
Contact Studs, ¼ in. by ¼ in., complete with nut and washer, 6d. doz.
Copper Foil Sheets, uniform thickness, 12 in. by 3 in. .. .. each 3d.
Crystal Detectors on Ebonite. Each 2/6. By post, 3/-. Also 3/3; by post, 3/9.
Crystal Detector, cup enclosed with glass cover, dust proof 4/6. By post 5/3.
Ebonite Dials, with engraved scale 0–180, 1/- each. By post, 1/6.
Engraved Ivorine Scales, 0—150, round or square ends, 4½d.
Filament Resistances. Each 2/6 and 3/6. By post, 3/- and 4/-.
Inductance Coils Wound Enamel Wire, 12 by 4, 3/3. By post, 5/-.
1½ Insulating Sleeving, 6 yds. for 2/2. By post, 2/6. 12 yds. for 4/-. By post, 4/6.
Insulators, Egg, 4 for 11d.; 2/6 per doz. By post, 3/6 doz.
Insulators, Reel, 2d. each. By post, 2/6 doz.
Intervalve Transformers (low frequency), tested and guaranteed 5–1, 14/- each. By post 15/-.
Knobs, with brass nut (2 B.A.), 4½d. each. By post, 7d., 6 for 2/-. By post, 2/6.
Large Spacer Washers, 3 doz., 9d. By post, 1/-.
Lead-in Tubes, ebonite with brass terminals, 9 in., 1/2. By post, 1/6. 12 in., 1/4. By post, 1/8.
Slider and Plunger, 5d. By post, 7d.
Slider Knob, Plunger and 13 in. rod, 8d. the set. Cannot be sent by post.
Small Spacer Washers, 6 doz. 1/-. By post, 1/4.
Switch Arms, with polished knob, bushed 2 B.A. nut, laminated blade, spring coil washer, nuts and bush, 1/6, 2/- each. By post, 1/9, 2/-.
Tin Foil, free from lead. Sheets, 17 in. by 11 in., each, 4d.
Valve Legs, with nuts and washers, 1d. each, 9d. doz.
Valve Holders, turned ebonite, complete with nuts, 1/3; 2nd quality, 1/-.

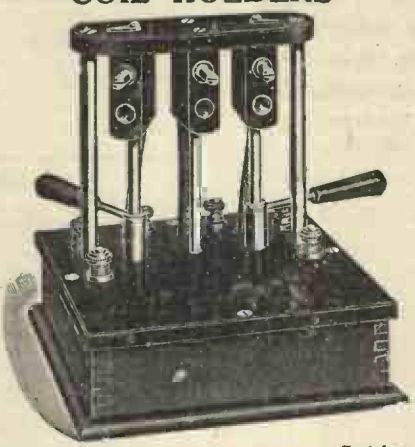
Trade Supplied—Terms on Application

TERMINALS



No. 3 Terminals, with nut and washer, 2/- doz. By post, 2/6.
No. 2 Terminals. War Office Pattern, with nut and washer 2/- doz. By post, 2/6.
No. 4 Terminals, telephone, with nut and washer, 2/- doz. By post, 2/6.
No. 1 Terminals, with nut and washer, 1/6 doz. By post 2/-.
Terminals (large), aerial and earth, complete with 2 nuts and 2 washers (2 B.A.), 2 for 8d. By post, 1/-.

COIL HOLDERS



Our Coil Holders are made in solid Ebonite, matt finish, and are beyond doubt the best on the market .. Post free. **22/-** each

RECEIVING SETS

(In Polished Mahogany or Oak Boxes.)

1-Valve	£4	10	0	plus Tax	£1	0	0
2-Valve	£8	8	0	„ „	£1	15	0
3-Valve	£12	12	0	„ „	£2	5	0
4-Valve	£18	18	0	„ „	£2	15	0

ACCESSORIES for THE ABOVE

Amplifiers
For 1-Valve Set, £2 15 0. For 2-Valve Set, £5 5 0. For 3-Valve Set, £7 0 0.

High-tension Battery, 60-Volt
For 1-, 2-, 3- or 4-Valve Set .. £0 12 0

Low-tension Accumulator, 6-Volt
For 1-, 2-, 3- or 4-Valve Set £1 12 0

Valves .. .. 15/- each

Telephones, complete, per pair, from 18/6 to £3. *Note*—Any number of Telephones may be used with a receiver.
Loud speaker, adaptable to Nos. 2-, 3-, and 4-Valve Sets, £3 2 6 to £6 10 0.

"EBONITE"

Postage free. Any size cut.

¼ inch thich.	s.	d.	Matt surface.	£	s.	d.
8 × 1		7	12 × 10 ..		7	6
4 × 4	1	3	17½ × 8½ ..		9	6
7 × 5½	2	8	18 × 18 ..		12	10
10 × 6	3	9	36 × 18 ..	1	3	0
17 × 5	6	3	7 lb.	1	3	0

INSTRUMENT WIRES

British Made Copper Wires.

Prices per lb.
All other sizes in stock. A charge of 3d. extra is made for reeling off in small quantities.
Postage extra.

S.W.G.	yds. per lb.	ohms per 1,000 yds.	S.C.C.	D.C.C.	S.S.C.	D.S.C.	En'd.
22	140	39	2/9	3/-	4/-	5/-	2/7
24	230	63	3/-	3/6	4/6	6/-	2/8
26	340	95	3/7	4/1	5/-	8/-	3/2
28	530	140	4/4	4/8	6/-	9/-	3/6
30	710	200	5/-	6/6	7/-	10/-	3/10
32	950	262	6/-	7/3	8/-	12/6	4/2
34	1,300	362	7/-	8/3	9/-	13/6	4 4
36	2,000	630	8/8	10/-	12/-	15/6	4/8

WIRELESS CRYSTALS

"Hertzite"	1s. 6d.	Carborundum	6d.
Zincite	6d.	Molybdenite	6d.
Silicon	6d.	Iron Pyrites	6d.
Bornite	6d.	Galena	6d.
Copper Pyrites	6d.	Graphite	6d.
Wood's Metal	6d.	Tellurium	Dram. 2s. 6d.

— Post free —

INTERVALVE TRANSFORMERS

Size 3 × 3 × 1½. Ebonite Top and Bottom
Ratio 5 to 1
Post Free, **15/-**

The most suitable transformer for panel mounting.

Celluloid Accumulators

We are introducing a new model consisting of individual two volt units. This MODEL to be known as T.9 has an actual capacity of 18 ampere hours, and an intermittent capacity of 34 ampere hours.

PRICE AS FOLLOWS
2 volt .. 6/- each, post 9d.
4 volt .. 11/9 „ „ 1/-
6 volt .. 17/6 „ „ 1/6

H.T. Batteries, 30 volt, 8/- (by post, 9/6).
H.T. Batteries, 60 volt, 13/6 (by post, 15/-).

INDUCTANCE TUBES

Cardboard.

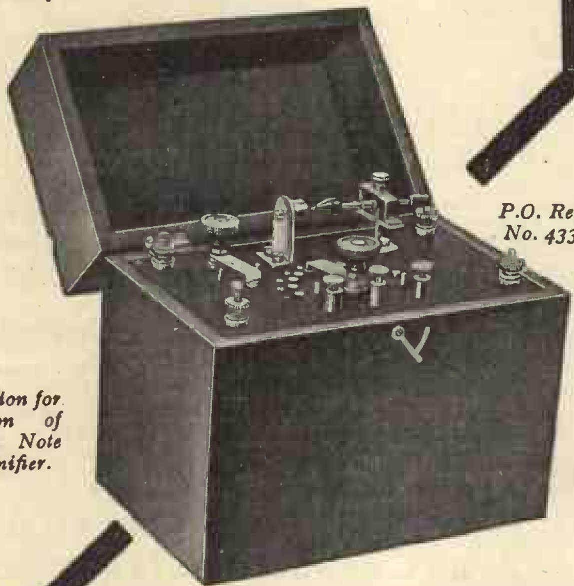
12 in. by 4 in., 8d. each. Post 2d.

MAHOGANY BOXES

Polished.		Post.
4½ × 4½ × 3½ in.	3/-	3d.
4½ × 4½ × 5 in.	3/6	6d.
6½ × 6½ × 4 in.	4/6	1/-
13 × 6½ × 4 in.	7/-	1/-

The Ediswan MODEL 1923B Crystal Set

The Set that is bang up-to-date and bristling with good features. Selling like hot cakes. Supplies being turned out at rate of one every 6 minutes. Shoals of enthusiastic reports from users everywhere. Acknowledged to be the "best crystal set yet."



P.O. Reg. No. 433.

Provision for addition of Valve Note Magnifier.

Sound construction. Best materials only. Guaranteed. 200 to 500 metres reception. Cat whisker adjustment permits finest crystal regulation; can be locked in position. Most sensitive crystal known, protected by ebonite cap. 25-mile range guaranteed.

Entirely British Made.

COMPLETE *with all accessories ready for instant use*	..	**£4 7 6**
B.B.C. Tax extra	.. ..	**7 6**

Ask your usual dealer and if unable to supply send us P.C. with his name and address.

Also manufacturers of the famous Ediswan Valves (15/- and 17/6), H.T. and L.T. batteries, accumulators, etc.

The EDISON SWAN ELECTRIC Co., Ltd.

Contractors to H.M. Admiralty, War Office, Royal Air Force.

123/5, Queen Victoria Street, E.C. 4, and 71, Victoria Street, S.W. 1.

Works: Ponders End, Middx.

Branches in all Principle Towns.

EDISWAN EVERYTHING ELECTRICAL

The Crystal Menace

DO you know that crystal receiving sets may interfere with reception and transmission? *The Broadcaster* has discovered that certain crystal sets do so, but that it is possible to avoid this interference.

Those who do not wish to annoy neighbouring listeners-in should be particularly interested in the subject, which is discussed in the May *Broadcaster*, just out.

In the same issue, a feature of practical help commences, in which three commercial receiving sets are reviewed each month, with complete instructions for working them. Confusing technicalities will be avoided.

Get your copy of the May *Broadcaster* to-day.

The Broadcaster

THE RADIOPHONE MONTHLY FOR LISTENERS-IN

MONTHLY ONE SHILLING

SOME FEATURES OF THE MAY ISSUE

Professor A. M. Low asks "What's Wrong with Loud-speakers?" He discusses the subject fully.

Expert Advice Free.—A wireless expert has been retained for the purpose of answering by post any questions *Broadcaster* readers may care to ask.

A report on the Manchester Radio Exhibition.

A prophetic article entitled "Power from the Ether."

"Laughter on the Ether Wave."—Norman Long tells of the difficulties to be overcome by the radio comedian.

Everything Wireless at Autoveyors

Parts and accessories of all kinds, including the famous "AUTOVEYORS" 3-ELECTRODE VARIABLE Condenser, the most efficient precision controller of oscillations in Radio circuits. Marconiphones and all leading Broadcasting Sets in stock. Catalogues on application. ADVICE AND INSTALLATIONS BY EXPERTS.

AUTOVEYORS, LTD.

Radio Supplies and Service

84 VICTORIA STREET, WESTMINSTER, S.W. 1.

(Phone: Victoria 309)

CRYSTAL SETS

AT A POPULAR PRICE

Price 21/- each

Packing and Postage 1/- extra.

(Design improved since illustration was made.)

Write for Yours now.

We can deliver from Stock at the present moment, but this condition will not last.

R. Egerton-Green & Co.

Manufacturing Wireless Engineers.

ESTABLISHED IN 1913

22, DYOTT STREET, NEW OXFORD STREET, LONDON, W.C. 1.

Telephone: Museum 6607.

Hear them at home

A wonderful 2-Valve Set

THE specification includes Variometer tuning (the ideal form). Range, 75 miles. Will operate loud-speaker up to 20 miles range on P.M.G. Aerial, or four pairs of phones at 50 miles. Complete with 6 V. 60 amp. Accumulators, 60 V., H-T. Battery, 100 feet Aerial Wire, four Insulators, one pair 4,000 ohm Phones.

Price (including all Royalties), £15 : 15 : 0.

Write for revised List No. 15 of all components and everything wireless.

BEL BOWER ELECTRIC L^TD.

15, GRAPE STREET,

SHAFTESBURY AVENUE, LONDON, W.C.2.

Back of Prince's Theatre. *Phone: Regent 2636.*

Branches { *15, Kingston Road, Wimbledon.* *Wimbledon 1030.*
10, Station Road, Finsbury Park, N. *Hornsey 3373.*

ROWLEY & LOUIS

'Phone: 668 Hornsey.

12, THE BROADWAY, MUSWELL HILL, N.10.

Compare Our Prices.

SPECIAL FRENCH HEADPHONES, 4,000 ohms 17/6 per pair.

GENUINE "BRUNET" HEADPHONES, 4,000 ohms 22/6 per pair.

AMERICAN FEDERAL PHONES, 4,400 ohms 25/- per pair.

ERRICSSON HEADPHONES CONTINENTAL, 21/- per pair, Stamped B.B.C.

CRYSTAL SETS from 19/6.

VALVE SETS from £6/6/0.

Aerial Wire 100 ft. 7/22 ..			.. 2/6	
Lead-in Wire			.. 4d.	yd.
Silk (covered) twin flex ..			.. 4d.	yd.
		gross yds.	21/-	
Enamelled wire	20, 22	G.	2/6	per lb.
,, ,,	24, 26	G.	2/9	,, ,,
,, ,,	28	G.	3/-	,, ,,
,, ,,	36	G.	3/6	,, ,,
D.C.C. ,,	18, 22	G.	2/6	,, ,,
,, ,,	24	G.	2/9	,, ,,
,, ,,	26	G.	3/4	,, ,,
,, ,,	28	G.	3/6	,, ,,
,, ,,	36	G.	8/-	,, ,,
D.S.C. ,,	24	G.	6/-	,, ,,
,, ,,	30	G.	8/-	,, ,,

All reels by Post 3d. *extra.*

Switch Arms complete ..	1/- each
Filament Resistance ..	2/6 ,,
Fixed Condensers .. from	1/4 ,,
Condenser Dials, best quality, engraved	2/- ,,

Basket coils 250 to 5,000 metres	4/9 per set
Valve holders	1/- each
,, legs	9d. doz.
,, pins	6d. ,,
"Brunet" Inter-valve transformers	15/- each
"Polar" Condensers ..	14/- ,,
Crystal detectors, complete in glass	2/6 ,,
Hertize Crystal, large size, from	9d. ,,
Condenser plates	1½d. per pr.
Contact studs	6d. doz.
2 B.A., 4 B.A., 5 B.A. nuts	4d. ,,
Threaded brass rod 2 B.A., 4 B.A.	4d. ft.
Shell Insulators, large size..	6d. each
Ebonite, cut any size ..	4/6 per lb.
Knobs, bushed and threaded, 2 B.A.	4d. each
Lead-in tubes, 6 inches ..	10d. ,,
,, 11 inches (Ebonite)	1/4 ,,

Ever-ready Batteries in stock ... 16 volt, 30 volt and 66 volt.

All kinds of Accumulators.

EDISWAN, MULLARD AND MARCONI VALVES

All goods sent off same day as ordered.
Cash returned if not satisfied.

Enclose sufficient for postage.

Type A I. Cap. ·0005.

APPRECIATION FROM PEOPLE WHO MATTER

11, Albert Grove,
Southsea, Hants.

Gentlemen,

. . . . . The quality of your products is good and the price is very reasonable.

Yours faithfully,
John H. C. Harrold,
Radio Engineer and Lecturer.

The Manor, Willenhall.

Dear Sirs,

I thank you for Condensers as per invoice enclosed dispatched to Park Engineering Co., Willenhall. These are eminently satisfactory . . . .

Yours faithfully,
W. Harvey-Marston,
Manufacturer of Wireless Components.

SINGLE CONDENSERS AT WHOLESALE PRICES

Direct from the Makers—Saving Middlemen's Profits.

Complete in *EVERY* respect and exactly as illustrated, to the following specification—

Rotary, Air Dielectric, 22 Gauge Aluminium Vanes. Metal to Metal Adjustable Bearings. Spacing between plates sufficient for pressure up to 1,000 volts. Engraved Ebonite Dial.

TYPE A I. is enclosed in Celluloid Transparent Case with circular Ebonite top and bottom plates. High-class finish. A very fine piece of workmanship which will compete favourably with the most expensive Instruments on the market.

TYPE A II. is suitable for mounting on any Panel up to ½" thick by drilling 3 holes. Supplied with screws for fixing.

PRICES :

TYPE A I.			PLATES.	TYPE A II.		
·001	..	17/6	57	·001	..	10/-
·0005	..	15/0	29	·0005	..	8/6
·0003	..	13/9	19	·0003	..	6/9
·0002	..	12/6	13	·0002	..	5/6

VERNIER CONDENSERS, 3-PLATE, 3/9; 5-PLATE, 4/6.
Postage and Packing - - 1, 1/-; 2, 1/3; 3, 1/6.

If more than 3, kindly include ample for packing and carriage.

Don't allow our low prices to prejudice you. They are no criterion whatever of the value we offer. Our Motto is QUALITY FIRST, and every Condenser carries our money-back guarantee.

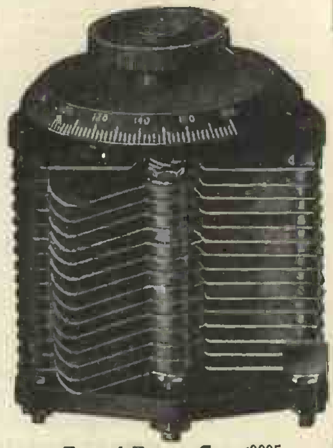
In response to numerous enquiries we beg to state we manufacture Variable Condensers only.

PROMPT DELIVERY ***CASH WITH ORDER***

FALLONS

THE CONDENSER PEOPLE

230a, HERMITAGE ROAD, LONDON, N. 4.
(Finsbury Park : near the Manor House).
FALLON CONDENSER MANFG. CO. LTD.



Type A II. Cap. ·0005

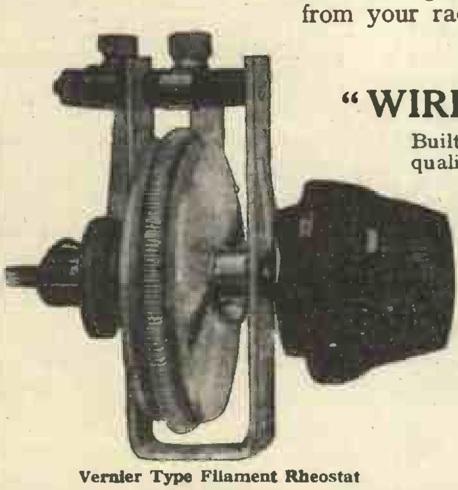
West End Agents:
Premier Electrical Supplies Ltd., 3, New Oxford St., W. 1.

DO YOU OBTAIN GOOD RECEPTION?

You will gain the utmost satisfaction and enjoyment from your radio set if you include in your instrument

"IGRANIC" "WIRELESS" COMPONENTS

Built scientifically, embodying the best quality materials and careful workmanship.



Vernier Type Filament Rheostat
(Patent applied for).

IGRANIC FILAMENT RHEOSTATS
operate your valves at maximum efficiency.

IGRANIC L.F. INTER-VALVE TRANSFORMERS
obtain maximum amplification without distortion.

COIL HOLDERS.
HONEYCOMB INDUCTANCES.
VARIOMETERS.
VARIO-COUPLERS, Etc.

WRITE FOR LEAFLETS Z 36.

Low Frequency Intervalve Transformer
(Patent applied for.)

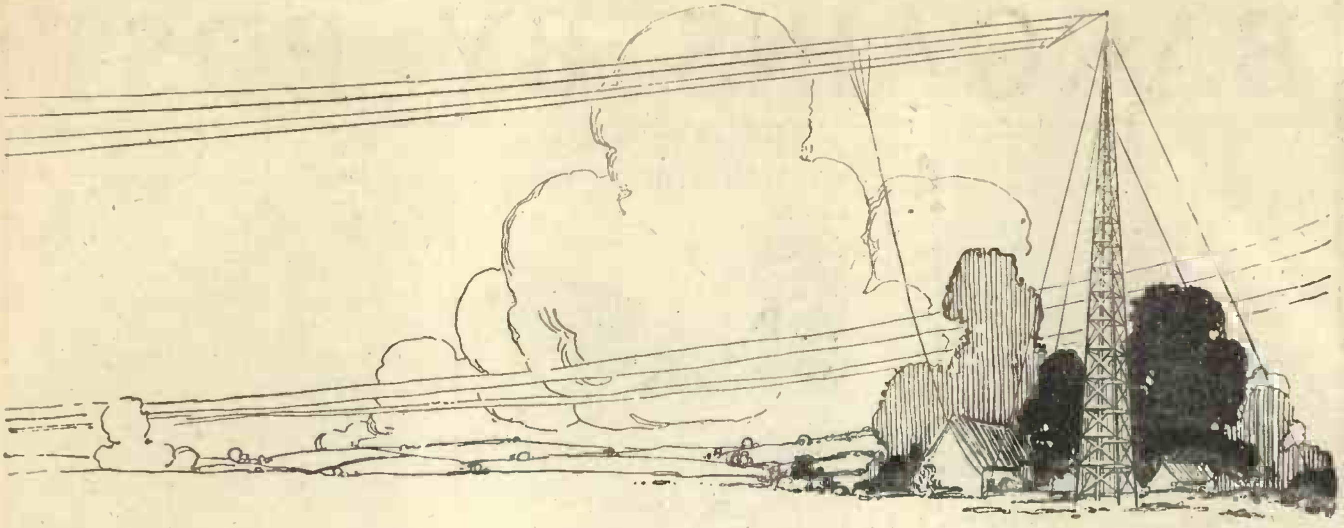
GLASGOW.
MANCHESTER.
BIRMINGHAM.

149, Queen Victoria St., LONDON.

RADIO IGRANIC ELECTRIC Co. Ltd WINDINGS

BRADFORD.
NEWCASTLE.
CARDIFF.

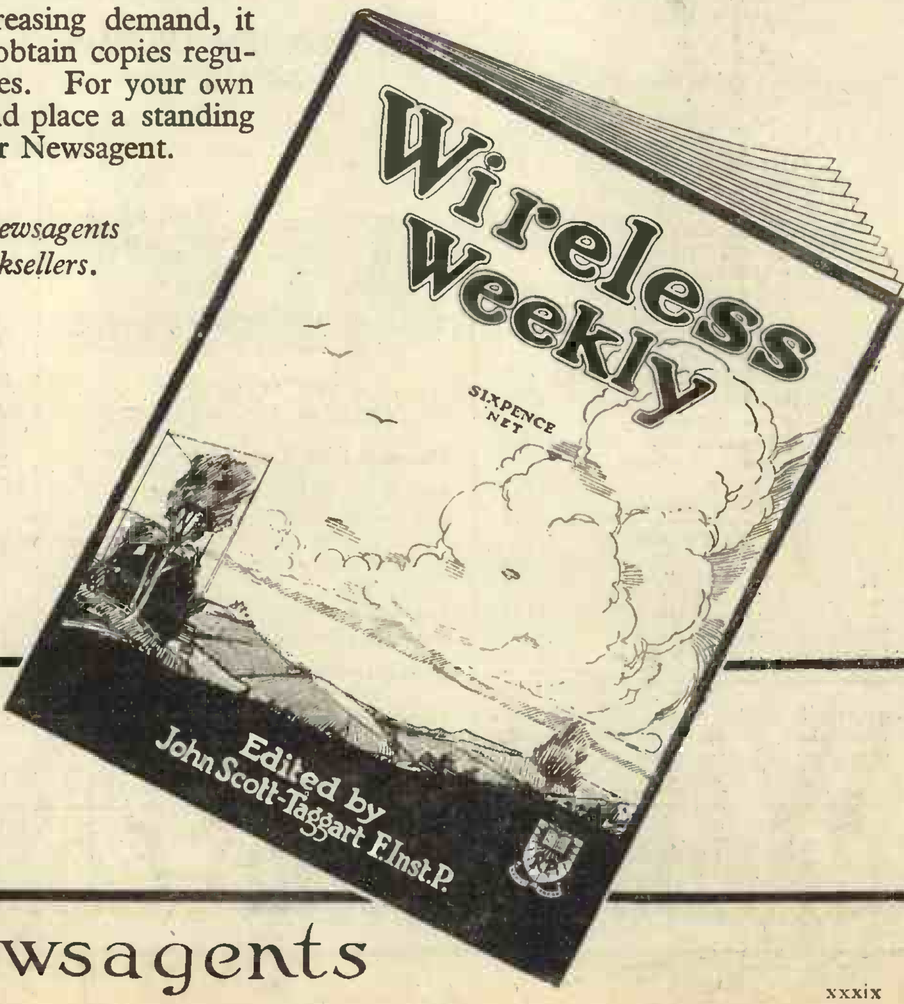
Works : Elstow Road, BEDFORD.



—as good as MODERN WIRELESS.

"WIRELESS WEEKLY" is published every Wednesday and is sold by all Newsagents and Booksellers. In view of the immense and ever-increasing demand, it may be difficult to obtain copies regularly in some localities. For your own protection, you should place a standing order with your Newsagent.

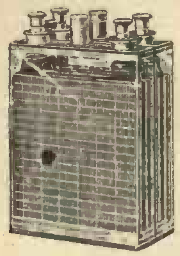
From all Newsagents and Booksellers.



PUBLISHED BY
Radio Press, Ltd
PUBLISHERS OF AUTHORITATIVE WIRELESS LITERATURE
DEVEREUX COURT, STRAND, W.C.2.

6D

from all Newsagents

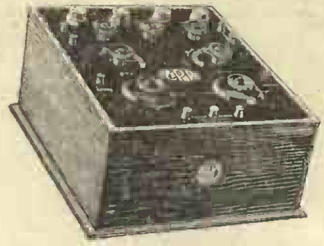


The E.P.R. Accumulators

have 20 years' reputation for dependibility and efficiency.

ALL CELLS GUARANTEED

EPR ACCUMULATORS AT REDUCED PRICES



POPULAR TYPE

No.	Voltage	Ignition Cap. Amps.	Act. A.H. Cap.	Price
1000	4	17	8	9/11
1310	4	20	10	12/11
1315	4	30	15	14/11
1320	4	40	20	16/11
1330	4	60	30	22/6
1340	4	80	40	29/-
1420	6	40	20	27/6
1430	6	60	30	33/9
1440	6	80	40	39/6
1450	6	100	50	45/6

"C" TYPE ACCUMULATORS

Special Features. Extra Stout Cases (Celluloid) Specially Formed Lattice and Plates. Absoutely the Finest Cell yet produced.

No.	Voltage	Ignition Cap. Amps.	Act. A.H. Cap.	Price
1720	4	44	22	22/-
1730	4	66	33	27/6
1740	4	88	44	35/-
1820	6	44	22	33/3
1830	6	66	33	42/6
1840	6	88	44	52/3
1850	6	100	55	63/-

Special Offer.
2-volt 40 amps. Fuller Block Acc. 12/11 each. Carriage extra.

Wireless Accessories

BASKET COILS, 4/- set 7
CRYSTAL DETECTORS, 2/3 each
" " Enclosed, 4/6 "
" " Perikon, 3/9 "
AERIAL WIRE
7/22 copper, BARE, 2/9 100 ft.
WOUND FORMERS, 12 × 4, 3/6 each
Lead-in WIRE, RUBBER Cov., 3d. per yd.
ARMY TEL. CABLE, SUITABLE FOR LEAD-IN WIRE
20 YD. HANK, 1/6 each
SWITCH ARMS, 1/3 and 1/6 each
FIL. RESISTANCES, 2/9
VALVE HOLDERS, with NUTS & WASHERS, 1/- each
CAT'S WHISKERS, 9ct. gold, 9d. each

SPECIAL E.P.R. FOUR-VALVE SET
Complete with 6 v. 60 amps. E.P.R. ACCUMULATOR, 60 v. HIGH-TENSION BATTERY, LEAD-IN WIRE, ETC., ETC. PHONES, VALVES, ETC.
£22 0 0 Tax, £2 15 0
2-VALVE DITTO, complete with all accessories
£10 10 0 Tax, £1 15 0

Wireless Accessories (*contd.*)

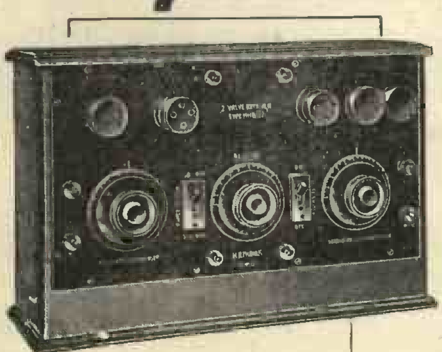
PHONES IN STOCK.		VALVES.	
Ericsson	..23/11 pr.	Dutch	..10/6 ea.
French	..21/-	French "R"	..12/11
Federal	..25/11	Ediswan	..13/11
Sterling	..30/-	Extrudion	..13/11
T.M.C.	..26/11		
Sensaphone	25/11		

ALL PHONES GUARANTEED AND EXCHANGED if unsuitable.

RICHFORD & CO.,

153, Fleet Street, London, E.C. 4.

ESTABLISHED 1876. Telephone: HOLBORN 5126.



Two-Valve Broadcasting Set
(No. M.H./B.R. 2)
Price, as illustrated,
£18 - 18 - 0
Price, including all accessories for a complete receiving station,
£24 - 6 - 0
(Carriage Paid).
(Illustrated Catalogue 3d.—post free).

Congratulations

on the excellence of our sets:—

"*Dear Sirs,—We cannot speak too highly of your* 2-Valve Broadcasting Set *recently received from you.*

"*The reception and selectivity has without exaggeration astonished us in comparison with 4- and 5-Valve sets of other makers, which we have had in stock for some time.*

"*The ease of manipulation—in the hands of an inexperienced operator all stations have been received successfully within less than one minute's search.*"

The original of above and many other letters of congratulation can be inspected at our showrooms.

This 2-Valve Broadcast Set is the result of careful experiment; we claim that in results it is superior to any other 2-Valve Broadcast Set on the market.

With this Set all Broadcasting Stations can be received with an average aerial.

B.B.C. Guarantees Government Approval.
WE Guarantee Highest Possible Efficiency.

Accessories recommended for making complete receiving stations:—

2 Valves	£1 15 0	*Brought forward* ...	£3 10 0
4-Volt Accumulators ...	1 10 0	H.T. Battery	0 15 0
Aeriel Wire	0 5 0	Telephone	1 0 0
		Insulators	0 2 0
	£3 10 0	Accessories cost	£5 7 0

L. McMICHAEL, Ltd.

Retail Showrooms: (RADIO CORNER) 179, STRAND (Corner of Norfolk Street), LONDON, W.C. 2.
Head Office (to which all correspondence should be sent): Hastings House, Norfolk Street, Strand, London, W.C. 2.

USE THIS COUPON

CUT HERE

In connection with your announcement in MODERN WIRELESS, please supply me with:

Enclosed please find remittance of..........
(Leave blank if not an order).

If an open envelope is used in applying for catalogues a half-penny stamp will cover postage.

Name..........

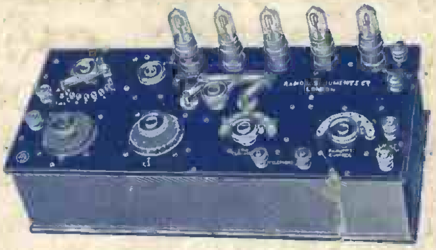
Address..........

....

Date..........

CUT HERE

Sets that Satisfy.



5-Valve Set. Price £41 10 0.
Price without Accessories £35.
P.O. Registered No. 1108.

2-Valve Set.
Price complete £25 5 0.
Valve Amplifying Receiver alone, without Accessories, £19 15 0.
P.O. Registered No. 2008.

3-Valve Set.
Price, £32 5 0.
Valve Amplifying Receiver alone, without Accessories, £24 15 0. P.O. Registered No. 0109.

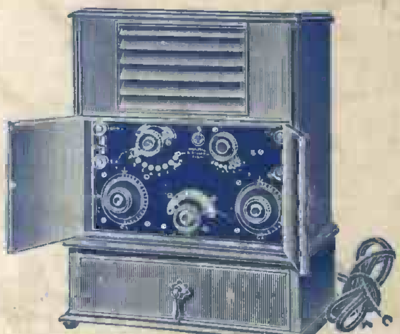
A Complete Range

R.I. new multi-valve sets contain the most efficient form of variable reactance that modern wireless science has produced. Increased selectivity and amplification of signals is far greater than on any other form of instrument.

All our Broadcasting Models are self-contained instruments, fitted with high-frequency amplification, 300–4,000 metres Wavelength range, bringing in the British and Continental telephony without the use of any additional accessories.

All bear the Broadcasting Seal and G. P. O. Registered No.

7-Valve Set.
Price complete with all Accessories £76 15 0.
Price of Instrument alone £67 10 0.
Valves Extra. P.O. Registered No. 0140.



4-Valve Receiver.
Complete with Loud-speaker, Batteries and Head Telephones,
Price, £48 15 0.
Self-contained.

Descriptive Catalogue will be sent free on application.

Radio Instruments Ltd.

Managing Director: J. JOSEPH, M.I.E.E.
Chief Designer:
W. A. APPLETON, M.B.E., M.I.R.E., *late Admiralty Technical Research Officer.*

ONLY ADDRESS, Works, Offices and Showrooms:

12, HYDE STREET, NEW OXFORD STREET, W.C. 1.

Telephone: Regent 1908. *Telegrams: "Instradio, London."*

(E.P.S. 44)

Printed by Spottiswoode, Ballantyne & Co., Ltd., Colchester, London and Eton, and published on the 1st of every month at 3, Bolt Court, Fleet Street, London, E.C.4 by the Proprietors, Radio Press Limited, Devereux Court, Strand, W.C.2. Subscriptions and editorial communications to go to latter address. Advertisement Offices: Scheff Publicity Organisation, Ltd., 125, Pall Mall, London, S.W.1. Registered as a Magazine for transmission by Canadian Magazine Post. Sole Agents for Australasia: Gordon & Gotch (Australasia), Ltd. Sole Agents for South Africa: Central News Agency, Ltd. May, 1923.