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Final Lucerne Wave-plan

FOLLOWING considerable discussion, a final European wave-plan has been evolved at Lucerne and it has been accepted by the majority of delegates. Holland, Hungary, Finland, Poland, Lithuania, Sweden and Greece, however, have not agreed to the allocation of wavelengths, but as no general change-over can take place before January, 1934, there is every hope that they may be induced to give their consent before the plan is brought into operation. So far, at the time of writing, Great Britain appears to have succeeded in securing almost everything she requires—we have lost no channels—and subject to some exchanged frequencies between home transmitters, the B.B.C. stations will work on the following wavelengths: Daventry National (1,100 m.); North Regional (449.1 m.); Midland Regional (591.1 m.); Scottish Regional (373.1 m.); London Regional (541.1 m.); West Regional (307.1 m.); North National (396.2 m.); Scottish National, Bournemouth and National (386.7 m.); Belfast (397.4 m.); London and West National (201.1 m.); and Plymouth (203.5 m.). It will be seen from the above that, in general, this noise by means of loud-speakers and oscillating valves. The mosquitoes roll up in thousands to be caught in a trap, and reports and any other information he might require. It is no larger in size than an ordinary two-valver and weighs only 11½ lbs. The other item is somewhat more strange! It has been found that mosquitoes are attracted by the loud humming noise that the female insects make while in flight, and a band of radio inventors have imitated this noise by means of loud-speakers and oscillating valves. The mosquitoes roll up in thousands to be caught in a trap, and

A Novel Use for Radio in America

I HAVE so got into the habit of telling you a bit of freak radio news from America, or elsewhere, week by week, that I feel I cannot disappoint you by failing to do so even though, to be candid, I am sometimes hard put to obtain something authentic to tell you from "over there." This week I offer you two items of interest, one of which cannot be called "freak." A large number of foreign stations. The fate of the American works. This discovery led to the production of this time radio destroys lives instead of saving them. This method of fly-catch ing was hit upon quite by accident for it was found that mosquitoes were being burnt by the thomond in an electric furnace that made a humming noise while working in an American works. This discovery led to the production of the radio catcher!

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The Radio Tourist Special

AS an experiment the Belgian Railway Company has brought into operation this summer a special train, "radio-touristique," working a circular tour between Bruges, Liège, Sp.a, Ghent, etc. All first and second class carriages are equipped with four loud-speakers connected with a microphone and amplifying panel located in the guard's van. By this means, a running commentary is given to passengers on all historical and other places of interest met with during the trip. Tests are also being carried out with wireless receivers, gramophones and electrical pick-ups. If the scheme proves successful, some 200 trains will be similarly equipped as it is calculated that the cost of the installation in each instance could be completely covered in the course of one summer season.

If Belgium Raises the Tax

THEE rumours that the Government would shortly increase the broadcast licence fee from 60 to 100 francs has raised thousands of protests from all over the country. Most of the wireless associations which provide entertainment programmes to the two Brussels stations have decided to appeal jointly to the authorities on the grounds that such an increase in cost would strangle the radio industry in Belgium. Roughly speaking there are 400,000 wireless sets registered, representing about one and a half million listeners.
Promenade Concerts 1933

A SUMMER in London is unthinkable without the Proms. There is no need to announce that another season of them will be held this year, any more than the public has to be told that the conductor will be Sir Henry J. Wood, who, like the concerts themselves, reappears for the thirty-ninth consecutive year. For particulars, however, may be of interest. The season is to last eight weeks, with the usual additional Saturday at the beginning. The opening concert has been fixed for August 12th, and the series will come to a close on September 7th. Needless to say, the B.B.C. Symphony Orchestra will play throughout. The programme makes no great change from that of previous years, but one or two features will be new. There will be the usual generous allowance of British music, but instead of being substantially included in special "British Composer" nights, it will be fully distributed throughout suitable programmes.

Excerpts from Seaside Shows.

Nothing is more welcome during the summer months than the regular relays of excerpts from the best seaside shows. One of the most popular of these is at the Beach Pavilion, Aberdeen, from which the inimitable Harry Gordon and his Company will broadcast to the Scottish Region on August 4th. While the majority of outside broadcasts to Scotland at this time of year come from the seaside, the microphone still remains faithful to the Edinburgh Theatre Royal, where the traditional spirit of Variety lives on as vigorous as ever. An excerpt from the show at this theatre will be relayed on Tuesday, August 1st, and should be a fitting tribute to the holiday season.

Royal Dockyard Draughtsmen's Choir.

The Royal Dockyard Draughtsmen's Choir, conducted by George Boland, will give a concert from the Plymouth studio on August 2nd. Marcel Kingdon (tenor) will sing, and Ernest Watkiss will play two groups of violin solos at this concert, which will be relayed to West Scottish listeners.

Cycle Racing Broadcast.

MOTOR cycle racing on grass is a sport that provides plenty of thrills, and listeners will be interested to hear that an eye-witness account of the Grass Track Motor Cycle Racing at the Maze Racecourse will be given from Belfast on August 5th. This event has been organised by the Lisburn Motor Cycle Club.

"The Week in Scotland.

DURING August the regular series of talks on "The Week in Scotland," which, since its inception at the beginning of the year, has been given with great success by Mr. George Blake, will be taken over by Mr. Herbert Fairbanks and Mr. Blakes, who combines wide knowledge with an admirable microphone technique, has set views of a representative of the West. Mr. Herries will give his first talk on August 5th.

Dual Band Broadcast.

A CONCERT which promises to provide varied entertainment will be broadcast from Belfast on August 12th. In it will be heard two bands, the Argyle Tenor Saxophone Band, and Samuel Adams (baritone), who will sing a number of well-known songs.

THE "ARTIFICIAL TRAIN" TEST

Submarine built a simple three-valve equipment employing a variable-mus H.F. stage, S.G. Detector and Pentode output stage. A special pair of condenser was made for him and the battery was completed with great care. On switching on results were very disappointing, owing to the improper adjustment of the bias and the negative plug he was surprised to find that the battery was quite hot. What was wrong? Three books will be awarded for the first three correct solutions opened. Address your solutions to The Editor, PRACTICAL WIRELESS, Geo. Newnes, Ltd., 54, Southampton Street, Strand, London, W.C.2. Mark your envelopes Problem No. 45, and post to reach here not later than July 31st.

SOLUTION TO PROBLEM No. 45.

The circuit which forms the up should have been mounted on a metal chassis, when the connection would automatically have been made to the condenser. As he used a wooden baseboard the earth connection was omitted. This accounted for the fact that the condenser did not tune. The following three readers received books in connection with Problem No. 43, Mr. Herkes Fairbanks, M. Thoms Grove, Blythpool; Mr. James McCarrick, 29, Hayfield Road, Bedford 4; Mr. G. Howe's, 2 Rothney Avenue, Richmond.
The Problem of Low Frequency Couplings is Not Always Understood by the Home Constructor. In this Article FRANK PRESTON, F.R.A., discusses the Pros and Cons of Every Type of L.F. Coupling.

**The BEST L.F. COUPLING**

There are so very many methods of coupling low frequency valves that the amateur is likely to experience a good deal of difficulty in deciding which is best for his own requirements. The question is not simplified by reading such bald, but oft-written, statements as "Resistance-Capacity Coupling gives most purity, but Transformer Coupling affords more amplification."

Whilst this very general rule might be true in some slight measure there are so many factors to consider that it cannot be applied with impunity.

Correct "Matching".

The primary essential if we are to get the best out of any valve is that the impedance (or resistance to alternating currents) of the component connected in its anode circuit should bear a definite relationship to the impedance of the valve itself. For all practical purposes it can be taken that maximum efficiency is obtained by choosing a coupling component whose impedance is not less than twice that of the valve, or conversely, by choosing a valve which has an impedance equal to or one-half that of the component to be connected in its anode circuit. An example will make this point quite clear. Suppose our valve is one of the "210 L.F." type, having an impedance of 10,000 ohms (the exact figure is always quoted on the makers' instruction sheet), the component—transformer, primary, resistance, choke, etc.—to be wired in its anode circuit should have a minimum impedance of 20,000 ohms if the full amplification of which the valve is capable is to be obtained.

If the rule just cited is kept clearly in mind the advantages and defects of the several L.F. coupling arrangements will more readily be appreciated.

Resistance-Capacity.

Without any further deliberation let us examine the simplest method of feeding a low-frequency valve, that is, by means of a resistance-capacity circuit. The connections are shown both practically and theoretically in Fig. 1, from which it can be seen that a simple fixed resistance is connected between the anode of V.1—which might be either a detector or L.F. valve—and high tension positive. The grid of V.2 receives its signal voltages through a fixed condenser joined to the anode of V.1. Although it does not take any part in the transference of energy from V.1 to V.2, a grid-leak is joined between the grid of the latter valve and the G.B. battery to permit of the application of the correct bias voltage to V.2.

It is an easy matter to find the correct ohmic value for the anode resistance when the impedance of V.1 is known, but the question of deciding on the optimum high signal voltages. A poor condenser will "break down" in very little time, and, besides silencing the receiver, will probably cause valve V.2 to be ruined by the application of a large positive grid-bias derived through the anode resistance.

Uniform Impedance

A resistance-capacity amplifier properly set up will produce very fine results in the way of good quality reproduction. The main reason for this is to be found in the fact that the impedance of the anode resistance remains practically uniform at all audio frequencies. We shall see later that the impedance of other coupling devices is subject to wide variations. Resistance-capacity is not the only form of coupling that will give pure reproduction, though it is undoubtedly the cheapest.

Disadvantages of R.C.C.

But it has two notable defects. Firstly the coupling device does not, in itself, provide any amplification and thus the increase in volume obtained is only that produced by the valves. In the second place the anode resistance has the effect of cutting down the high tension voltage supplied to the valve V.1. This loss is not serious where the resistance is 50,000 ohms or less, but for higher values the valve may be prevented from working at its best unless the H.T. battery is of unduly high voltage.

Choke-Capacity.

The latter difficulty can entirely be overcome by substituting a low-frequency choke for the anode resistance, because a choke has a comparatively low resistance.

(Continued overleaf)
to direct high-tension current, despite its high impedance to alternating or signal currents. So to be more explicit, a well-known L.F. choke rated at 20 henries inductance has a D.C. resistance of only 250 ohms, whilst its impedance at 1,000 cycles (equivalent to the average female speaking voice) is over 100,000 ohms. Choke-capacity is thus better than R.C.C. in one respect, but it is somewhat worse in another. The impedance of any choke varies with the frequency of the alternating current; it has to carry—it becomes less at lower frequencies and more at higher ones. Thus the impedance of the component referred to above is only about 6,000 ohms at 50 cycles, although it is nearly 600,000 ohms at 5,000 cycles. It will be appreciated that this explanation that a choke must have a sufficiently high impedance—twice that of the preceding valve—at the lowest frequency at which perfect reproduction is required. Unfortunately most manufacturers do not state the impedance of the chokes they supply, but, instead, give the inductance. It will therefore be helpful to know that the inductance at 256 cycles (middle C) on the piano can be found very approximately by multiplying the inductance in henries by 1,500. Moreover, in most cases it will be found that satisfactory results can be obtained over the whole musical scale by so choosing the choke that its impedance is correct at 256 cycles.

The principal advantage of push-pull is that a large undistorted output can be obtained even when the H.T. supply is of comparatively low voltage, and by using two small power valves in the last stage. This is because the two valves work together, each dealing alternately with the negative and positive half-cycles; one valve can thus be said to be "pushing" whilst the other is "pulling." In consequence, any distortion which might occur in one valve is cancelled out by another, so that the output is virtually free from distortion.

Quiescent Push-Pull

The system just dealt with is that which has been in use for several years, but a newer "version" of it has only become popular during recent months. I refer to quiescent push-pull, or, by another name, "push-pull." The new method differs from the old only in respect to the way in which it is used. The two valves are given a very heavy negative grid bias, so that they are "off" at a considerably lower grid voltage than when used in the conventional way; the result is that the valves are not "saturated," as many people wrongly imagine, at all the intermediate stages. It is rapidly being replaced by a system which combines the R.C.C. and transformer methods, and which is illustrated in Fig. 3. The resistance R.L. and condenser C.L. are the same as the two similar components shown in Fig. 1, but a transformer is inserted between the coupling condenser and the grid of V.2. It will be seen that the anode resistance carries the direct H.T. current, whilst the alternating signal currents only. This component can thus be made quite small without there being any danger of the choke becoming "saturated." The degree of amplification to be obtained in this way is greater than that obtainable by the transformer alone, and the quality of reproduction is equal to that given by the R.C.C. method of coupling.

Push-Pull

The next system of L.F. coupling I wish to mention is known as push-pull, and which has recently come into great prominence in two or three different forms. Connections for a P.-P. amplifier are shown in Fig. 4, from which it can be seen that two valves are used in the output stage. Their anode feed is from a special input transformer having a centre-tapped secondary, and an output transformer with centre-tapped primary is used to collect the amplified signal currents from the anodes of the two valves. It can be seen from Fig. 4 that both valves receive their grid bias from the anode of V.1 and that the coupling is decoupled by means of a 100,000 ohm fixed resistance.

When more than a single L.F. stage is employed it is almost invariably better to use Resistance-Capacity or Choke-Capacity coupling for the first stage at any rate, since when two transformers are used there is always a danger of causing instability or overloading, due to the excessive amount of amplification produced. Two, or even more, transformers can be used together, but for good results great care is necessary in designing the receiver.

Resistance-Fed Transformer

Because of the disadvantages mentioned, it is more than probable that ordinate coupling or transmission transformer coupling, as illustrated in Fig. 2, will gradually die a natural death. It is rapidly being replaced by a system which combines the R.C.C. and transformer methods, and which is illustrated in Fig. 3. The resistance R.L. and condenser C.L. are the same as the two similar components shown in Fig. 1, but a transformer is inserted between the coupling condenser and the grid of V.2. It will be seen that
THOSE who have followed Mr. Barton Chapple's articles on The Development of the Tuning Coil in Nos. 20 to 23 of Practical Wireless, will have observed that the wire coil of to-day is not an ephemeral cult of the moment, but a design evolved through many varying shapes from an ancestor remarkably like its present-day descendant. This family likeness is unfortunate in some respects, for it is primarily responsible for the idea that the revulsion to type is also a revulsion to inefficiency. The radio amateur who has not delved very deeply into the matter, may well be excused for comparing unfavourably the insignificance of its present-day descendant. The author has observed that the dual coil of to-day is little more than one desirable purpose, and tuning transformers throbbing by his claims for comparison between a single winding and a layer winding, it may be desirable to enlarge a little on one aspect of resistance.

Ordinary direct current flowing through a layer winding is evenly distributed throughout the whole section of the wire, but alternating current, which, of course, travels backwards and forwards in any given length of wire, keeps the periphery topsy-turvy. At the very high frequencies used in wireless this tendency is greatly emphasised, and as the magnetic field of the coil as a whole accentuates the effect, it follows that the greater and more bunched the magnetic field of the coil, the greater will be the unwanted ohmic resistance present.

The coil must always be considered in relation to the efficiency of the other components in a wireless set. There is no inherent merit either in a fixed coil with one or more windings, or in a combination of plug-in coils with corresponding constants, apart from their suitability to the form of circuits in which they are employed. For instance, when swinging coil reaction was common practice, it would have been cumbersome and ineffective to have utilised solenoid coils in the anode and reaction circuits. It would be equally ridiculous to-day to employ a movable plug-in coil in a modern design where the stability of the set is often calculated to such fine margins that the failure to utilise metallic screening on a small lead may set up oscillation.

Modern Requirements
A few years ago, the set designer worked to approximations and wide margins, because the efficiency of the average valve and tuning condenser was a variable quantity. It was advantageous, therefore, to be able to ring the changes on coils to compensate for deficiencies in other respects. A greater use, too, was made of plain coil coupling, particularly in inter-valve links and in neodyme schemes, and as components were very approximately matched, it was convenient to use a form of coil that was quickly adaptable to variations of type. These were rarely the only considerations that made the plug-in coil so universally popular. To-day, when multiplicity of valves and circuits are a necessity, it is essential that coils should be mathematically exact in their constants, that all windings, including reaction, should be meticulously proportioned, and that screening should be possible without loss of efficiency. From a manufacturing point of view, the solenoid coil lends itself more readily to the attainment of these ends at a reasonable price, and when all the windings are incorporated in one fixed form, the amateur is relieved of the possibility of setting up undesirable interaction effects through the use of separate coils.

It has to be understood that this discussion refers to apparatus constructed for the broadcast band. Practical considerations outside the broadcast band, where selectivity is not a vital question, may indicate a preference for other forms, but that is a matter with which the amateur is not concerned. Hypercritical amateurs may possibly be inclined to point out that the 6-pin coil was a plug-in coil, but it was a solenoid limited in its adaptability, and I have understood the term "plug-in" in this article to refer solely to the non-solenoidal type usually implied by that description.

A Question of Efficiency
One cannot be dogmatic about such components as valves or transformers, since their functions are varied, and a change in design may not only revolutionise their efficiency but even add to their functions. A coil, however, has one function only, and its maximum theoretical efficiency, although not attainable in practice, is within the sphere of calculation. There was a time when a designer was able to set the pulses of amateur constructors throbbing by his claims for a variety of coil dimensions wound with something like a small bale of fencing wire, but those happy days of ignorance are no more. No coil, whatever its shape, or composition, can serve, or it required to serve, more than one desirable purpose, i.e., to develop as large an oscillating voltage as possible across its windings, in tune with the frequency of the required transmitter. The main factors which militate against efficiency in any coil are three in number—self-capacity, dielectric absorption, and resistance. It is assumed that readers are familiar with recent articles on the meaning of self-capacity and dielectric losses, but in order to make a better comparison between a single winding and a layer winding, it may be desirable to enlarge a little on one aspect of resistance.

Dielectric Absorption
Consideration will now make it obvious that, since all the self-capacity in a solenoid coil is in the form of a minimum of line, the losses in the winding must be less than that of a layer coil, where the condenser-effects are necessarily more numerous. Similarly, the dielectric absorption of the plug-in type must be less controllable, and from what has been said above about coil resistance, it is plain that the concentration of the windings in the multiple-layer system results in increased coil resistance. Again, it is not possible in any plug-in coil of normal type to obtain the big separation necessary between turns with large differences of H.F. potential. Generally, then, from a purely theoretical point of view, the solenoid coil scores over the plug-in coil as an efficient coil form.

At this point, the plug-in enthusiast may point out that the original coils were solenoids, and that they were abandoned for the reasons above, of course. It is true, but quite apart from the fact that many of the factors which determine the efficiency of a coil were imperfectly understood at that time, the revulsion of to-day often fails to realise that the principles of circuit design in those days called for a handy compact form of coil that could readily be changed for one of another value.
THE majority of short-wave adaptors comprise a detector stage (capable of operating upon short waves) which replaces the detector stage of the broadcast receiver when plugged into the detector socket. With receivers employing a powerful audio frequency stage this method is hard to beat. It is when we come to small two and three-valve receivers that we desire something different.

If it is possible to add an L.F. stage to the receiver it will be found that results are as good as could be desired. On the other hand, it is not always possible to add an L.F. stage to every broadcast set. If an L.F. stage is employed in the adaptor a number of new components are required, and it was with a view of constructing an adaptor capable of amplifying as well as detecting that resulted in my constructing the "Extramp," which is short for extra amplification.

Small Extra Cost
This is a unique adaptor which employs the detector stage of the broadcast receiver as an L.F. amplifier, resulting in extra amplification at little more cost than if the usual type of adaptor were constructed. A perusal of Fig. 1 will show how this is done. It will also show that the construction is simplicity itself.

Before starting upon the constructional details there are one or two points which should be remembered. In the original model an aluminum panel was employed to overcome hand-capacity effects. Although this luxury is not essential, and therefore the wiring diagram (Fig. 3) shows the receiver with an insulated panel. If a metal panel were employed the panel could be used to take the place of various wires.

Now place all the components in their proper positions, as shown in diagram, and fasten down. Do not economize in screws, but fix every component firmly to the board. If one screw is employed there will be a possibility of the component moving when knocked, resulting in a loose contact, which is just the thing to create rushing and crackling noises.

If the wires are soldered, care should be taken to observe that the resultant joints are clean and firm. Failure to do so may result in more crackles—which, when amplified, will create a terrific amount of noise.

Adaptor Plug and Coils.
Having placed the components and wired the receiver, we have now to consider the adaptor plug and coils. The former must be of such construction as to enable a valve to be plugged into it when it is plugged into the detector socket of the broadcast set. There are quite a number of plugs (constructed for pick-up work) which are ideal for this purpose. Care should be taken not to twist the wires which travel from the receiver to the plug tightly, as interaction may result. If loosely wound no trouble will be experienced.

The coils employed in the original set were home-made affairs. These are readily constructed, and they are cheaper than commercial coils.

Although the constructor may feel tempted to employ a clip to short a larger coil down so as to enable it to receive upon more than one waveband, I do not recommend this procedure if the receiver is to be operated much below 15 metres. Far better to construct a coil for each waveband.

Testing the Adaptor.
Having constructed the adaptor, we may now test it. To do so we should insert the plug into the detector socket of the broadcast receiver, insert the valve in the adaptor, and place a H.F. or B.C.C. valve in the adaptor socket (which is plugged into the receiver). You will be surprised at the volume obtainable. With my model I found results far better than with any other class of adaptor I have employed. During the evening I have heard R669 and REN, Moscow, DMC, DJD and other German stations, GSA, Daventry, HVJ and 2RO, Italy, OXY, Copenhagen, and many other European stations provided excellent loud-speaker results. W2XAD and WBXK provide loud-speaker reception upon most evenings. ZSJ and TLO have also been heard at good strength.

To realize the full capabilities of the adaptor it is necessary to tune it between 4 and 6 a.m. Employing my adaptor with a two-valve receiver I can log W3XAU, 8XX, 8XL, and many other American stations.

Fig. 1.—Circuit diagram of the adaptor for use with a battery set.

Fig. 2.—Circuit diagram of the adaptor modified for use with an A.C. mains set.

Fig. 3.—This practical wiring plan shows all the connections.

A Unique Short-Wave Adaptor
BY LESLIE W. ORTON

July 29th, 1933

PRACTICAL WIRELESS
Keeping Twin Aerials Horizontal

THE accompanying sketch illustrates a simple and inexpensive device that I employ to steady my twin aerial and prevent any liability to swing. A piece of lead piping, encircling the guy rope, so as not to impede the lowering or raising of the aerial, acts as a weight. It holds itself in position upon the guy rope, and its two guides prevent the spreaders from swinging or rotating and, also when hoisted in position, it does not put any undue tension upon either the aerial or the guy ropes.—Wm. S. Harrison (Aintree).

Semi-Gang Device for Portables

IN home-made portables where space is of paramount importance, even at the expense of range and quality, it is useful to tune with solid dielectric condensers. This arrangement gives many of the advantages of ganging, but also gives separate adjustment. These are not easily obtained in very small sizes. This arrangement gives many of the advantages of ganging, but also gives separate adjustment.

The spindle (a) of the first condenser is drilled to fit a steel knitting needle. Any watchmaker will do this, but it is preferable if a lathe is available, to turn a new spindle, drilling it first and mounting it between centres, thus ensuring absolute truth. The knob (b), which is larger than (c) has its end filed flat. The outside end of the needle drive is fitted with a bush, as shown, and through this a hole is drilled, while in the knob (c), to accommodate a set screw, and a tap is run in. The threads thus started are finished by taking it out of the knob and tapping again. It is drilled right through to facilitate this. A longer set screw is then used and a flat filed or ground on the needle to prevent slip.

The end (d) holding the second condenser is made from a piece of brass rod, first drilled to fit the needle, then enlarged half-way to fit the condenser spindle. As before, set screw holes are drilled right through to help in tapping. It is advisable not to make the second condenser mounting too rigid. If the inside spindle is made quite free and smeared with oil, the condensers may be operated quite independently or, by holding both knobs, as ganged condensers.—J. H. Rowe (Dublin).

A Temporary Stage for your Wireless Set

THE accompanying sketch shows how I have brought my S.G. three receiver up to its original winter strength by the addition of an extra stage temporarily connected, and mounted on the battery shelf inside the cabinet. It will be noted that I have taken the precaution to decouple the new stage, and that a H.F. stopping resistance is included in the grid of the output valve. The original output valve (super-power) is now in the extra valve-holder, and an ordinary I.F. valve used to replace it.

This little unit, which functions very well, will, no doubt, be of interest to other readers.—F. Jackson (Holywood, N. Ireland).

Improving a Moving-coil Speaker

HERE is a dodge which will be found useful for old type moving-coil speakers which are not fitted with hum neutralizing coils. All that is necessary is a small amount of rotten or enamel-covered copper wire of any gauge between about 20 to 30 s.w.g., this depending of course upon the room available for the winding; the thickest where possible is best, owing to its lower resistance. This coil is wound on top of, and insulated from, the field coil. And as it consists of comparatively few turns it is best to slot these through the magnet yoke instead of dismantling the speaker. The number of turns to wind are the same as on the speech coil. These turns are connected in series with the speech coil, and to do this break one connection from the secondary of the output transformer, and connect each end to the coil just wound. Try this coil connected both ways round, as it functions best when the two voltages are in opposition, thus neutralizing each other.
Simple Remote Control Switch

This remote control switching device, which makes use of old phone bobbins, may be of interest to other readers. The parts required are as follows:

- one block of wood (3 fin. by 2 fin. by 1 fin.);
- two sets of bobbins; one rocking arm;
- two sheet iron strips (3 fin. by 1 fin.);
- one socket and two push buttons. These parts, details of which are given above, are mounted on the baseboard in the positions shown above. In operation, the pushing of button A causes strip 1 to move inwards, pushing the contact tip of the rocking arm into the socket, and thus breaking the L.T. circuit. The voltage required can be obtained from the H.T. on the set, 100 volts giving the strip a noticeable effect in the screen.

Insulating a Metallised S.G. Valve

The following dodge will be found useful in cases where a metallised screen-grid valve has to pass through a metal screen, which must not come in contact with the metallised coating. The hole in my screen being 1 fin. diam. I obtained a strip of ebonite 1/16 in. wide and 1/16 in. thick and of a length sufficient to go round the circumference of the hole in the screen. Along the centre of this strip, with a hacksaw, I cut a slot 1/16 in. deep, and rounded off one corner, as shown below. After placing the strip in boiling water it was bent to a circular shape and pressed round the hole in the screen, the edge of which fits neatly in the central slot. The diagram shows this ring in position.—E. Buus (Blackburn).

New Panels for Old

I often happen after being in use for some time that the highly polished marbled bakelite panels and fittings so popular just now become scratched or marked, and thus lose their original brilliant appearance. As these sundry scratches or markings spoil the look of the front of the set and thus mar its general appearance, the following method of restoring a panel, which is very successful, can be used to advantage. A really good panel, slightly damaged, can often be picked up at a considerable reduction in price. Take a piece of sand-paper, grade “OOO” or “OO,” a piece that has been used before preferred, or failing this, rub the sand-paper on a piece of hard wood to wear it down a little, and rub gently, using a circular motion, along the marks to be removed. The marks or scratches are usually only on the surface, and in a short time the part so treated will have a dull even appearance. Now take a buffalo stick (if you do not possess one), you can make one by tacking or gluing a strip of soft leather on to a piece of hard flat wood) and work over the whole surface of the panel, again with a light circular movement, and in a short time you will find that all the marks have disappeared leaving a nice even surface. It only remains now to apply a few drops of good liquid polish to the surface, and in a short time the part so treated will have a dull even appearance. Post Office is making 10s. 6d. to each cap.

How to make novel short-wave chokes.

One of the most useful improvements is the use of 'short-wave' chokes for short-wave reception, and for this purpose novel chokes have been made.

Novel Short-wave Chokes

Many constructors have on hand one or two of the old heavy duty cartridge type wire-wound resistances from which excellent short-wave H.F. chokes can be made. First de-cap one end and take out the resistance element, replace cap and place cartridge in holder. Using 36 or 40 s.w.g. enamelled wire, solder the start, to one end cap, and turning the cartridge by hand, fill up space between caps and solder end to other cap. The chokes made this way are easily changed although not as good as the commercial variety.—S. J. Bond (Leeds). Use for Old Aerial Wire

Plain copper wire aerials that have been in use three or four years are usually taken down and replaced in order to obtain better efficiency. The aerials, however, need not be thrown away as quite a good earth can be made from them. Rub the wire with emery-cloth to brighten it, and then obtain an old broom handle and cut off about four feet. To one end of the wood fix one end of the aerial with a staple, and wind the wire along the shaft in the same manner as winding a coil. Stop within about two inches of the end of the shaft and fix the wire with a staple if required, a terminal can be fitted to shaft and the end of the aerial connected to it.—H. H. Astin (Lincoln).

Aerial and Earth System

Many listeners suffer a good deal of losses in their sets due to long earth and arial leads. If a system is erected the same as shown in the accompanying sketch the losses will be reduced to a minimum. I have used the method for two years and have found that it gives better results than an ordinary outdoor system. The aerial is erected in the loft in the usual way and the lead-in is taken through the bedroom ceiling and then through the ceiling of the room which houses the set. At the point where the aerial passes through the ceilings an ebonite rod is slotted over the wire and pushed up flush to the ceiling; this of course insulates the wire and stops leakage. At the same time it makes a neat hole, and is therefore not unsightly.

As regards the earth, part of a floor board behind the set was removed and the earth rod buried as shown in the sketch. In the board taken up a hole was bored so that when the board was replaced the hole was practically over the earth tube.—S. Day (Hull).

An ingenious aerial and earth.
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USING SELENIUM CELLS

(Concluded from page 591, July 22nd issue)

By J. R. FENNESSY and H. WELTON

The Electrolytic Cell

While on the construction of cells, a word on the electrolytic cell would not be out of place. This cell, although light-sensitive, contains no selenium, and since one is easily made, it is worth while having one handy both on account of its interesting action and for comparison with the selenium operated type.

Cut two thin squares of copper foil, place these face to face, and slip a rubber band over them. Now separate their two inner surfaces by inserting two split match sticks, and solder a wire to a corner of each foil square. Prepare a 1 per cent solution of copper sulphate (about 4) grains of the salt in each ounce of water, place sufficient of this in a glass jar to cover the foil cell, which is supported in an upright position therein. The now-completed cell should be placed in a dark place and allowed to remain undisturbed for a week, during which period a coating of oxide will have formed on the plates. One side of the jar should now be masked, the other half being left open to the light source, which must be allowed to operate on one foil only.

An assembly of elements for the electrolytic cell was shown last week.

Operating Selenium Cells

A simple circuit is shown in Fig. 5. It consists of a battery (a radio H.T. battery with tappings), a selenium cell, and a galvanometer arranged in series. The cell is placed first in darkness and then exposed to light. The galvo needle will be deflected immediately light strikes the cell. When the beam is broken, as, for instance, when a person passes between the light source and the cell, the galvo needle will fall back to a zero value. In this way it is possible to detect the approach of anyone.

A more ambitious and useful circuit is shown in Fig. 6. Here a relay has been substituted for the galvanometer in the first circuit. The purpose of this is evident for it enables a local circuit to be brought into action when light affects it, alternatively, ceases to affect the sensitive cell. It is not within the scope of this article to describe the construction of a sensitive relay; moreover, really good relays of the moving-coil type (essential for our purpose) are to be purchased very reasonably from dealers in government surplus, so that it is scarcely worth while attempting to make such an important and delicate component in the home workshop. To return, however, to a further inspection of the circuit given in Fig. 6, it will be observed that the local circuit closed by operation of the relay contains an electric bell. It follows that the ringing of a bell is but one of the applications of the circuit; we can, for instance, place the relay in series with lighting mains and a lamp, or a local bell and a room, or again we may substitute for the latter an electric motor.

There are alternative connections to the relay where the object is not to wire the circuit so that the contacts are closed when the cell is in darkness, and opened as light strikes it, or vice versa. Thus, it may be arranged so that all cell of dusk in lights may be automatically switched on, or a burglar alarm sounded the moment an intruder casts his shadow on the cell. We may use the circuit in Fig. 5, test the comparative efficiency of illuminants by taking readings of the galvanometer deflections due to these, the distance between cell and light source remaining constant during the experiments.

One of the most interesting branches of light ray experiment occurs in connection with the infra red or "black" rays. These rays lie beyond the red end of the spectrum, and their frequency of oscillation is so low that they are invisible to the human eye. That a selenium cell can "see" them, however, you can prove by performing the following experiment. Arrange your apparatus as in Fig. 6, turn out all lights so that the room is in complete darkness, and then project a strong beam of light from a torch on to the selenium cell. The relay is connected to operate the bell when the cell is in darkness, so that the effect of the beam is to keep the bell silent. If you break the beam by walking through it or by placing some opaque object in its path to the cell the bell will ring. Now to demonstrate the infra-red effect. Place in front of the lamp a thin sheet of ebonite—a thick piece is of little value as it passes less light and that with increasing the size of the lamp or bringing it nearer the cell. No light should be now visible in the room, yet we find that the bell still rings when we switch off our hidden light. It is a fact that the cell is so sensitive that any burglar alarms are set up and operated.

Hearing an Electric Light

If your home-made cell has any frequency response at all (depending on the manner in which you have made it), it will enable you to hear the frequency of the lighting mains if alternating. The connections are as shown in Fig. 5 with this exception— a pair of headphones are substituted for the galvanometer. On allowing the cell to "see" an A.C. fed electric light a hum or ring is heard; there of the mains will be heard in the 'phones.'

It would be impossible to describe here the multitude of further experiments for the amateur or the countless possible applications of the light-sensitive cell, nor do we consider it necessary. An interest and enthusiasm will endow the worker with far more knowledge than any amount of written matter.

At the commencement of this article mention was made of a disadvantage of selenium prohibiting its wider application. In conclusion we will briefly consider this. Referring to those applications indicated in this article, it is evident that the effect of the cell has been to create a definite impulse or a break in the circuit. The value of any variation in current under the influence of an inconstant light source has been shown; one of the practical applications is to make and break the local circuit. There is a very considerable time lag which can in many instances be measured in seconds. Hence, the photo-electric cell is used in talking picture work and all undertakings employing modulated continuous systems. Such cells are possibly a little less sensitive than the selenium variety, but their response is so immediate, and there is a total lack of inertia. In spite of the fact that many experimenters long ago discarded selenium in favour of the photo-electric cell, it is interesting to note that quite recently a selenium cell of unique design, the Bridge of L'Arche, has been marketed. In this product the makers appear to have overcome the undesirable features present in the normal type of cell.

Ride the Range with Oliver Strange

This story has the authentic reek of ponies and burning gunpowder, and also presents a lovable character in "Sudden," who is something of a detective. Author of "Wild West," Oliver Strange, or as he is better known, is an authentic cowboy of the "old school" who writes with the authentic American Western accent.

The Field.—"An exceptionally fine and powerfully written novel, "The Law o' the Lariat," with which Oliver Strange has added another to his already extensive list of novels."—The Truth. —"An exceptionally fine and powerfully written novel, "The Law o' the Lariat," with which Oliver Strange has added another to his already extensive list of novels."—The Truth.
Fourth Article

ChANGING FASHIONS IN SET DESIGN

A Brief Survey of the Development of Wireless Receivers
from the Inception of British Broadcasting to the Present Day

By H. J. BARTON CHAPPLE,

Up to this time, technical considerations had always come first in the design of receiving apparatus, and far too little attention had been paid to the external design of the set. Such developments in appearance as had occurred were all on the lines of facilitating construction and improving the accessibility of the internal arrangements, and the normal construction at the time was a flat baseboard with a vertical ebonite panel. One improvement which had been made was to limit the contents of the panel to the operating controls—tuning condensers, wave-change switch, filament switch, and volume control. Filament resistances, if used, were of the pre-set type and mounted on the baseboard. Terminals for aerial, earth, output, and H.T. and L.T. supplies were invariably mounted on a terminal strip at the back of the receiver.

The baseboard, panel, and terminal strip formed one complete technical unit, which was slipped into a simple cabinet from the back or front, while a flap or sliding back (or alternately solid back) was provided. The whole was thus readily withdrawn from the cabinet for adjustment and repair, and the set itself presents a most pleasing appearance, can be designed or into a compartment of a radiogram. Here again it is customary to keep all the controls as close together as possible, so that the technical features of the set interfere as little as possible with the external design of the cabinetwork.

This form of design is particularly satis-

what was called the "S.G.P." specification, namely one screen-grid high-frequency stage, a detector valve, and a pentode output valve. The screen-grid valve gave a good choice of stations; two tuned circuits, frequently ganged, provided very fair selectivity; and the pentode output valve gave adequate volume by the use of a single low-frequency stage. Not only so, but the pentode also afforded important economies in initial cost and working expenses. Results hitherto only possible with a four-valve set were obtained with three valves—one valve, one holder, and one interstage coupling were thus saved, and at the same time both low-tension and high-tension consumptions were reduced, while a certain amount of space was also saved inside the set, which had some effect upon the appearance of the receiver and the cost of the cabinet.

The next stage came with the introduction of complete ranges of individually shielded or into a compartment of a radiogram. From this it was but a short step to the all-metal chassis design which we now know so well—main components mounted on the top of an inverted metal tray, smaller components accommodated beneath, and the whole slipped into a handsome cabinet, or into a compartment of a radiogram. Here again it is customary to keep all the controls as close together as possible, so that the technical features of the set interfere as little as possible with the external design of the cabinetwork.

This form of design is particularly satis-

For example, a set of ganged coils had its built-in wave-change switch; re-

action condensers were mounted on small metal brackets which could be bolted to the main tuning condenser frame, and so on. The best practice of the time, therefore, was to mount all the components on the base-board, which was of wood and covered by a thin sheet of metal. The controls protruded over the front edge of the baseboard, and the cabinet was designed with a closed front with holes through which the control spindles projected when the baseboard was pushed home in the cabinet.

From this it was but a short step to the all-metal chassis factory when applied to receivers incorporating built-in loud-speakers. The whole of the technical equipment can be withdrawn from the cabinet for adjustment and repair, and the set itself presents a most pleasing appearance, can be designed to harmonize with any style of furnishing or decoration, and is now welcomed by the housewife instead of being spurned—or tolerated at the best, as was so often the case with the inartistic and even ugly apparatus of earlier seasons.

H.F. Valve Changes

But while external appearance was receiving all this overdue attention, techni-

ical matters were not being overlooked.

(Continued overleaf)
Radio engineers were not yet entirely satisfied with high-frequency amplification.

The screened-grid valve was extremely sensitive and normal circuits employing the valve were reasonably selective. But with the power-of-broadcasting stations it was found that high-sensitivity screened-grid valves were liable to be overloaded when local or powerful foreign transmitters were tuned in. Early in 1931, or thereabouts, a solution to the difficulty was forthcoming in the production of variable multi-valves. These special screen-grid valves are extremely sensitive when operated at low or zero grid bias, but by applying a profound effect upon the grid, the sensitivity is decreased at the same time the acceptance of the valve, that is to say its signal handling capacity, increases.

It will be clear, therefore, that a valve of this type is almost an ideal radio frequency amplifier for use under modern broadcasting conditions. When receiving weak or distant stations the valve can be adjusted to its most sensitive condition by reducing the negative bias to zero or to such low value as is necessary to avoid grid current.

Then, if the bias is required to be increased by means of a potentiometer, thus avoiding distortion, and maintaining volume at a reasonable level. Moreover, the adjustable bias can be employed at all times as a handy volume control.

Up to a few months ago the variable multi-valve, which was already available in battery-operated and mains types, represented the high-water mark of radio development, so far as valve and circuit design was concerned. Then, however, came a further development, Class “B” amplification, in which double valves are operated at low or zero grid bias, but by applying a profound effect upon the grid, the sensitivity is greatly decreased. By this device, the output of a battery set could be practically doubled without increasing materially the high-tension consumption.

Following hot on the heels of Q.P.-P. came a further development, Class “B” amplification, in which double valves are employed, without grid bias, the two halves operating again in push-pull. In Class “B” the anode current, when no signals are received, is very small indeed. Each half of the valve is operative only during that portion of each signal when the grid is positive, and the value of the anode current depends entirely upon the value of the signal applied to the grid.

One disadvantage of Class “B” is that the grid current flows all the time the valve is operative. Listeners have always learned to appreciate the current which is obtained with distortion, but in Class “B” the ill effects are counteracted by actually supplying power to the grid circuit by means of a “grid” valve forming a previous low-frequency amplifying stage.

Class “B” amplification is having this effect upon modern receiver design, it is making available in battery sets maximum undistorted outputs up to some 2 watts — comparable with that of a good mains set. And for the point of view of external appearance it is making little difference, but it will mean bigger volume and better reproduction of high-frequency periods. Of these, the general application of special combination valves such as double-diode-tetrodes and diode-tetrodes will further improve detection and facilitate the use of automatic methods of volume control. Then again, it must not be forgotten that we have at our disposal amplifiers which can replace the ordinary detector valve. New types of high-frequency amplifiers will, undoubtedly, be adopted — the lines of screened-grid valves but having a third grid between the screen and anode, and connected to the cathode, thus forming a high-frequency pentode, whose output stage of battery sets.

Another development, originated in America, but certain to be introduced on a large scale in this country, is the “super midget,” a tiny self-contained receiver which surpasses all previous models in cost and inconspicuous as an ordinary telephone. If these baby sets ultimately displace the radio engineer alike for testing continuity of circuit.

Fig. 3.—Will the multi-valve sets of the future be like this?

**A TRIPLE-PURPOSE TESTER**

To test for continuity of circuit, plug adaptor D into any light socket in the output stage were greatly decreased. By this device, the output of a battery set could be practically doubled without increasing materially the high-tension consumption.

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**A handy triple-purpose tester.**
OLD CIRCUITS REVIVED

Up to five or six years ago the wireless amateur and experimenter used to think of his hobby in terms of "circuits," and whenever members of the "fraternity" met, such names as "Colpitts," "Hartley," "Meisner," "Armstrong," "Flewelling," and many others could frequently be heard. Many of these readers, whose interest in wireless goes back over the past ten years, will recall most of these names, but to those who have only recently taken up the hobby the names will probably have no significance whatever. With the idea of refreshing the memories of "old hands," and of giving the younger generation a little food for thought, it is proposed to give brief particulars of some of the circuits that have been popular at various times during the past ten years or so. It would be quite impossible to mention all the circuits, so reference will only be made to those which were in the nature of "supers" or "stunts;" most of the others were merely embryos from which the circuits in use at the present time have developed.

"Special" Crystal Circuits

Before passing on to the more elaborate arrangements it will be interesting to look at one or two modifications of the simple crystal set. In the earlier days, when components were particularly expensive, the crystal was as much as most of the more or less impecunious experimenters could afford, and for that reason it came in for a considerable amount of experimentation with a view to bringing its efficiency up to the highest possible level. One apparently simple way of increasing the signal strength from a crystal set was by the use of a dual arrangement, like that shown by Fig. 1. Two complete receivers were used in conjunction with two aerials and a single earth, but instead of operating a pair of "phones," each one had to drive only a single earpiece. Theoretically, this system should provide twice as much volume as the more conventional one; in practice, however, there were a number of "snags," such as getting the two halves of the set into exact balance, matching the crystals, and finding a position for the aerials so that they did not tend to shield each other. In consequence of these difficulties, the final result was not always better, or even as good as that obtained with a standard type of set. For the keen experimenter this circuit can still provide ample scope and is very interesting.

Full-Wave Detection

Another attempt to double the power of a crystal set was by the use of full-wave rectification, the circuit employed being somewhat like that represented by

![Full-Wave Detection Circuit](image)

Notes Regarding a Number of Circuits Which Have Been Popular During the Past Few Years and Are Still of Interest to the Experimenter.

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Loud-Speaker Crystal Sets

In the earlier days of broadcasting numerous attempts were made to operate a loud-speaker from a crystal set without the use of costly valve amplifiers. The simplest of these, and one which met with some measure of success, was to attach a small microphone to an ordinary telephone ear-piece and to connect this to a speaker through a high-ratio transformer; the general idea of the circuit connections can be gathered from Fig. 3. The idea appears to be perfectly simple and straightforward, but it was found very difficult to produce the extremely small and light-weight (as they must be) miniature microphones for this purpose. Consequently, in most cases, a considerable amount of experimental work was necessary before anything like satisfactory results could be obtained.

Reflex Circuits

Immediately following the crystal "era," and by which time components were cheaper and more easily obtainable, numerous circuits were evolved in which a crystal detector was used in conjunction with valve amplifiers. In some cases the valves acted purely at low-frequency or high-frequency amplifiers, but in others a single valve was made to amplify at both low and high frequencies. Circuits using the latter arrangements became to be known as "reflex," since the signal first passed through the valve and was amplified at high frequency; next it was rectified by the crystal, and then passed back to the valve, which then magnified the low-frequency impulses. A simple and one-time popular reflex circuit is represented by Fig. 4, from which it can be seen that the valve is coupled to the crystal on the tuned-anode system, and the output from the crystal is fed back to the valve through a low-frequency transformer, across the secondary of which is connected a fixed condenser to rectifier of the types at present used in A.C. eliminators. Although I can claim to have obtained quite satisfactory results with this circuit, there is no doubt that it is definitely tricky and demands the use of almost identical crystal detectors, and of an accurately centre-tapped secondary tuning coil. Incidentally, the latter is most easily obtained by the use of the old-fashioned slider or by taking a number of tappings and finding the one most suitable.

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Super-Regeneration

At about the same time as the reflex circuit was meriting a good deal of attention, other experimenters were trying to get a maximum amount of amplification from a single valve by a different means. It was, of course, known that a detector valve could be made to amplify by feeding back into the grid circuit the H.F. currents appearing in the anode circuit—in other words, by applying re-action. This was satisfactory up to a point, but as the valve fell into self-oscillation (so producing the well-known heterodyne whistle) when more than a very limited amount of re-action was used, it was felt that the valve was not being made to operate at its full efficiency. The consequence was that two new circuits, known as the Armstrong Super-Regenerative and the Flewelling, were invented by the American investigators whose names they still bear.

Fig. 5.—A two-valve reflex circuit which can be built from modern components.

Fig. 6.—Circuit of the Armstrong Super-Regenerative single valve.

Fig. 7.—The Flewelling circuit.

Fig. 8.—Circuit of a two-valve set—L.F. high-tension-less receiver.

Fig. 9.—The Ultra-Audion, a tricky but interesting single valve "super-circuit.

(Continued from previous page)

For the ordinary dual-range tuners are employed and the values of the more important components are indicated.

Super-Regeneration

At about the same time as the reflex circuit was meriting a good deal of attention, other experimenters were trying to get a maximum amount of amplification from a single valve by a different means. It was, of course, known that a detector valve could be made to amplify by feeding back into the grid circuit the H.F. currents appearing in the anode circuit—in other words, by applying reaction. This was satisfactory up to a point, but as the valve fell into self-oscillation (so producing the well-known heterodyne whistle) when more than a very limited amount of reaction was used, it was felt that the valve was not being made to operate at its full efficiency. The consequence was that two new circuits, known as the Armstrong Super-Regenerative and the Flewelling, were invented by the American investigators whose names they still bear. With both of these circuits, which are shown in Figs. 6 and 7 respectively, the principle was practically the same, namely, that although the valve was allowed to remain in a state of oscillation the customary whistle was not heard, due to the fact that oscillation was periodically "quenched" or "damped". The quenching was provided by so arranging the circuit that the valve could oscillate at two frequencies at the same time; one of these corresponded to the signal being received and the other was of about 10,000 cycles, or just above audibility. As a result, the former oscillation was quenched by the latter at the rate of 10,000 times per second. At first, much difficulty was experienced in disposing of a constant "hiss" which marred reception, but by making various fine adjustments it could, at least, be reduced to so low a level that it was not very troublesome.

Of the two circuits, the Flewelling was least used and never became very popular. The Armstrong, however, has remained in more or less constant use right up to the present time, and is, in fact, coming very much to the fore at the moment for the reception of ultra-short-waves. There is no need to describe the circuit in detail here, since that was done in an article recently published in PRACTICAL WIRELESS.

High-Tension-less Circuits

In evolving new circuits the fundamental idea was almost invariably one of economy, of making one valve do the work of two, or of minimizing the consumption of high-tension and low-tension current. I have already mentioned some circuits whose main aim was to get equal efficiency with fewer valves, so now we shall make to a scheme that was originated during 1924 for disposing of the high-tension supply. The circuit of a high-tension-less Det.-L.T. two-valve set is given in Fig. 8. From this it can be seen that the valves are of the four-electrode type, having two grids; diagrammatically, they are like the later screened-grid valves, but otherwise they have no resemblance. The inner grid is connected to L.T. positive, the outer one forming the usual "control" grid. To describe how this circuit worked it is necessary to refer to the normal functioning of a triode valve whose filament emits electrons ("particles" of negative electricity), which are attracted to the plate by the positive charge usually derived from a H.T. battery. In the normal type of valve there is a comparatively wide gap between the filament and plate, and to
THE BEGINNER’S ABC OF WIRELESS TERMS
(Continued from July 22nd issue, page 602.)

Plug-in coils are not now used to any great extent, except for short-wave work, as they have been replaced by the more popular dual and triple-range coils in which wave-changing is performed by means of a switch instead of by removing the coils.

Polarisation
When a simple primary cell is being discharged it will be noticed that the current rapidly falls after the first second or so. If the cell is then given a rest it will again deliver the full current, but it will also die down again in the same manner as before. This phenomenon is known as polarisation.

Potential Difference (P.D.)
The difference in pressure or voltage which causes an electric current to flow. Just as pressure is needed to cause water to flow along a pipe so pressure is required to produce a current of electricity.

Polarisation
Strictly speaking this is a “measurer of potential,” but the term is used in wireless to indicate a divider of potential. It consists essentially of a resistance with a slider, which can be moved along the resistance element at will. In this way any intermediate voltage can be obtained between that of the two ends. As you know, when a resistance is connected in a circuit there is always a difference of

(Continued overleaf)
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From the primary winding it is transferred by magnetic induction to the secondary winding. See TRANSFORMER.

Push-Pull
A method of connecting up two amplifier valves so as to share the total grid swing between the two valves. Its advantages are greatly increased handling power, freedom from distortion, less need for de-coupling, etc. The connections for two valves in push-pull are shown in Fig. 4, which also gives the normal connections when using only one amplifier valve. The push-pull arrangement must not be confused with two valves just connected together in parallel. It has definite advantages over parallel connection.

Quiescent Push-Pull
A modification of the push-pull arrangement in which the power consumed from the high-tension supply is proportional to the signal strength. Thus if there are intervals or quiet parts of the programme practically no current is taken. This is attained by using a very high grid-bias voltage. Quiescent push-pull is an extremely economical method of power amplification and therefore particularly suited to battery sets. Fullest advantage of the system is obtained when the valves used are pentodes.

Radio-frequency
Frequencies from about 15,000 cycles upwards. See HIGH-FREQUENCY.

Reaction
An arrangement by which some of the energy in the anode or output circuit of a valve is fed back to the grid or input circuit. This has the effect of overcoming the resistance of the grid circuit and so gives an increase in signal strength. Reaction can be controlled by a movable coil (magnetic reaction) or by a variable condenser (capacity reaction). If the control is advanced too far the energy fed back more than compensates for the losses in the grid circuit and the circuit breaks into self oscillation. When in this state the receiver will produce howls and whistles when tuned to a broadcasting station and will also cause interference with other nearby receivers. See OSCILLATIONS.

Rectification
The process of converting alternating current into direct current. The detector valve in a receiver rectifies the high-frequency current produced by the incoming waves, that is to say, it changes it from a current moving rapidly first in one direction and then in the other into a current going in one direction only, but still rising and falling according to the rise and fall or modulation of the original currents.

Another case where rectification takes place is in the case of a receiver operated from alternating current mains. Here the current must be converted into non-pulsating (direct) current before it can be used to supply the valves. This is carried out either by a metal rectifier or a special rectifier valve in conjunction with smoothing chokes and condensers.

Rectifier
A device for converting alternating current into direct current. See RECTIFICATION, VALVE, METAL RECTIFIER, etc.

Resistance
The opposition that a substance offers to an electric current passing through it. The energy expended by the current in overcoming resistance produces heat. In the case of an electric lamp, for instance, the heat produced is so great that the filament becomes white hot.

The term resistance is also used to denote a resistor, that is, a device used to introduce a certain resistance in a circuit. Resistances or resistors are made in various forms. Some contain a coil of special resistance wire and are called wire wound resistances, while other types include metalised resistances, composition resistances, etc.

Fig. 5.—Two types of primary cell—the Bichromate battery and the Leclanché cell.
The Speech Coil in the Gap

THERE are two complementary functions performed by the moving coil, one of these is to receive electrical energy and the other to deliver this as mechanical energy to the diaphragm and so to the air. The speech coil in its magnetic field is thus a specialized form of electro-motor, and is subject to the ordinary laws—namely, the cutting of the magnetic lines of force by the conductor gives rise to back E.M.F., resulting in a flow of current in the coil.

The calculation connecting the electrical and acoustic quantities, based on these fundamental laws, is most instructive, but this does not form the subject of the present article.

The essentials for good performance from the standpoint of design are:

1. That the moving coil shall be capable of sufficient free movement, especially for the rendering of low tones.
2. That the maximum movement permitted shall not affect materially the mean length of the field or the number of turns within the field.
3. There shall be no selective resonances such as will interfere with a good frequency characteristic.
4. There should be a certain amount of damping to avoid resonances.
5. The motional impedance should be high and the copper resistance low.

Now (1) depends very much on the centring; it is unusual to find the movement unduly limited by the surround, but the centring at the small end of the cone is often cramped. The importance of (2) is often overlooked. If, as in many of the moving-coil speakers of a season or two ago, the winding is of exactly the same length as the gap, just to match it exactly, then, when any movement of the coil takes place, the number of turns in the gap will diminish—this is inevitable. But it may be avoided by making the speech coil winding either much greater than the gap length, Fig. 1, or alternatively very much less, Fig. 2. In either case a quite considerable movement of the coil may take place without any change in the number of turns in the gap field. The type of winding shown in Fig. 1 is the better from the point of view of cost limitation; the whole field is in use all the time. Fig. 2 is most extravagant in the matter of field, but it results in a much lighter moving coil for the duty performed.

The winding shown in Fig. 1 has been found more suitable for the usual open cone type of speaker; in this the weight of the moving coil and diaphragm as a matter of experience is not a difficulty; in fact, if it be made too light the very high frequencies come through too strongly, and the 9 kilocycle heterodyne from the adjacent station becomes a constant source of annoyance. The type of winding shown in Fig. 2 has been found better suited to the horn type of M.C. speaker, and is used in the Lancaster acoustic tube type.

The question of clearances. There is a natural tendency on the part of designers to cut the clearances down to a minimum in order to obtain a stronger field for a given cost in magnet steel. In the writer's opinion the internal clearance between centre pole and sleeve should not be less than 5/000 of an inch, that is, a diaphragm clearance of .001 in. or 1 mm., and the external clearance about half as much again, i.e., a diaphragm external clearance of .0014 in. It may be asked why a greater clearance on the outside? The reason is that if the sleeve touches the centre pole very little harm is done, but if the winding should touch on the outside not only will there be a much greater acoustical disturbance due to momentary shorts, but actual injury may be done, and the coil may have to be rewound.

The question of resonant frequencies, (3) above, also the questions of motional impedance and copper resistance (4 and 5), will be dealt with in a later article.

Composition Resistances

THERE are still many receivers about using old type composition anode resistances. Any of these fall short of the modern variety, inasmuch as their value does not remain constant, but increases with time. Many of these resistances, 60,000 ohm resistance may steadily increase in value until there is only a volt or so on the detector valve, with consequent loss of reaction, quality and volume.

Grid Leaks and Instability

GRID leaks have a habit of increasing in value when their age is considerable, resulting in reduced handling capacity, instability and considerable backlash on reaction.

Tuning Correction

THERE has been much written on the subject of tuning correction by cutting off the top notes with a condenser or stopping them by means of series resistances, but it is seldom that reference is made to increasing low base.

When a resistance-fed L.F. transformer is used much care has to be taken to cut-off the low frequency of the primary circuit forms a tuned acceptor at some definite frequency, say, 60 cycles, the response curve will rise sharply at this frequency.
He Never Switched Off!

A GOOD French story was recently published in one of the Paris "dailies." It concerns a forty-year-old citizen who, wishing to secure an annuity policy from an Insurance Company, consulted his doctor as to the means to be adopted to live to the ripe old age of four-score-and-ten. The practitioner examined him and pronounced him a perfectly healthy case. "Do you smoke?" he asked the patient. "No," said he. "Do you drink?" "No," said he. "Do you enjoy amateur. This theory was soon disproved, because announcements were given by H.H. himself. Could it be an error in transmission?

So we concluded that we must be listening to some concern being felt about the undue publicity given to cases of electrical shocks resulting in deaths through the use of electrical apparatus in bathrooms. There have been several cases of this sort lately, but it has been pointed out that prejudice should not be felt against the use of electricity any more than against such power mediums as petrol or gas. One does not need to be told that it is dangerous to look for gas or petrol leaks with a lighted match, although perhaps it is not so commonly known that it is dangerous to use such apparatus as hair-dryers and massage machines whilst in the bath. All the same, it is not to the interest of progress or to us who, by our constant experimenting, the development of radio and electricity in general that fear should be felt by the public in its use. You may say that it is not everybody that wants to listen to radio programmes in the bath. But this is as few joints as possible, and well cover them with insulating tape, or preferably use the special bakelite covered connectors that can be purchased quite cheaply and which make a neat and safe job when two leads have to be joined together. See that the metal case of your mains unit is connected to earth, and also of course that the fuse is of the correct rating and that it is not blown by too high a current. This gadget consists of a little Neum tube which provides a visual indication of tuning.

The general idea is that with a station calibrated A.V.C. set the loud-speaker is shorted by a switch, the wanted modulation tuned in by watching the grid glow tube brilliance, and then the L.F. portion is switched off, and the receiver turned on and tuned in. Correctly tuned. The idea is to obviate the annoyance of passing over in one's programme, and to concentrate on one's hands or ears. As the master tune is kept in mind, no more frequent adjustments are necessary, and there is no annoying loss of volume. The gadget is made up of a small Neon tube, a filament, and a small holder, and is guaranteed to be silent, in the radio sense. A guarantee of the word, so surely it is not beyond the power of the Government of England to introduce laws which will make electrical interference illegal here.

Precautions Necessary with Mains Apparatus

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due to its negative bias being momentarily reduced by the positive signal voltage. The other valve, which receives the negative half-cycle, is biased still more heavily and, therefore, does not operate, or, in other words, it remains "quiescent." As positive and negative half-cycles are alternately applied to both valves, the latter works "in turns." In consequence of this the average anode current remains very small in amount, and it can thus be supplied by an ordinary dry battery.

It has become customary to employ a pair of pentode valves in the Q.P.-P stage, and although these do give more amplification there is no reason why small power valves should not be used.

Special input and output transformers must be used for Q.P.-P. for reasons which will be explained. To load the valves fully the input transformer should have a step-up ratio of about 9:1 (as compared with 3:1 for ordinary push-pull). Since the current flowing through the primary winding of the output transformer is rapidly fluctuating between, say, 2 and 30 milliamperes, this winding must have a low D.C. resistance of the order of 400 ohms.

Another modification of push-pull is that known as Class "B" amplification. This has the same objects as Q.P.-P., namely, of giving a large undistorted output for a minimum consumption of high tension current. A special "double" valve has been developed for Class "B," and this really consists of two triodes in a single glass bulb; it has two filaments, two grids and two anodes. The new valve functions in almost the same manner as the two valves in Q.P.-P., but instead of requiring a heavy G.R. voltage it is so designed that it passes an almost negligible amount of high-tension current when the grids are at zero potential.

Since the grids actually become positive it is evident that there will be a flow of grid current through the secondary of the preceding transformer. To prevent distortion it is therefore essential that the secondary winding should have a very low resistance, and to ensure this it must have comparatively few turns. This fact makes it necessary to use a step-down transformer in order that the primary may be matched to the preceding valve. To make up for the loss of amplification caused by the step-down transformer an additional L.F. stage; this valve is referred to as a "driver," but it is really an ordinary small-power valve.

The circuit arrangement for a Class "B" amplifier is shown in Fig. 5, where the names of the various parts are indicated.

By way of "summing-up" the conclusions drawn above it can be said that the best form of coupling for a battery set which is required to give only a comparatively small volume or for a mains receiver, is the resistance-fed transformer. For a battery set intended to give a large volume sufficient to produce really good reproduction with a moving-coil speaker the constructor cannot do better than employ Class "B" or Q.P.-P. Special "constant-voltage" eliminators are now made for use with the new systems of amplification, whilst most ordinary eliminators can be suitably modified by connecting a "neon stabilizer" across the output terminals.
The H.F. is the most interesting, as it may be mounted on a panel and furnished with a knob in the same manner as the remaining controls of the receiver and operates in the normal mode of the knob. The switch itself is of the usual quick-make and break type.

The Lissen I.F. transformers are the very next intermediate frequency transformer for superhetraphonic receivers that has been produced by Messrs. Lissen and this incorporates some interesting features. Of the loud-post type, the two coils are wound on pullox insulators, and these are fixed at the correct distance apart on a central column. The two trimming condensers are fitted under the bakelite base of the coil, and these are adjusted at the factory to provide the necessary frequency, which in this particular case is 128 cycles. There is thus no need for the operator to touch the condensers and they are covered by the metal base out of harm's way.

The current fittings round the bakelite base and are of the correct transformer should in all cases be used, and not only in the interests of obtaining the best quality, but also to operate the valve correctly. Most transformers are already fitted with a transformer, and this is not always suitable for Class B circuits, and there is then a position to use here to carry out the matching. Messrs. Amplon have produced a 3-turn tapped output choke which is designed to enable a Class B or O.P.P. stage to be coupled to any speaker fitted with a transformer. Three ratios are provided, 1 to 1.5 to 2 and 3 to 1. A twist will select the correct connections to employ. The component is nicely made and finished in a bakelite case, and a terminal is provided for earthing the core. The price is 6s.

The new rotary toggle switch is also interesting as it may be mounted on a panel and furnished with a knob in the same manner as the remaining controls of the receiver and operates in the normal mode of the knob. The switch itself is of the usual quick-make and break type.

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SPECIAL NOTE

We wish to draw the attention of our readers to the fact that the Queries Service is intended only for owners of receivers, and that the answers given are arrived at from the construction of receivers described in our pages, from articles appearing in other journals, and from our own and other experts. We regret that we cannot, for obvious reasons, deal with queries arising from the construction of multi-valve receivers.

(1) Always give as much information as possible. Ask no questions for which a positive answer cannot be given.

(2) For certain types of apparatus, such as the O.P.A., the O.T.P., and motors, a list of manufacturers and agents will be found in our pages, or on general wireless matters.

(3) Suggest alterations or modifications to difficulties encountered.

(4) Answer queries over the telephone. Please note also, that all sketches and drawings which are sent to us should bear the name of the sender.

HIGH-PITCHED WHISTLE

"I have finished a three-valve set employing S.G. valves, output, and a potentiometer; I am troubled by a very high pitched whistle all the time the music is on, although signals are fairly clear and loud. The whistle is still there when the volumes is closed. Can you help me to get rid of this annoyance?" — F. H. (Brixham).

There are several causes of whistles in a simple receiver; some of which are due to H.F. instability and some to L.F. instability. For a start, reverse the connections to the secondary of the L.F. transformer feeding the pentode valve. This may cure it. If not, examine carefully the H.F. end of the receiver and make certain that the H.F. valve is not oscillating. Connect the receiver to the outside lead of the S.G. valve, and remove that valve. If the whistle stops, it is due to the S.G. valve, and it should be examined for faults and the various voltages checked. A resistance in series with the pentode grid lead may also help. A value of about 10,000 ohms should be (iron).

SHORT CIRCUIT IN SPEAKER

"My set has developed a very peculiar fault which prevents me from enjoying any sort of music. When the music is being played, the other night things were all right for about twenty minutes, but then the two loud-speakers shut down and the music stopped. Within a few seconds it had come on again just as loud, but it gradually got quieter, there was another gloop, and it was gone. I kept on, and it won't keep playing for any time now, but just goes pop and stops for about ten or fifteen seconds. Where shall I look for trouble?" — T. H. (Barking).

It is almost certain that one of the grid circuit leads or components has broken down. First of all, examine the grid bias battery and make certain that this is not exhausted and see that the bias plugs are latching tightly against the grid stop. Then examine all wiring leading to grid terminals and make certain that none has come in contact with metal. You can do this replacing the grid leads and transformers (where space allows) to ensure that these are in order. We think one of the above tests will find the fault.

MUSICAL COMPONENTS

"I have built several sets employing S.G. valves, but the results are very disappointing. When I disconnected my speaker I obtained a faint noise, and the music came out through the loud-speaker. You have said that this is wider at one end than the other. How is this to be remedied?" — F. H. (B탑ham).

The sounds you could hear were coming from the L.F. transformer lamphouse. The sound impulses pass through the windings of the transformer, and these are wound over a number of thin pieces of iron (the laminations). Theoretically, these should be tightly clamped by means of bolts, but in many cases this point does not receive sufficient attention, and the bolts are either insufficiently tightened at the factory, or they work loose in transit, etc. Consequently, the thin strips are made to vibrate in sympathy with the impulses through the windings in exactly the same manner as an ordinary violin or cello is in use, and you can imagine that if the transformer is in the wrong case you will probably be able to do anything. If the bolts are all tightened, they should be tightened, and you will then find that the sounds will stop. If there is any risk of microphonic troubles if the vibrations are permitted to continue.

IRON SCREWS

"I should like to receive your advice on the following delicate point. I have built several sets, and have used iron screws in the place of brass screws in the cases. Should all the components be fixed down with brass screws or otherwise? Please give me your ruling." — R. A. (Scarborough).

We wish to draw the reader's attention to the difficulties arising from the use of iron screws. There is risk of microphonic troubles if the clamping bolts are visible, however, they should be hidden by an iron covering. If you wish to avoid iron screws altogether, we advise the use of nickel screws, which are entirely free from this point. A solution of problems or difficulties may arise from their use.

BROKEN GRID CIRCUIT

"I have finished a three-valve set employing S.G. valves, output, and a potentiometer; I am troubled by a very high pitched whistle all the time the music is on, although signals are fairly clear and loud. The whistle is still there when the volumes is closed. Can you help me to get rid of this annoyance?" — F. H. (Brixham).

As you remark, the resistance will be of real use, and the set will be in perfect working order if the fixings are out of the fields, but provided that it is wider at one end than the other. How is this to be remedied?" — F. H. (B탑ham).

The arm is, of course, joined to the armature loud-speaker. The method in which automatic volume-control is obtained when automatic volume-control is employed is to connect across the moving-coil loud-speaker. The armature loud-speaker is the point of the type of screws which is sent must bear the name and address of the sender. Send your queries to the Editor, PRACTICAL WIRELESS, Groc. Neumans, Ltd., 8-11, Southampton St., Strand, [London, W.C.2.]"
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DUBLICOM COMPONENTS

SOMS constructors will find much to interest them in two booklets recently issued by the DUBLICOM Condenser Company. One deals with condensers and resistance, and the other with the characteristic properties of condensers, such as condensers, block condensers, and high-voltage condensers. Resistance capacity coupling networks and distribution networks are among the other components listed. The other booklets deals with the use of different circuits, such as the one shown in Figure 9, which is designed for use in mains-operated receivers for voltage dropping. The circuits are given for both small and large tables, giving the maximum currents and voltages, and graphs showing the voltage drop and currents at a glance, if included in the booklet. Interested readers should write for copies of these booklets to DUBLICOM Condenser Co., Ltd., 56 Church Road, North Acton, London, W.3.

FERRANTI ELECTRIC CLOCKS

A CLOCK which always keeps correct time, requires no winding or regulation, and costs only 1d. per quarter to run with electricity, has many advantages over an ordinary timepiece. The instrument consists of 26 parts, which are for use only on A.C. accuracy of timekeeping with a minimum of attention are outstanding features. The usual spring and escapement mechanism is replaced by a small, beautifully-made electric motor, so designed that its speed is proportional to the voltage drop across the portion of the circuit (as this circuit was called) is sufficient to attract the electrons to the negative plate. The valves in use at the time the Ultra-Audion circuit was introduced, were found to be frequently in need of adjustment, but, with the Ultra-Audion circuit, a single coil was used both for controlling reaction by the usual swinging rheostat and filament rheostat. As may be seen that a single coil was used both for controlling reaction by the usual swinging rheostat and filament rheostat.

Ferranti movement, specially designed to replace existing clock movements in existing clocks, is also available. Ferranti movement, specially designed to replace existing clock movements in existing clocks, is also available. Address is Hollinwood, Lancs.

NEW FERRANTI COMPONENTS

We have just learned that Messrs. Ferranti are preparing a new line of ultra-frequency detectors and superheterodyne receivers. Commonly termed the Pentode, although the antenna is among the usual "old" nomenclature, this valve is being named by Messrs. Ferranti under the name of Mepode (this term which is, of course, more in keeping with the English method of describing valves. In addition, a constructor's kit for a short-wave receiver, and a meter-valve tester will also be produced in time for the Exhibition. They are also producing a home-constructor's television kit.

TELEVISION CORE COILS

Laminar coils on the iron-core principle are now in our hands, and these possess many novel features. The principal point of interest is the very small former upon which the coils are wound.

Replies to Broadcast Queries

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July 29th, 1933

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This offer applies to licences which are actually in force on Saturday, July 29, 1933.

Before the awards are paid, claimants will be asked to undertake a simple publicity service in distributing leaflets to encourage the sale of Practice Wireless licences so as to enable them to hold their subscriptions by lending them to a Further Free Wireless Licences before receiving broadcast programmes. Claimant cannot be considered in connection with any Licence the date of issue of which is after July 31, 1933.

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