Public Address Amplifiers

Medium Power Circuits Suitable for Amateur P.A. Work are Given in This Article, Together With Details Concerning the Construction of Speaker Flares.

In a few weeks' time we shall be entering the summer season, and one's thoughts will be turning to outdoor activities. Although these will, of necessity, be less ambitious than those we normally enjoy during peace-time, occasions are bound to arise when some form of P.A. equipment will be in demand. Circumstances might prevent the use of the highly developed commercially produced installations, therefore the amateur with a modest outfit will, no doubt, be able to offer valuable assistance to his local clubs and public bodies. It is not, of course, recommended or expected that the amateur will tackle large P.A. jobs involving the use of several speakers and, possibly, many hundred yards of cable, each necessitating the use of very expensive apparatus and a considerable amount of experience; therefore, it should be left in the hands of the firms who specialise on such matters.

As is, however, quite feasible that small installations may be catered for and carried out with every degree of success, providing that particular attention is given to the whole installation, the conditions and the placing of the speaker or speakers.

Fig. 1.—A single two-stage plate cascaded output. The ear, for the rapid clearance of the mains, is of the mains operated type, and as the mains should be available, barely sufficient for record in the acoustic output of the hall. Three watts under whole network is, therefore, the output required without some form of high-efficient amplifier and there is one model of S.G. Brown and Amplion, can often be used.

Fig. 2.—A three-stage amplifier, with mixed couplings, and tone-controlled push-pull output stage.

What Power is Required

The extent of the amateur's activities will be governed by the gear at his disposal, so the first thing to be considered is the type and number of amplifying stages, and the output circuit.

One L.F. stage, such as that usually embodied in a three-valve S.G. receiver, is out of the question, but a "straight" three, of the D.C. and L.F. type can be of some use if a power pentode, large "Class S," O.P.P., or two super power valves in push-pull are used in the output stage.

With mains-operated receivers or amplifiers, a wide choice of valves is permitted as one is not tied down by H.T. current consumption, as in the case of battery receivers; therefore, it is very advisable for anyone interested in amateur P.A. work to build some form of mains-operated apparatus.

An undistorted output of 2 watts is of no practical use for outside work, and it is only by the gear at his disposal, so the first thing to be considered is the number and type of amplifying stages, and the placing of the speaker or speakers.

An undistorted output of 5 watts is doubtless if they would handle the output required without some form of appreciable distortion.

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speaker is that they are very directional, and while this may be an advantage in some instances it is not generally a desirable feature. For indoor work, the "long" horn is practically useless, as its effective area is too remote, and "weak or dead" spots are likely to be very pronounced. This will be appreciated if Fig. 3 is examined, which shows a horn of this type, the dotted lines representing the approximate maximum area of sound distribution. It is obvious that if the speakers can be placed well away or above the area to be covered, the horn type will be all right, but such placing often requires much more power, and is more likely to be affected by high winds.

To overcome these defects, P.A. engineers now use the "short" horn or "flare" baffle, as shown in Fig. 4, while a further improvement is obtained by the "horizontal" or "mono-plane" flare which, while allowing ample horizontal spread, greatly reduces the unwanted radiation skywards.

Moving-coil Units

These are divided into two classes, permanent magnet and light, the most widely used is the permanent magnet type. It is required that the amplifier will do, providing it is fitted with a 5in. or 6in. cone and a suitable matching transformer. The W.B. Stentorians are ideal, and it will be found that they are easy to match up, owing to the switching device embodied, and that they will stand up to a most useful input.

If mains-operated apparatus is being used, it is usually possible to have one of the speakers energised, the field acting as the smoothing choke of the mains unit. It is, of course, necessary to select a field winding suitable for the mains unit output, and for the H.T. current requirements of the amplifier, while the speaker must be so arranged that excessively long leads are not required. The use of one mains energised speaker, acting as the chief supply and erected close to the amplifier, is usually an advantage as slightly greater power is obtained, thus leaving the P.M.s to be placed to cover the fringes, or out-of-way spots.

In the placing of the speakers, a great deal of consideration is necessary. The whole performance can be ruined or, on the other hand, the utmost satisfaction can be obtained with the minimum of power. It is no use putting one here and another there: one must consider the total area, the acoustic properties of the building, or the absorption of nearby objects out of doors, where the maximum crowds are likely to assemble, and the effect of the speakers on the microphone.

How to Make a Flare

As most constructors possess one or more moving-coil loudspeakers, and may desire to use them for small P.A. work, the constructional details of one of the latest "horizontal" baffle horns are given, as these units play a very important part in the game. They are, however, rather expensive to buy.

All the details are shown in Fig. 8, from which it will be seen that it has an overall length of 9ft., tapering from 3ft. at the rear to 2ft. at the mouth. The horizontal
Music While You Work
A Brief Description of G.E.C. Loudspeaker Equipment as Installed in Factories and Workrooms

Much has been said and written from time to time on the value of music as an aid to production. Time was when the majority of factory executives viewed the subject with a certain amount of mistrust. It is of interest to note, however, that many who were inclined to hold such views have since become ardent supporters of music as an accompaniment to work.

Government Factory Installations
Production graphs are not the only means of proving the case for a musical accompaniment to industry: a walk round some factory or workshop where electrical amplifying equipment is installed, noting the quiet hum of voices subconsciously following the rhythm of the music and the general air of contentment is perhaps even more convincing testimony.

It is significant that in many Government factories music is considered an invaluable aid to production. Such equipment need not necessarily be confined to the “broadcasting” of gramophone records or radio programmes. It can, of course, be used with a microphone, or alternative sound inputs for internal communication—for “paging” executives with urgent messages, for giving general instructions to all workers, and for the radiation of air-raid warnings and time-signals.

As is shown by the illustration on this page, the “broadcasting” of gramophone records or radio programmes, or the “paging” of executives with urgent messages, for giving general instructions to all workers, and for the radiation of air-raid warnings and time-signals

The G.E.C. has been particularly active on installations of this character for industrial war-time purposes, one example being provided by a system which has been completed quite recently in a large factory in the North. Radio signals are provided by a special panel-built three-waveband, five-valve superheterodyne; gramophone records are played on an automatic turntable unit and each can be connected at will to amplifying equipment in two parts, each with a power handling capacity of 750 watts.

Back and Panel Equipment
As is shown by the illustration on this page, the rack and panel principle of assembly is adopted for the three units. The radio and gramophone equipment, together with a pilot speaker, form one unit and the other two panels embody the amplifying equipment. Each of these amplifier panels employs seventeen valves including four stages of push-pull amplification, each terminating in a power stage employing two Osram DA.250 valves also arranged in push-pull.

A feature of the radio and gramophone panels is that whilst the input to the main amplifiers is maintained at a steady value, the input to the pilot speaker on the panel can be set to any strength required by the operator.

Wiring System
Throughout the various buildings the wiring of this installation is suspended on porcelain cleats, a method which, whilst being simple and comparatively inexpensive in itself, has the added advantages that it is readily accessible for the addition of more speakers and, should the occasion arise, for the rapid clearance of line faults. The system is very efficient and there is no appreciable variation in the acoustic output of the speakers throughout the whole network.

There are three groups of buildings, and as the main group is the most heavily loaded, one of the amplifier panels is located to serve this group only, whilst the output from the other panel supplies the other buildings.

At all times, the operator in the control room who then radiates a signal can be quickly transmitted via a loudspeaker to the roofs. This hut is equipped with a standard G.E.C. 14 watt amplifier and microphone. Thus a warning can be quickly transmitted via a loudspeaker to the operator in the control room who then radiates a signal throughout the works.

Music While You Work
A Brief Description of G.E.C. Loudspeaker Equipment as Installed in Factories and Workrooms

March, 1942
PRACTICAL WIRELESS

www.americanradiohistory.com
Housing the Rx

The housing of the Rx and amplifier was a problem for which I could not see a simple solution. The making of a cabinet was not a prospect I viewed with pleasure, whilst the thought of getting or making a metal box was rendered highly improbable owing to cost factor, supply, etc. However, the whole matter has been settled in an unexpected manner, and the set, plus a H.F. and a L.F. amplifier, is now neatly housed in a wooden cabinet as depicted by the illustration, Fig. 1. If I picked up the cabinet, at a very reasonable cost, in a second-hand junk shop, and older readers will recognize it as one of the type which used to be called "American" pattern, owing, I believe, to their introduction of a H.F.C. Securing the panel was a great stroke of luck, as it was unmarked and I was able to cut from it the two blank panel throwers and the .

In the 21's and 24's, it is 24ins in length by 19ins in height, and it is fitted with a full lid, and a narrow opening on the left suggested a H.F. stage, and, after due consideration, it was decided to balance up the circuit by means of controls, and when a signal is received the switch can be thrown over and the aerial circuit tuned.

To couple the output of the H.F. stage to the detector, the normal aerial coupling coil on the coil unit in the Rx is used as a primary winding, thus, with grid coil winding forming a variable coupling H.F. transformer. This feature should enable very satisfactory results to be obtained, and I hope in the next extract from my notes to give some actual details as to whether the idea works as well in practice as it sounds in theory.

For a H.F. control, full use is made of the variable pin characteristics of the valve, and it is for this reason that the 50,000 ohm potentiometer was required. An ordinary " straight " S.W. or H.F. peak indicator could be used —if components are very scarce—but some form of

Components

The next problem was components. Well, I could only do what we all have to do these days, and that was to keep my eyes open and try here, there and everywhere until I collected the required parts. This is what I eventually managed to obtain:—A black crackle finish metal panel—again from a surplus merchant's place—from which incidentally, I also got some fixed condensers, and an Erie 50,000 ohm potentiometer and a S.W. H.F.C. Securing the panel was a great stroke of luck, as it was unmarked and I was able to cut from it the two pieces required for the spaces mentioned.

A double-pole double-throw switch and a J.B. S.W. 0.005 mfd. variable condenser I picked up on another day and, finally, I eventually secured two S.W. baseboard type four-pin valveholders and five S.W. four-pin gizmos of various makes. These parts enabled me to construct a unit, the theoretical circuit of which is shown in Fig. 2.

H.F. Amplifier

We were all entitled to our opinions about tuned and untuned S.W. H.F. amplifiers, therefore, I do not wish to start a debate on the matter. It does seem, however, that little additional amplification is obtained by tuning the circuit when receiving wavelengths below 35 to 40 metres, therefore, as this includes the most popular wave bands, it hardly seems worth while incorporating the extra components and control. There is, however, the question of selectivity, and, considering all points, it seems that the best one can do is to make a compromise. If the circuit is examined, it will be seen that I have attempted to satisfy my own views by making the aerial circuit meet both requirements. The D.P.D.T. rotary switch enables the aerial and the grid of the H.F. valve to be switched over from the S.W. H.F.C., which forms an aperiodic circuit, to the coupling coil on the tuned coil circuit, thus allowing a tuned and an untuned aerial grid circuit to be used at will. This arrangement does permit one to explore a band of frequencies with the minimum of controls, and when a signal is received the switch can be thrown over and the aerial circuit tuned.

Fig. 1.—The cabinet with the H.F. unit and o.-V.t set in position. The blank panel can be thrown over and the aerial circuit tuned.

Fig. 2.—The circuit of the H.F. unit, showing the arrangement to provide a tuned or untuned aerial circuit.
control is very handy in this part of the circuit, especially if one wishes to receive powerful local transmissions.

The L.F. Side

Complete details of the proposed new L.F. amplifier cannot yet be given, as time has not allowed me to complete it, but it will consist of two resistance-capacity coupled stages, complete with volume and tone controls. Jacks are to be included between the two valves and in the anode circuit of the output pentode, this being advisable for headphone and/or speaker work. House-board construction—the same as the other two sections—will be used, the panel being formed from one of the pieces of black cracker finished metal mentioned previously.

H.T.-L.T. Unit

In the February issue, I said that I was hoping to make an H.T. eliminator and a trickle charger, using a mains transformer salvaged from a defunct mains set. On examination of the component, it was found that the primary and L.T. windings were quite O.K., but the H.T. secondary, which originally delivered 350/0/350 volts at 120 mAs, was open circuited. The conversion of this transformer was one of the jobs which I was able to see to when conditions prevented me from doing other work. First of all, I unwound the H.T. secondary, taking care to wind the wire on a spool which I made from a piece of broomstick fitted with cardboard cheeks. After this, the core area was measured, this was 1 by 1.33 ins. which gave a figure: 8 by 1.33 and this gave 6 which is the number of turns required for the new outputs, I divided 8 by 1.33 and this gave 6 which is the number of turns for every volt I required: W {lifl.

The two rectifiers I propose using are 500/0/500 volts at 120 mAs, and the lead to H.T. positive, have been added a double-throw switch can be used for the aerial and grid control. The aerial coil unit, the fixed condenser, shown in broken lines, and the lead to H.T. positive, have been added to the set wiring. Any type of low-capacity double-pole double-throw switch can be used for the aerial and grid change-over.

On the Air

To be quite frank, circumstances have prevented me from doing any serious listening, by which, I mean, results have not been such that they are worthy of mention. This, when ringing a new station, is not, in itself, unusual, as I think most S.W. enthusiasts will agree. There are always many little items to be seen to—before one is satisfied with the efficiency of the installation—and when facilities and time are limited this process naturally takes longer. One thing I have noticed, that is the absence of congestion on the air, a feature which is most pleasing in many respects, but, owing to the reasons responsible for it, I for one will welcome the return of the old state of affairs, provided we are then able to eliminate those alleged amateurs who, comparable only with the traffic hogs on the road, had the idea that they were the only folks who had the right to use the air.

Wiring Plan

The layout and wiring for the H.F. unit are shown below (Fig. 3) and, owing to their simplicity, they call for little explanation. A standard type of four-pin S.W. jack is used for the aerial circuit, the primary winding being returned direct to earth, but the low potential end of the grid coil is isolated—a D.C. sense—from earth by the .01 mfd. condenser, thus allowing the necessary bias to be applied to the grid. The anode lead is anchored close to the valve-holder and then taken to one side of the coupling coil on the original aerial coil unit. The fixed condenser, shown in broken lines, and the lead to H.T. positive, have been added to the set wiring. Any type of low-capacity double-pole double-throw switch can be used for the aerial and grid change-over.

ARE YOU ON "PIECE" WORK and Making a "Pile"?

Every piece of waste paper helps to make the 100,000 tons of those bits and pieces of paper.
A Refresher Course in Mathematics

By F. J. CAMM

(Continued from page 106, February issue.)

I MENTIONED last month that, when multiplying decimals by ten, or any multiple or submultiple of ten, it is merely necessary to move the decimal point one place for each power of ten in the multiplier.

Example: Multiply 394,264 by 100.
Answer: 39,426,400 (the decimal point moved 2 places because 100 = 10 x 10).

In multiplying by any multiple or submultiple of 10 the decimal point is moved, as in the above example, to the right. If the decimal includes a whole number, if the decimal is purely fractional, the decimal point is also moved to the right.

Example: Multiply .8854 by 100.
Answer: 88.54.

The number of places the decimal point must be moved when multiplying by functions of 10 is to count the number of digits in the multiplier and subtract 1 from it. Thus:

To multiply by 10, move decimal point 1 place (2 - 1);
To multiply by 25, move decimal point 2 places (3 - 1);
To multiply by 1,000, move decimal point 3 places (4 - 1);
To multiply by 10,000, move decimal point 4 places (5 - 1); and so on.

Division of Decimals

In dividing decimals by 10 or multiples of 10, move the decimal point to the left—reversing the process explained above.

Example: Divide .453 by 100.
Answer: .00453.

Divide 375.625 by 100.
Answer: 3.75625.

Division of decimals is carried out in the same manner as for whole numbers, and the fixing of the decimal point is the only part of the process which needs explanation. For example, divide .95 by .25. In other words, we must find a number which when multiplied by .25 produces .95. It is nearly always convenient to multiply the numerator in the divisor by some multiple of ten which will make it a whole number. Thus, in the example given, .25 x 10 produces 2.5. We must, of course, multiply the dividend also by 10,000, thus producing 9,500. Division is then carried out in the following way:

\[
\begin{array}{c}
25 \\
4,750 \\
2,375 \\
1,125 \\
540 \\
0
\end{array}
\]

The same method is adopted if the divisor includes whole numbers as well as a decimal fraction. For example, divide 23,006.25 by 3.125. Here we multiply the divisor by 1,000, producing 31,250; multiplying the dividend also by 1,000 we obtain 23,006,250. The division is then carried out in the following way:

\[
\begin{array}{c}
31,250 \\
12,500 \\
12,500 \\
6,250 \\
6,250 \\
0
\end{array}
\]

Recurring Decimals

In some cases of decimal division the calculation can be carried on indefinitely, and such decimals are known as recurring decimals.

For practical purposes it is not necessary to carry calculations beyond three places of decimals, and usually two or three significant figures suffice. It is important to remember that noughts immediately after the decimal point do not count as significant figures. Thus, in decimals such as 0.000939, the first significant figure is 3, and expressed correct to one significant figure the fraction is expressed as 0.001; to two significant figures, 0.00093.

It is always wise to discard the unnecessary figures, because they make the calculation unnecessarily lengthy and add to the possibility of error. Remember that for approximate results any figure over 5 may be added as 1 to the next decimal place to the left. The above decimal could thus be written (approximately correct) as 0.00094.

Recurring, circulating or repeating decimals are denoted by a dot over the recurring figure; thus, .303 means .303303303... and so on to infinity. Similarly, groups of figures in the decimal fraction may recur. Thus, .599399, or .733171717... In this case the dots are placed over the first and last figures of the recurring group. I shall deal with recurring decimals later, in connection with the conversion of fractions into decimals.

Contracted Multiplication

There is a contracted system of multiplication which saves considerable time when results are only required to be accurate to the first one or two places of decimals. I give an example, showing the usual and contracted methods:

Multiply .807453 by 8.325.


\[
\begin{array}{c}
74.3 \\
632 \\
37125 \\
2970 \\
2259 \\
16110 \\
100875 \\
0.807453 \\
8.325
\end{array}
\]

The same method is adopted if the divisor includes whole numbers as well as a decimal fraction. For example, divide 25,006.25 by 3.125. Here we multiply the divisor by 1,000, producing 31,250; multiplying the dividend also by 1,000 we obtain 25,006,250. The division is then carried out in the following way:

\[
\begin{array}{c}
31,250 \\
12,500 \\
12,500 \\
6,250 \\
6,250 \\
0
\end{array}
\]

It will be noted that in the contracted method the figures used in the multiplier are reversed, and the rows of figures resulting from each multiplication are arranged...
one place to the right of the previous result of multiplication. Those figures to the right of the dotted line would not, of course, be written down in practice. They are ignored, and are merely included here to indicate the method of working. In practice, therefore, the first figure is ignored, although any number to be carried is added in the usual way. The working would thus appear:

\[
\begin{array}{c}
3125 \div 3.125 \\
\hline \\
\hline
\end{array}
\]

Similarly, it is possible to contract the process of division and one example will suffice: Divide .031625 by 3.125. Ordinary method:

\[
\begin{array}{c}
3125 \div 31625 \\
\hline \\
3125 \\
\hline
295 \\
\hline
25 \\
\hline
2 \\
\hline
2 \\
\hline
.125
\end{array}
\]

Conversion of Decimals to Vulgar Fractions

It has already been explained that decimals represent tenths, hundredths, thousandths, etc., according to the position of the figure from the decimal point.

Thus \( .5 = \frac{1}{2} \), \( .75 = \frac{3}{4} \), and so on.

In order to convert a decimal into a fraction, it is only necessary to use it as a numerator, with a denominator of 1 followed by as many noughts as there are decimal places in the fraction. The above examples make this clear. Cancellation can then take place in the usual way. Examples:

\[
\begin{array}{c}
\frac{375}{1000} = \frac{75}{200} = \frac{25}{60} \\
\frac{375}{100} = \frac{75}{60} = \frac{3}{4} \\
\frac{375}{10} = \frac{75}{6} = \frac{5}{1}
\end{array}
\]

Some fractions and their decimal equivalents occur so often in calculations that they should be committed to memory. I give them here:

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Decimal Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{1}{2} )</td>
<td>.5 ( \frac{1}{4} )</td>
</tr>
<tr>
<td>( \frac{1}{3} )</td>
<td>.333( \overline{3} )</td>
</tr>
<tr>
<td>( \frac{1}{5} )</td>
<td>.2 ( .\overline{2} )</td>
</tr>
<tr>
<td>( \frac{1}{6} )</td>
<td>.1666( \overline{6} )</td>
</tr>
<tr>
<td>( \frac{1}{8} )</td>
<td>.125 ( .\overline{125} )</td>
</tr>
<tr>
<td>( \frac{1}{9} )</td>
<td>.\overline{1}</td>
</tr>
</tbody>
</table>

Converting Recurring Decimals to Fractions

Instead of using noughts as a denominator, nine, are used when converting recurring decimals into fractions. Thus:

\[
\begin{array}{c}
\frac{1}{9} = .\overline{1} \\
\frac{2}{9} = .\overline{2} \\
\frac{3}{9} = .\overline{3} \\
\frac{7}{9} = .\overline{7} \\
\frac{8}{9} = .\overline{8}
\end{array}
\]

Sometimes, by multiplying the numerator and denominator by a suitable number, it is possible to produce the decimal equivalent without division. Thus:

\[
\begin{array}{c}
\frac{1}{10} = .\overline{1} \\
\frac{1}{100} = .\overline{01} \\
\frac{1}{1000} = .\overline{001}
\end{array}
\]

Converting Fractions to Decimals

Reversing the process, vulgar fractions may be converted into decimals by reducing them to their lowest terms, and then dividing the numerator by the denominator. Examples:

\[
\begin{array}{c}
\frac{1}{16} = .0625 \\
\frac{7}{8} = .875 \\
\frac{5}{16} = .3125 \\
\frac{7}{16} = .4375 \\
\frac{5}{8} = .625
\end{array}
\]
These are pure recurring decimals. In the case of mixed recurring decimals, in which the decimal point is followed by some figures which do not recur, the rule is: Subtract the non-recurring figures from all the figures, using the answer as the numerator, and for the denominator use as many nines as there are recurring figures, followed by as many noughts as there are non-recurring figures.

Examples:

\[
\begin{align*}
0.6\overline{6} - 0.6 &= \frac{0}{99} = 0 \\
0.2\overline{3} - 0.2 &= \frac{0.03}{9900} = 0.0003
\end{align*}
\]

Short Cuts

Practical men use a vast number of short cuts in calculations. I cannot deal with all of them this month, but a few of the more useful are given.

To multiply by 5, add nought to the number to be multiplied and divide by 2.

To multiply by .25, add two noughts and divide by 4.

To multiply by 125, add three noughts and divide by 8.

To divide by 5, multiply by 2 and divide by 10.

To divide by 25, multiply by 4 and divide by 100.

To divide by 125, multiply by 8 and divide by 1,000.

Division and multiplication by contracted methods have already been given.

A convenient method of squaring a number is to multiply the number plus the unit figure by the number less the unit figure, and add the square of the unit.

Example: Square 92.

\[
92 + 2 = 94 \quad 92 - 2 = 90
\]

\[
94 \times 90 = 8460 + 4 \times 4 = 16
\]

Extracting Square Root

The method of extracting square root is as follows:

Mark off the number, the square root of which is to be found, into periods by marking a dot over every second figure commencing with the units place. Draw a vertical line to the left of the figure and a bracket on the right-hand side. Next, find the largest square in the left-hand period, and place this root behind the bracket. Next, the square of this root is subtracted from the first period, and the next period is brought down adjacent to the remainder and used as a dividend. Now multiply the first root found by two and place this product to the left of the vertical line; then divide it into the left-hand figures of this new dividend, ignoring the right-hand figure. Attach the figure thus obtained to the root, and also to the divisor. Multiply this latest divisor by the figure of the root last obtained, finally subtracting the product from the dividend. Continue this operation until all the periods have been brought down. If a decimal fraction is involved, the periods for the decimal are marked off to the right of the decimal point.

The following examples will make the process clear.

The first trial divisors are underlined in each case.

Example.—Find the square root of 1256:

\[
\begin{align*}
3 & \quad 1256 \\
\quad 9 & \quad 34
\end{align*}
\]

Find the square root of 54756:

\[
\begin{align*}
2 & \quad 54756 \\
\quad 4 & \quad 234
\end{align*}
\]

Find the square root of 39,476,089:

\[
\begin{align*}
6 & \quad 39,476,089 \\
\quad 6 & \quad 367
\end{align*}
\]

Notes and News

Mr. Graham Leitch Porter, one of the senior engineers of Ferranti, Ltd., died recently after a long illness. Born in 1853 in Ceylon, he came to Edinburgh to be educated, and was first employed in the electrical department of the North-Eastern Railway Co. Later he went to the Newcastle-upon-Tyne Electric Supply Co., and thence to the staff of this company’s consulting engineers, Nortz and McLellan. In 1927 he joined Ferranti, Ltd.

Mr. E. H. Wellins, Grad. I.E.E., and former member of the technical staff of Mullard Radio Valve Co., Ltd., has been appointed commanding officer of the Wigan Squadron of the Air Training Corps.

Grid Condenser and Leak Alterations

A good deal of improvement can often be made by the simple process of altering the values of the detector grid condenser and grid leak. Reducing the former to about 0.001 mfd. and increasing the latter to some 5 megohms will, in many instances, make quite a considerable improvement. For purposes of trial it is an excellent idea to fit a 0.001 mfd. preset in place of the fixed grid condenser, and try various settings. The only objection to this suggestion is that if a high signal voltage is applied to the detector, there is some chance of overloading and consequent distortion, although in the majority of cases, especially where an effective pre-detector volume control is fitted, there will be no difficulty whatever in this respect.
Radio Extension Lines

Maximum Entertainment is Obtained from One Receiver when Full Use is Made of External Speakers

There are many alternative arrangements whereby radio can be extended to every room of the house, and not only do these fully cater for the needs of listeners, but also furnish opportunities for the home constructor to exercise his ingenuity. These schemes can be divided into two distinct types, which may be termed the single receiver and extension circuit type, and the communal aerial system using either a transportable set or several receivers.

Loudspeaker Extension Systems

Because they call for only one centrally located set and simple low frequency wiring, extension systems are used to a greater extent than communal aerial systems. Most commercial sets are now fitted with extension sockets which can be connected to lines running to speakers in other rooms, and it is quite an easy matter to fit such connections to existing sets. Figs. 1, 2 and 3 show a number of typical arrangements, the choice of which depends upon the design of the output circuit of the set. In Fig. 1 is shown one scheme whereby the extension circuit is taken across the secondary of the set's output transformer, and the insulation of the extension wiring need not be of such a high grade, while the extension transformer, and the insulation of the extension wiring shown in Fig. 4. It is an advantage to provide a switch whereby the speaker in the set can be silenced if desired without cutting off the extension circuit, and the position of this is also indicated in Fig. 4.

Remote Control

Although the arrangements indicated certainly permit expansion speakers to be used in any part of the house, and in most cases represent the normal installation, they have the disadvantage that if, when listening in another room, it is desired to hear another programme or to switch off entirely, a visit must be paid to the room in which the set is situated in order to return or to operate the switch. Remote control of tuning has been achieved in one or two commercial sets, but is only practicable for the constructor on a small scale, that is to say, by employing a set which can be tuned to only two or three different stations by means of pre-set tuned circuits switched by means of relays. In view, therefore, of the limited field of application of remote tuning, this section of the subject will not be discussed here; but remote control of the on/off switch is quite a practicable proposition.

One arrangement is to use a "latching" relay in which a switch, which acts as the main on/off switch for the set, is opened and closed by means of two-way push buttons at the various loudspeaker points. Suitable relays are on the market and consist of two electromagnets, one of which opens the relay contacts when energized, the armature being latched in the "off" position by the armature of the second magnet. When, however, the second magnet is energized, its armature is attracted and releases the first armature, thus causing it to close the main circuit. Three control wires are required, as shown in Fig. 5, but if choke output is used the common lead of the control circuit may also be used as one of the extension speaker leads, so that only four wires in all are necessary, as shown in Fig. 6.

A very simple but most efficient complete remote control loudspeaker extension outfit is the Whiteley "Long Shot" unit. A push-button and volume control is provided on each W.F. extension speaker, and the unit may only be operated from a distant point with the volume control in its minimum position. The unit is fitted...
in a position conveniently close to the set, and the set leads (battery or mains) attached to the plug provided by the unit. The extension speaker leads from the set are attached to terminals also provided on the unit. Three terminals are provided for output from the unit to the extension speaker, and also from the extension speaker push button to the battery operating the relay. The third lead provides the other connection from the push button to the battery. The two leads to the battery are specified as 23/36 to maintain a low resistance line and thus avoid excessive voltage drop on the relay circuit. The relay is operated by means of a 4.5 volt solenoidal magnet. This magnet pulls down a hinged top yoke to which is attached a silver-faced contact. Another silver-faced contact mounted on a pillar completes the supply circuit when the hinged top yoke is in the lower position, where it is held by means of an ingeniously locating spring. When the relay is operated, the hinged top yoke is released and the circuit broken.

A circuit diagram showing the complete scheme for this device is given in Fig. 7, and it has the distinct advantage that current is only drawn from the battery during the short time that the push button is operated, the main unit spring ensuring correct make or break as required.

Ingenious constructors may like to experiment with relays of their own design, and in this connection the mercury-tube switch offers great possibilities. Sealed tubes containing two fused-in contacts and a small quantity of mercury, which connects the two contacts when the tube is tilted, may be bought very cheaply, and Fig. 8 illustrates a simple suggestion for a suitable mercury switch relay for remote control.

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The Communal Aerial System

Instead of employing one receiver in a permanent position with speakers in different rooms, the receiver may be moved from room to room, or there may be a different set in each room, or a family set in the lounge and a small set which can be taken to any other room. The case of the portable battery set with its self-contained frame needs no explanation, and a set of this type is an adjunct to the fixed receiver may solve the extension problem in many instances. There are also many transportables with frame aerials, and many other mains sets have mains aerial connections which permit transraplability without the necessity of connection to an external aerial. While allowing local control of tuning, volume and so forth, impossible with simple speaker extensions, the frame-aerial or mains-aerial system usually imposes some limits on the range of the receiver, and less than the normal number of stations is receivable, while mains interference may be increased.

In the majority of instances, however, it is better for the subscriber to connect to a proper aerial and earth system, and a number of different schemes are possible. If the receivers under consideration are sufficiently sensitive, and local conditions are favourable, the complications associated with running two or more receivers from one aerial can be avoided by rigging up separate picture rail or loft aerials. For example, one main receiver may be operated from the central aerial and the set in the dining-room from a picture rail aerial, while another aerial in the loft may be provided for use when a set is wanted in the bedroom.

Where a single aerial is required to serve all parts of the house, proper arrangements must be made, for if two sets are connected directly to one aerial, they usually upset tuning to a considerable extent unless they are tuned to stations greatly differing in wavelength. The usual solution is to fit a communal aerial, which is connected to each via the primary of a specially designed radio-frequency step-down transformer, the secondary winding being connected to a pair of lead-covered leads which run to the various rooms. At each point where it may be desired to connect a receiver is placed a socket connected to the aerial extension circuit, and each receiver is fitted with a step-up aerial transformer to match the input to the low impedance aerial line. This, in addition to confirming the break, will be the advantage that, if the aerial proper is erected outdoors and outside the field of electrical interference, the lead-covered transmission line will not pick up any interference on the way to the receiver, and may be connected to the radiated type will be avoided. Within reason, the transmission line may be of any length—certainly up to several hundred feet, and any number of sets up to, say, ten may be connected to the communal aerial system, each, of course, through its own transformer.

Although the communal aerial is a very important matter in the case of different ideas as to what they wish to hear. The home constructor may also welcome this arrangement, as it affords him opportunities for making up a multiplicity of receivers. Most amateurs have a number of old or partly dismantled sets on hand, and these may be modernised as suitable instruments for installing in different rooms.
With all the Ocean for a Road....

...a ship ploughs its way to port. Often contact with the world seems all but lost through fog or gale. But thanks to radio, contact is never lost. Each ship, great or small, can receive whatever warnings, whatever orders, whatever news or encouragement its guardians afloat and ashore may send forth.

Dubilier are proud to know that they are helping this great work, helping in the equipment which is bringing the ships home.
NEGATIVE feedback, or degeneration, solves many of the problems connected with "quality" amplifiers, especially those of otherwise simple and straightforward design. This system of coupling provides one of the easiest possible methods of improving reproduction, and even goes so far as to "correct" imperfections of the loudspeaker itself.

The underlying principle can readily be followed, but some of the advantages are not so obvious until the question is considered from the theoretical aspect. As the name suggests, the object is to feed back some of the energy from the output circuit to the grid circuit of an L.F. or power amplifier. This is done in the case of a regenerative detector, of course, but in that case the feedback can be described as positive since it is in phase with the original input and therefore has the effect of increasing the output from the valve.

In the case of negative feedback, the voltage fed back is out of phase with, or in opposition to, the audio-frequency input. That is, when the grid swings negative feedback is positive, so that the overall amplification is reduced. There are various results from this, one of which is that the amplifier is made more stable; this would naturally be expected since stability is more easily obtained when the stage gain is reduced.

It were the only advantage to be gained, the system would have little practical value, because the same result could be achieved by reducing the H.T. voltage, increasing the grid bias or using a different inter-valve coupling. A far more important result is that the response of the amplifier is made more nearly uniform over the frequency range, and that unwanted harmonics are partially cancelled. In consequence of these advantages even a poor amplifier can be made to give approximately better reproduction by incorporating negative feedback. This is not an excuse for making a poor amplifier and then level as that provided before applying degeneration.

Before considering the other advantages and studying a circuit arrangement, it will be best to gain a fair impression of the fundamental principles. One simple method of demonstrating these is by means of the diagrams given in Fig. 1. Here, the upper "box" represents our amplifier, L.R. is the normal output load (usually the loudspeaker), and the lower "box" indicates the "feedback amplifier" or attenuator. It should be explained that an attenuator is the reverse of an amplifier, and that the negative feedback does give attenuation although in practice there is no special form of amplifier for this purpose, as will be seen later.

Let us assume that the audio-frequency output across the load resistor is a volts (the Greek letter alpha as usual here is a convention, and any other letter could be used). If it is also assumed that the gain of amplification of the amplifier is a times volts—input multiplied by the "gain." If, now, this output is applied to the input of our "negative feedback attenuator" it must be a volts. This also happens to be a convenient method of explanation, and any other figure could be taken. Now it may be seen that if degeneration were not used, an input of r volts must be applied to the amplifier in order to give our "standard" output of a volts.

The position is somewhat different when negative feedback is applied, and we can consider that our "negative feedback attenuator" has an amplification of times. This may, of course, be fractional, or may be negative amplification. Since the input to this amplifier or attenuator, whichever we choose to call it, is a volts, the output must be a times a volts—input multiplied by the "gain." If, now, this output is applied to the input of our original amplifier in series with our original A.F. input, the total A.F. input to the amplifier...
itself must be \( z + \beta \) volts, since the feedback acts in opposition to the normal input.

The gain or amplification of the amplifier without degeneration has been stated to be \( z \) and it can now be seen that the gain when applying negative feedback is \( z \) divided by \( z + \beta \) — since for the same output a greater input is required. If \( \beta \) is appreciably greater than unity, as it is in practice, the gain with negative feedback is equal to \( z/\beta \). And as \( \beta \) remains constant the overall gain must remain constant irrespective of the amplifier characteristics.

A Worked Example

A simple arithmetic example will demonstrate this.

Suppose the gain of an amplifier without negative feedback is 5,000 times and that \( z \) per cent. of the output is fed back as negative feedback; find the gain in the latter case. Using the simple formulas devised above, we can see that the gain is \( 1 - z \), \( \beta = 1 + a = 5,000 \). When this is worked out the answer can be seen to be almost precisely \( z \). Now suppose that at a different frequency the gain falls to 5,000 times. The overall amplification, with negative feedback, then becomes \( 1 - z \), which again is almost exactly \( z \).

This gives clear proof of the uniform response given by an amplifier fitted with a system of negative feedback, and also shows the very great reduction in overall gain. In practice, the reduction in gain is not as severe to the ear—as the figures indicate. This would be better appreciated if the decibel notation (explained in the November, 1941, Issue of Practical Wireless) were employed.

The Simplest Method.

Now we can leave behind the theoretical considerations and look at the more practical aspects. The simplest possible method of applying negative feedback is by omitting the electrolytic condenser normally wired in parallel with the cathode-load bias resistor of a mains set; see Fig. 2. It will be appreciated that as the grid is swung positive by the positive half-cycle of a signal, the anode current flows through the valve. And since this passes through the bias resistor, the cathode is made more positive and the grid more negative, because there is an increased voltage drop across the bias resistor. On negative half-cycles the reverse occurs, the negative potential being partially cancelled.

The principal objection to this very simple and effective method of obtaining degeneration is that, due to the action explained, the effective internal resistance of the valve is increased. This means that the "regulation" is poor, any change in the impedance of the anode load having a marked effect. In consequence, the system is of practical advantage only when applied to an L.F.—as contrasted with a power—valve, and preferably when resistance-capacity coupling is used following the valve.

**Voltage Feedback.**

The system of degeneration described above is known as series or current feed, for reasons which should now be obvious. A method which is of wider application is known as voltage or parallel feedback, and a circuit is given in Fig. 3. Here it will be seen that a potentiometer is connected across the output of the power valve, a tapping from this being taken to the lower end of the secondary winding of the L.F. transformer. It may at first appear that the feedback would be positive, until the 180-degree phase reversal brought about by the valve itself is called to mind.

This system does not suffer from the disadvantage of poor regulation and, in fact, has the valuable advantage of reducing the effective internal impedance of the valve. Because of this, the method is of especial value in the output stage, where low internal resistance is very important in maintaining uniformity of load. This point is doubly valuable when using a valve of the triode or penode type which has, in the ordinary way, a comparatively high internal impedance. Values of components indicated in Fig. 3 are good average ones, which may well form the basis of experiments; the resistance values will, naturally, have to be modified slightly according to the valve in use, the loss of amplification that can be afforded, and the importance of high quality reproduction.

For Use in Push-pull.

Fig. 4 shows a circuit similar in general type to that given in Fig. 3, but with two tetrodes in push-pull. It will be seen that the push-pull transformer must be of the double centre-tapped kind; otherwise special components are not called for. It should be mentioned in passing that the two 5,000-ohm resistors in the grid circuits are merely grid stoppers, which are generally undesirable in a push-pull circuit to compensate for slight differences in valve characteristics.

In Fig. 5 another method of applying degeneration is illustrated. This time a 3-megohm resistor is joined between the anode of the output valve and the anode of the valve preceding it. The variable or pre-set component is fed back as negative feedback; the effective feedback is equal to \( z/\beta \). A method which combines the principles of the circuit arrangement shown in Figs. 2 and 3.

**Combined Feedback.**

The circuit shown in Fig. 6 combines the arrangements of Figs. 2 and 3, since current feedback is obtained in the penultimate valve stage by omitting the bias-resistor by-pass condenser, while voltage feedback from the anode of the output valve is taken through a fixed condenser and variable resistor to the cathode of the L.F. valve which precedes the output stage. An on-off switch is also included so that voltage feedback can be eliminated when desired.
A Remote Control System

In the past, remote controls as applied to home radio broadcast receivers have been relatively complicated and expensive, requiring, at the control point, either a miniature transmitter or a control box containing numerous contacts connected to the radio receiver through a cable of, perhaps, a dozen wires. Because of this, although many people work one or more remotely situated loudspeakers from a single receiver, few of them have the apparatus necessary for control of the receiver from the room or rooms in which the remote loudspeakers are situated.

The object of this article is to describe a remote control system which is much simpler than the above-mentioned types, and requires but a single pair of conductors to connect the receiver to the remote control point. Furthermore, proper control of the receiver from the remote control point may be provided by means of a single push-button switch.

Motor-driven Mechanism

The basic idea is as follows: A motor-driven cam mechanism is arranged so that when the motor is energized, it slowly depresses first one, then another, in sequence, of all the push-buttons of the tuning unit in the receiver. The motor is controlled by a switch located at the remote point so that if this switch is closed, all the stations to which the push-button unit is adjusted will be tuned in one after another. If the listener at the remote point releases the switch, his receiver will remain tuned to the station corresponding to the last push-button depressed. Means may also be provided for giving the listener an indication as to which station he is tuned for this purpose the cam mechanism which depresses the tuning buttons is provided with means to strike or pluck a series of musically tuned reeds, so that as each station button is depressed a characteristic musical note is emitted from the receiver. If each of these musical reeds be adjusted to a different note, the operator will soon learn to associate the proper station with its corresponding tone.

Referring to the accompanying illustrations, Fig. 1 is a schematic circuit diagram of an embodiment of the idea using a motor-driven cam, and Fig. 2 shows one way in which the distinctive tones may be produced.

In Fig. 2 A represents the preliminary circuits of a radio receiver and B the diode output. This output is fed to the lower contact 1 of single-pole double-throw relay FG. C is the audio amplifier of the radio receiver and E is the loudspeaker. The input of the audio amplifier is connected to the armature 2 of relay FG. J is a drum containing several cams K. This drum is rotated by motor I through suitable gears D. The cams K are arranged to depress the receiver tuning buttons, and also pluck the musical reeds, as shown in Fig. 2. L represents a series of pick-up coils associated with the musical reeds in such a way as to pick up voltages corresponding to the reed vibrations. These pick-ups are connected to contact 3 of relay FG. M represents the radio receiver power transformer, and low voltage winding of which drives motor I and actuates the electromagnetic Q of relay FG through one of the remotely-located push-button switches H. It will be seen from Fig. 1 that upon closing switch H motor I is set in motion, and that relay FG disconnects the audio amplifier C from the radio receiver diode output B and connects it to the reed pick-up coils L. As motor I revolves it slowly turns cam J, depressing first one and then another of the push-buttons in the tuning unit, also plucking the corresponding musical reeds. The tone from each reed, as it is plucked, passes into audio amplifier C and is emitted from the speaker. The operator listens until he hears the particular musical tone associated with the station he desires, and then releases push-button H. This stops the motor I on the station he desires and relay FG allows its armature to drop, thereby disconnecting the reed pick-up coils and connecting the diode output B to the audio amplifier C.

Reed-plucking Mechanism

Fig. 2 illustrates one possible arrangement in which a rotating cylinder containing cams can be made to depress the tuning buttons and pluck the reeds just referred to. In this diagram K is the front panel of the radio receiver, Y is the tuning unit, and X is one of the levers that depress variable gears D. The cam cylinder contains cams K. As the cylinder J rotates the cams K depress the corresponding L-shaped bars W, which are suitably pivoted, as at Z. Each bar W is provided with a reed-plucking arrangement U, which plucks its corresponding reed V. As J rotates each cam K depresses its bar W, thereby plucking its corresponding reed and pushing down its corresponding tuning lever X simultaneously.

The electric motor I can, of course, be replaced by any other suitable form of motive power, such as, for example, a magnet-operated ratchet and pawl mechanism. This system was developed in the laboratories of The Radio Corporation of America.
The Brine Trust!

As we have to take such a large chunk of salt with some of the statements made by B.B.C. speakers, I suggest that the latter body introduces a new feature known as the Brine Trust. I am taking especial care to listen to the Brains Trust items, and I am still of the opinion that they do not answer questions satisfactorily. Miss West made the suggestion that after the war she hoped that there would be a standard education for all. Apparently Miss West would like everything to be standardised—standard food, standard dress, standard wireless sets, standard cars, standard homes, standard music, standard hours of rising, and rest, and so on. There will never be a standard of education which is bound to vary according to the needs of the individual. Creoners, jazz-band leaders, musicians in general, poets, announcers, and no other sections of the community do not need much education.

Vocabulary

I was more particularly interested, however, in their answer to the question as to what constituted the vocabulary of the average individual, whatever an average individual may be. Joad stated unequivocally that the vocabulary of the average individual was between 600 and 800 words. Who says so? Has Joad taken a census of the vocabularies of large numbers of people? Has he given these people a dictionary, and asked them to tick off all the words in it of which they knew the meaning? Of course not. Joad is in no position to make the assertion that most of us have a vocabulary limited to 600 words, and I assert with all emphasis which cold print can lend that Joad is kidding himself. I do not think that he has made any investigation of this kind, and was merely hazarding a guess. Yet his statement goes forth to the whole world as a statement of fact. I now take this earliest opportunity of correcting Joad on this important matter. I gave six of my friends copies of a cheap dictionary containing about 50,000 references, and I asked them to tick off all the words in it of which they knew the meaning. Of course not. Joad is in no position to make the assertion that most of us have a vocabulary limited to 600 words, and I assert with all emphasis which cold print can lend that Joad is kidding himself. I do not think that he has made any investigation of this kind, and was merely hazarding a guess. Yet his statement goes forth to the whole world as a statement of fact. I now take this earliest opportunity of correcting Joad on this important matter. I gave six of my friends copies of a cheap dictionary containing about 50,000 references, and I asked them to tick off all the words in it of which they knew the meaning. Obviously the age of the person will affect the extent of his vocabulary, and it is equally well known that women cannot spell so well as men. I cannot too strongly deplore these Brains Trust answers. I do not think that there is anyone in the world over the age of 14 who has a vocabulary so small as 800 words. The average individual under 20 has a vocabulary of 2,000 words. The female over 20 has a vocabulary of 2,000 words. I have never seen in print the word "Brachiosaurus," but I do not think that it is small enough to fail to get a word of the meaning of it. I have not heard of many people who have a vocabulary of 2,000 words. I have always made a practice of tracing the meanings of words of which I had not formerly heard. I was not surprised when I counted up my list to find that I have a vocabulary of over 30,000 words. To this I could add at least another 10,000 technical words which I would exclude from a normal vocabulary.

The Stratosphere

The Brains Trust were equally illogical in their question asking concerning the stratosphere. They also seem unaware of the fact that special "planes are being built that fly through the stratosphere, or rather the lower belts of it. I have no doubt that some of these technical scientists should be answered by technical scientists, and I think we must blame the B.B.C. for their wrong selection of a Brains Trust expected to handle questions on all subjects.

Two Scottish Myths

The Brains Trust recently answered two Scottish propaganda questions. The first was: "Why are Scots more educated than the English?" No one in the Brains Trust gave the proper answer which is: "Scots are not more educated than the English." Instead, they accepted the Scottish myth without question and proceeded to find reasons for the myth. The other question was: "Why do Scots occupy the leading positions?" Joad answered that one correctly. He said it was a myth and there was no foundation for it. He stated that the English occupied the leading positions whilst the Scots were nearly always second or third. I have no doubt that by this time Joad has received a packet of letters from the more fiery members of that hasty race.

Our New Size

I have not had one letter of criticism concerning the new format of this journal. I have received some dozens of letters from readers praising the new size and expressing the hope that we shall maintain it after the war. That, of course, is in the lap of the gods. I must say that I prefer the new size. It is handy, and companionable, and when bound as a volume will be more convenient for the bookshelves.

Thermion's New Brains Trust

Good lad, Thermion! As an "opposition shop," competing with the B.B.C., I'll quickly put a stop to a most misleading current. That the "Brains Trust" are "the goods," Angostura by the gods themselves, To each his brains and oil! Fills we not get "education," And possess no high degree, But fate has made us realistic, And we've brains enough to see That on getting down to brass tacks It's invariably true, That there's lots of folks besides oneself, Who know a thing or two! And we know that mental arrogance, Of genius is no proof; Unless by practice first he's proved, ^ So we welcome "opposition." Be it a "Brains Trust," take a test, For we know at "Thermion's Ltd." To teach we brainless duds! It's "incorrigibly true," That there's lots of folks besides oneself, Who know a thing or two! And we know that mental arrogance, Of genius is no proof; Unless by practice first he's proved, So we welcome "opposition."
Wire-end Condensers.

I HAVE devised the following method for constructing small wire-end condensers from thin cardboard, tinfoil and Cellophane. The thin cardboard is first dried by placing it in front of a fire for some time, or in a warm gas-oven. A piece of the card is then glued on top of this, as shown in Fig. 1. The tinfoil sheets are provided with tags at the ends, and the Cellophane is of a size which overlaps the edges of the tinfoil, but does not cover the tag at the end. The glue used should be of the "cellulose" variety and not fish-glue. This glue has quite good insulating properties when dry. When all the sheets are firmly stuck together, a hole is pierced through the card or Cellophane, as shown in Fig. 2. Short lengths of wire are passed through the holes and the ends are bent round. The two parts of the wire are then pinched together firmly and carefully with pliers, so that the wire bites into the tinfoil and cardboard. A blob of solder can be placed to help to hold the joint together. Both of the wire connections are coated with glue and left to dry. Two sheets of cardboard, of the same size as the original sheet, are then glued on either side of the assembly, and the condenser is pressed under a pile of books, or preferably between two flat blocks of wood, in a vice. When the glue is dry a very strongly-made condenser is obtained. The whole condenser can be coated with shellac to keep out the damp, and then painted with black enamel. If an approximate idea of the capacity can be found, this can be written on the cardboard in aluminium paint. The final product presents a very pleasing appearance. I have found condensers made in this way to have quite good insulation, even for high frequency work, and they will withstand up to 200 volts across the plates. The units now function as a crystal set.

An efficient method of making small wire-end condensers.

A Coil Winding Hint.

WHEN winding coils of the pile wound variety, such as high frequency chokes, etc., where the wire is simply wound into narrow slots of a former, I have found the following simple idea very helpful in preventing the wire catching into the slots of the former, or riding over into an adjoining one, this being especially troublesome when hand winding. A small piece of card or stout paper, is folded into a V-shape, and a cut made at the base about halfway across. When the winding has been commenced, this paper is slipped under the wire, pushed into the slot until it stops, and then the winding continued.

The winding operation is carried out by revolving the coil former with one hand, whilst the card is kept in position with a finger of the other hand resting on top. The sketch explains the idea.

—R. L. Graper (Gillingham).

A Simple Multi-purpose Unit

IN my experiments I often need various kinds of simple apparatus, such as a wavemeter or a continuity tester. Unfortunately, I am not able to spare a valve or afford any costly equipment, so I have devised a multi-purpose unit that fulfils many of my requirements. The circuit is shown in the accompanying diagram.

The components required are: A buzzer; a coil and a condenser to cover the required waveband; an A.F. 32t transformer; two switches; a battery; a lamp or a galvanometer; 7 terminals; a crocodile clip to connect the battery — to the coil; wire.

The actual unit was built up on a 7in. by 10in. base board with a panel the same size. —Y. Pannett (Bromley).
Television in Colour and Stereoscopic Relief

A Brief Account of the Latest Experiments by J. L. Baird

To obtain the complete illusion of reality in the transmission of images to a distance, the received image should have both colour and also depth—that is, stereoscopic relief. In 1926, when television was demonstrated for the first time, the little pictures shown by Mr. Baird were small and imperfect, and it might be thought that at that early date no effort would have been made to complicate matters by attempts to produce a high definition stereoscopic image in colour.

The first experiment was applied to his 100 line two-colour apparatus. The red image was made to view the scene from a slightly different angle from the blue, so that the red and blue images constituted a stereoscopic pair, the receiving screen being viewed through glasses fitted with red and blue filters as in anaglyph process. This, while simple, had the disadvantage that it was necessary to wear glasses, and that, as the colour phenomenon was used to effect the change over from the right to the left eye, neither the colours nor the stereoscopy could ever be properly rendered.

Frame Frequency

So far the object in mind had been to produce a system capable of being transmitted through the existing channels available to the B.B.C., but in an endeavour to obtain as perfect a result as possible, it was decided to produce an entirely experimental apparatus regardless of existing practical limitations. In the apparatus demonstrated the frame frequency has been increased from 50 sec. to 250 sec., the scanning altered to a field of 500 lines interlaced five times to give a 1000 line picture, successive 100 line frames being coloured green, red and blue.

Operating Principles

It might be interesting to review briefly the principles employed in these first demonstrations, as they form the basis of present-day results. The monochrome television image was transmitted by scanning the image in a succession of lines. At the receiver a screen was scanned by a light spot, which varied its brilliance, depending upon the light and shadow of the picture. In the colour process three such pictures were transmitted, one red, one blue, and one green, the three blending to give an image in colour. Stereoscopy was obtained by transmitting two images corresponding to a stereoscopic pair, and viewing them at the receiving station through a stereoscope.

Little was done to develop either colour or stereoscopy for many years. In 1936, however, Baird showed a 12 ft. colour picture to a cinema audience at the Dominion Theatre, London, the picture being transmitted from the Crystal Palace by wireless. This was followed in 1939 by a demonstration of colour, using a cathode-ray tube in conjunction with a revolving disc—the method used to-day. Nothing whatever was done with stereoscopy until recently, when Mr. Baird set out to produce a high definition stereoscopic image in colour.

At the transmitter a cathode-ray tube is used in conjunction with photo-electric cells, the moving light spot being projected upon the scene transmitted. In front of the projecting lens a mirror device consisting of four mirrors at right angles splits the emerging light beam into two paths separated by a space equal to the separation of the human eye. By means of a revolving shutter the scene is scanned by each beam alternately so that images corresponding to the right and left eye are transmitted in rapid sequence. Before passing through the shutter disc the light passes through a rotating disc with blue, red and green filters. Thus superimposed red, blue and green pictures blending to form the complete illusion of reality.
give a picture with full natural colours are transmitted for left and right eye alternately.

Pairs of Images
At the receiver the coloured stereoscopic pairs of images are reproduced in sequence and projected upon a field lens, alternate halves of the projecting lens being exposed by means of a rotating shutter, the image of the shutter being projected upon the eye of the viewer so that his left and right eyes are presented alternately with the left and right images, the combined effect being a stereoscopic image in full natural colours.

Stereoscopic television is an entirely British achievement, it has been shown nowhere but in England, and this is the first time that stereoscopic television in colour has been achieved.

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The Following Short Description of a Simple Morse-sending Machine Should Prove Interesting to Readers Studying the Subject

The surface of the cardboard drum 1 should be piercing the surface of the drum and threading a length of tinned copper wire through the holes, the end of the wire being connected to the spindle 2. The cam 3 should be arranged so that immediately the Morse letter which the contact 4 is touching is sent, the stop-pin 5 is lifted out of one of the thirteen holes in the sliding strip 6; the contact 4 will then move across the clear segment of the drum 1, to be stopped by the pin 5, to send another letter. The spacing of the holes in the strip 6 should be the same as the spacing of the Morse letters on the drum 1.

The drum 1 can be driven at any desired speed by the wheel 7 from a graduograph, etc. The sliding friction spring 8 should not be too strong.

The use of a relay prevents noises due to the moving contact between the Morse letters and the contact 4 and between contact 9 and spindle 2.

The machine will send a continuous stream of ever-changing Morse letters. In the sketch some of the framework is omitted for clarity.

F. R.
Using a Pick-up With Modern Receivers

Suggestions are Given in This Article Regarding Suitable Pick-up Connections when Superhet and High-gain Circuits are Used

THE usual method of connecting a gramophone pick-up to a receiver employing a triode or pentode detector valve and a high-impedance stage, is to connect the pickup across the grid leak, without the complication of switching, but it is generally considered good practice to disconnect the detector grid from the radio-frequency circuits in order to prevent break-through of radio programmes when records are being reproduced. The basic circuits of these conventional arrangements have been published in previous issues from time to time.

Developments in receiver design have rendered it necessary to modify the pick-up connections in many circumstances, while the characteristics of the pick-up itself must also be taken into consideration when deciding the actual circuit to be employed. One of these developments is the steady increase in the sensitivity of the modern superhet receiver as a result of which it is found that, unless special precautions are taken, radio programmes are liable to impose themselves upon the gramophone reproduction, even though a switch is incorporated to isolate the grid of the valve to which the pick-up is connected from the radio-frequency portion of the receiver.

This break-through is probably due to capacitative coupling and, in order to avoid this risk, it is good practice to omit the isolating switch, merely connecting the pick-up to the control grid of the appropriate valve, and isolating the radio-frequency and intermediate frequencies by disconnecting the aerial, short-circuiting the control grid of the frequency changer, and disconnecting its anode. These operations call, of course, for fairly complex switching, but the multiple radio-frequency switch units now available can be readily pressed into service, and the necessary connections furnish an interesting problem for the amateur.

With Output Pentodes

Another development which has had considerable effect upon pick-up practice is the introduction of the high-sensitivity output pentode, which in many cases (particularly in the battery types) gives their normal output for a grid input which can be supplied direct from the pickup. There are instances, therefore, where the pickup may be switched directly to the output valve, but this connection should be taken to the volume control if this component directly precedes the output valve as it does in most modern pentodes using a diode detector. Fig. 5 shows this arrangement.

The morere general use of a diode detector presents further problems in connection with the loading of the pickup output into the receiver circuit, as it sometimes happens that the pickup voltage available is not sufficient to load the output valve. Where there is a first stage of low-frequency amplification between the diode and the output stage, the solution is quite simple—the pickup may be connected to the grid circuit of the first low-frequency amplifier with a simple changeover switch to insert the pick-up, and disconnect the detector output as indicated in Fig. 2. No change in grid-bias arrangements will be necessary in this case.

The arrangement shown is for use where a separate volume control for the pick-up is fitted, as is often the case, the volume control being incorporated in the base of the tone arm, or supplied as a separate unit. In receivers where the normal volume control for radio is included in the diode-detector circuit, it may be desirable to use this to control the pick-up also, in which case the pick-up must be switched across the control, and steps similar to those already described taken to prevent radio break-through.

Special Cases

In many cases, a double-diode-triode valve is used in place of a separate diode and low-frequency amplifier, and in such instances the pick-up can again be connected across the grid circuit of the triode portion of the combination valve. The actual arrangement will depend, to some extent, on the design of the low-frequency section of the receiver. If the volume control of the receiver is connected between the diode detector portion and the triode amplify portion of the double-diode-triode valve, it may be employed as a gramophone volume control; or switching may be so designed that a separate volume control for the pick-up is used. In some circuits, however, the volume control of the receiver is placed between the triode amplifier and the output stage. While in this position it certainly controls the volume on the gramophone, but it may not in itself fulfill the other functions of a volume control, namely, to avoid overloading. If the pick-up is connected directly to the grid of the triode section of the double-diode-triode, it is possible that with a sensitive pick-up, or on certain classes of record, the pick-up voltage will be too large to be handled without introducing distortion by the triode. It may be advisable, in such circumstances, to fit a separate volume control directly across the pick-up itself.

Ganging Volume Controls

There are two other cases in which the inclusion of a separate pick-up control may be necessary. The first is where the only manual volume control for radio is a potentiometer or variable resistance controlling the grid bias to variable-mu H.F. or I.F. valves. This practice is...
Beating the Band is now a national sport that is raising indispensable war funds in every part of Great Britain. The idea is to ask a question which a member of the band has to answer correctly with the title of a song—for instance: “What will Hitler never do?”—“Rule Britannia.” Those who do not give the right answer have to throw a penny on the drum. Clay Reves has already collected 12,000 pence in this way for the Old Town Hall Spitfire Fund. Every Thursday evening in thousands of homes, aboard ships on the high seas, in Army and R.A.F. messes, in camps and factories, men and women join in this money-raising game.

The Mayor of Greenwich recently received £3 12s. od. for his Spitfire Fund from a three-year-old boy named D. Moore, who had collected this sum in pence on his toy drum. A listener in Essex has collected 828 pence on his drum for the Red Cross during the last three months. A few weeks ago a member of a Working Men’s Club in Scotland celebrated his twenty-first birthday by joining in “Beating the Band” and raised ten shillings for the Red Cross. A listener in Yorkshire writes to say that although his grandmother always goes to sleep during the reading of the News at 9 o’clock she invariably wakes up in time to take part in “Beating the Band.”

Questions are submitted by listeners and anyone who succeeds in beating the band receives a certificate of Freedom of the Old Town Hall. These certificates are now in every part of the world, in Army and R.A.F. messes, Naval Barracks, on board the ships of the Royal Navy and Merchant Navy. One has a place of honour in H.M.S. King George V.

The Old Town Hall is probably the only institution in the country today which has to implore people not to send in money. Clay Reves, who, with his wife Gladys, is responsible for the show, is obliged to keep reminding listeners that any money really raised in this way should not be sent to him but to their local win-the-war funds.

“Beating The Band” has other applications. Not long ago, for example, a young man boarded a bus on which was an attractive conductor. When she approached him for his fare he smiled brightly and sang, “You are my heart’s delight.” “Wrong!” said the girl, “Penny on the drum!”
New Materials for Radio Parts

Engineers Consider Some Surprising Substitutes Owing to Changes Made Necessary by Defence Priorities

THERE'LL be some changes made!

That is the theme song of the radio industry and trade in the United States—at the present time, and for the duration of the Emergency!

Defence shortages of aluminium, nickel, steel, copper and plastics due to the Defence programme are causing little new substitutes are now being experimented with by radio engineers in laboratories all over the nation. And surprisingly enough, some of this research in substitutes is revealing new materials which seem even better adapted to the purpose than the familiar substances long used in the past.

Among the substitutes under test are new metallising processes in which the metal is first vaporised, and then projected electrostatically in a powerful beam (like a cathode-ray lens system) on to the paper, which is thus metallised more effectively than by any other process.

Silver and Gold

Silver- and gold-coated iron conductors are finding use as substitutes for copper wire. Such conductors have strength and, for high frequencies particularly, the outside silver coating provides high conductivity just where it is needed for currents travelling chiefly near the surface. And silver, of course, is available in unlimited quantities.

Gold-plated grid wires in valves, to reduce contact potential, offer another innovation. Gold with its excellent work-function characteristics, or low electron emission, so desirable in a grid, makes a durable, effective surface for a cheap grid structure.

The nickel shortage has worked a temporary hardship on valve manufacture, though here the resort has been to steel as the substitute. But the difficulty has been to get the right steel properly rolled into the thin sections required for valve parts. So acute has this shortage become that the valve people may have to acquire and set up their own rolling mill for the sizes and quantities needed.

The production of permanent-magnet speakers seemed to have finished a few weeks ago, because of the nickel and aluminium shortages. But suddenly there has been developed a new heat-treatment or tempering process, which, for the same magnetic properties, requires only one-third as much of these precious Defence materials as was before needed. As a result the P.M. speaker is again in good standing.

Aluminium has already vanished from the stores of radio tuning condensers, and may soon disappear generally from the condenser rotor plates as well, being replaced by steel sheets coated to prevent rust and deterioration. Already some remarkable fabrication of all-steel tuning condensers has been achieved, even in tiny condensers foridget sets.

Plastics and Formaldehyde

Shortage in plastics has been ascribed by some to the demand for plastics for the “fins” on tracer bullets, now being produced in huge quantities. Probably another cause has been the restricted production of formaldehyde needed for producing plastics. Much of the plant capacity hereforwards engaged in formaldehyde manufacture has had to be diverted to explosive-making. Results, less formaldehyde, and so less plastics, even though there is no shortage of the basic plastics material itself.

Silver solder; metallised paper shields; moulded chassis bases of nickel particles and a steel-like binder; paper and glass-based recording discs; steel-tube auto antennas—these are some of the other substitutions already being carried out.

Better Sets May Result

With engineers working individually and collectively to beat the problem of substitutes—and it is apparent that America is not going to lack for radio sets in 1942. Indeed, as a result of all these new components for chassis and tuned, there may be better products to offer than in the past.

Radio To-day.

Radio Engineer's Vest Pocket Book

HAVING felt the need for a multi-range test meter for some time, and due to the fact that at the present time such instruments are virtually unobtainable, I decided to experiment and see what could be achieved with a minimum of special components, while keeping the initial cost as low as possible, consistent with requirements of accuracy.

The following details of the instrument, in conjunction with the illustrations, will show that I have now a meter which compares favourably with the majority of commercial instruments manufactured to-date.

The basic meter used was the popular and well-tried 0.1 milliammeter, which gives me a sensitivity of 1,000 ohms per volt on voltage ranges, this being sufficiently suitable for measuring screen volts, etc. Incidentally, the meter internal resistance was 100 ohms. The switches used need a certain amount of explanation; these are of the Yaxley type, and originally were wave-change switches, but have been modified as follows: the selector switch consists of two “wafers” coupled together, each of which is a double-pole six-way switch. The range switch consists also of two “wafers,” one of which is a double-pole six-way switch, and the other a triple-pole four-way switch. As with the selector switch, both wafers are operated by a single shaft.

Nineteen Ranges

The instrument at present has 19 ranges, six ranges each of D.C. volts and milliamps, four ranges of A.C. volts, and three ranges of ohms; actually four ranges of ohms could have been made available, but not more than three ranges incorporated were required. It will be noticed also that there are two unused positions on the selector switch; this is quite intentional, so that at a later date if I wish I may increase the number of ranges available to 31 by adding another double-pole six-way “wafer” to the range switch, and utilising these two unused positions. Another interesting point is the metal rectifier used for the A.C. voltage ranges such as those manufactured by Messrs. Westinghouse, was not available, a conventional “bridge” type rectifier was made from four “oxide” washers from a dismantled rectifier belonging to an A.C. battery eliminator, and while this has proved very successful, it is recommended that the commercial article should be employed if it can be obtained. However, for the readers to whom it may prove of interest I give particulars of this home-made rectifier.

Constructional Details

All wiring is carried out in 20 G.T.C. wire, except that associated with the ohms range, which is in 18 G. wire. The panel can be of 4in. clonite or plywood painted black, the whole meter being fitted in a wooden case measuring 8in. by 6in. and 31/2in. deep (approx.), the interior being inside dimensions. The 3-volt cells are clipped to the bottom of the box by metal clips.

The 5Ω, 9.1Ω, 29Ω and 290Ω resistors are wound on small strips of paxolin sheet approximately 1⁄8in. wide, and are suspended in the wiring by their 1⁄32in. wire ends. The shunt resistors are wound on a paxolin strip 1⁄8in. wide, and this is secured by small angle brackets clamped under the screw fastening the plate to the two switches.

Switches

Regarding the functions of the switches, it will be seen that the two common points on the top “wafer” of the selector switch are connected to the test terminals and the two common points on the bottom “wafer” to the meter terminals. This switch simply connects the test terminals and the meter into the correct part of the circuit for the particular purpose it is to be used.
The Test Meter

An Instrument for the Experimenter

thus isolating the rest of the circuit except that pertaining to the range to which it is set. The function of the range switch is, by means of the top wafer, to bring into the circuit the appropriate D.C. series or shunt resistors for the volts and milliamps range, and by the bottom wafer to bring into the circuit the A.C. series resistors on the positions T2 to T3, and the appropriate series and shunt resistors used in the ohms ranges, and by adjustment of the rheostat, which for clearness has been designated M. On the medium range, that is the 0-20,000 ohms range, the series resistor on position 23, which is of 290 Ω, is put into series with the battery, and at the same time the resistors on position X2 are shunted across the meter and zero reading is obtained when the test terminals are short-circuited by adjustment of the 2 ohm rheostat designated N.

High and Medium Ranges

On the highest range, that is the 0-200,000 ohms range, the resistors on the position Y3, that is the 2,500 Ω fixed resistor and the 1,000 Ω rheostat, are simply in series with the self-contained battery, and upon the short-circuiting of the test terminals zero reading is obtained.

Low Ohms Range

On the lowest ohms range, that is the 0-2,000 ohms range, the resistor on position T3, which is of 29 Ω, is put into series with the battery, and at the same time the resistors on position Y3 are shunted across the meter, and zero reading is obtained when the test terminals are...
short-circuited by adjustment of the .2 ohm resistor designated P. It will be seen, therefore, that the adjustment on any one range is entirely independent of the other ranges, so that once the ranges have all been adjusted the meter may be switched from any one ohms range to any of the others without further adjustment being necessary. As the medium and high ohms ranges are exactly ten and a hundred times respectively higher than the low range, it is only necessary to calibrate the low range for the low range and scale by applying a known A.C. voltage to the test terminals by ranging until a correct reading is obtained. The lowest ranges should be calibrated first, and the others in ascending order after the one.

Regarding the D.C. shunt resistors, these were all hand-made from Eureka wire, using 22 G. for the 1 amp., and 100 ma. ranges, 30 G. for the 25 ma. range, and 50 G. for the .81 D resistor. The shunt rheostats also used in conjunction with the shunt resistors marked P and N were old household rheostats re-wound with Eureka wire, using 18 G. for P, and 22 G. for N. The 25 ma. series resistor was made from 36 G. Eureka wire, as also was the .81 D resistor.

Short-wave Transmissions

Essential details are given below of a selection of the short-wave transmissions from overseas. These will enable you to check your dial settings and complete the records in the log-book.

(Continued from page III, February issue.)
Piezo-electric Crystals

An Interesting Discussion, by a Well-known Radio Engineer, About the Properties and Applications of the Piezo-electric Group of Crystals

AMONG the electrical phenomena which, not so many years ago, were considered merely as scientific curiosities, but have, since then, been found applicable to numerous useful purposes, was the peculiar fact that certain natural crystals would generate electric voltages if mechanical pressure were applied to them in certain directions and, conversely, if they were subjected to electric pressures in certain directions, they would expand or contract. These phenomena were termed "piezo-electric" and, while at first discovered they seemed of little or no value, they now form the basis of many really important pieces of radio apparatus.

One of the first developed of these piezo applications was a means for producing oscillations of accurately maintained frequency for use in radio transmission.

Maintained Oscillations

In this arrangement, grid and anode calls are used, the latter preventing the feedback.

1. A simple quartz resonator.

Fig. 1.—A simple quartz resonator.

2. The modifications necessary for a quartz controlled oscillator.

Fig. 2.—The modifications necessary for a quartz controlled oscillator.

Sharp Tuning

It will be clear that a crystal of this type, having a natural frequency of its own, has certain properties in common with a tuned circuit and, in fact, since its mechanical damping is much less than the electrical damping of ordinary electrical tuned circuits, it is still more sharply tuned. A crystal can therefore be used in place of an ordinary tuned circuit for many applications where particular sharpness is desired, both as rejector or as acceptor circuits.

Crystals have, indeed, been employed in these ways in certain types of highly selective receivers, and are also now being used for controlling self-tuning receivers, more particularly that type of set in which the tuning condenser is rotated by an electric motor which is switched off as soon as a station is accurately tuned in. Crystals used in these ways are often referred to as "crystal gaters."

There are, also, a number of other applications which are assuming more and more importance to the general listener, and these refer particularly to piezo effects at audio-frequencies.

Amplifier Applications

It so happens that crystals of a substance known as Rochelle salt are many hundred times as sensitive in their piezo-electric reactions than quartz and, moreover, they possess the very valuable property that the relation between the electric potential and the mechanical pressure is a direct or linear proportion, that is to say double the pressure produces double the voltage, or vice versa. Hence, if the pressure is applied in a piezo-effect manner, it will be clear that an alternating voltage applied to such a crystal will cause it to vibrate, and if the alternating voltage is continually applied the "forced" vibration will be maintained at the frequency of the applied voltage. But a crystal of this type, having a certain degree of mechanical elasticity and inertia, will also have a natural period of vibration of its own, and if the frequency of the applied voltage is fairly close to the natural frequency of the crystal, the free mechanical vibration of the crystal will build up to a considerable amplitude and will, in turn, produce a correspondingly large oscillating voltage across the plates between which the crystal is clamped. This oscillating voltage can again be applied between the anode and grid of a valve, and will maintain the oscillations produced in the valve and its associated circuits.

There are two main ways in which such crystal control may be applied. In the first place, the crystal may be connected in series with a coil in the grid circuit of a valve, and the first impulse given to it by means of a reaction coil in the anode circuit. Such an arrangement, shown in Fig. 1, is termed a resonator, but is not considered the best form of control since the frequency is slightly affected by the presence of the grid coil. Fig. 2 shows an improved system in which the only coupling between the anode and grid circuit is that existing via, e.g., the anode-to-grid capacity of the valve. This arrangement must form a complete master oscillator. The amount of power which such a crystal oscillator can produce is, of course, very small, and it is necessary to follow the oscillator by further amplifying valves. Moreover, it is not always possible to make crystals having natural frequencies equal to the frequencies at which it is desired to transmit, and in these cases a valve having a frequency which is a sub-multiple of the desired frequency is used, followed by one or more frequency-doubling stages.
PRACTICAL WIRELESS
March, 1942

however, the two plates are cemented in a different way so as to render the combination sensitive to mechanical vibrations and, not to pressure. A similar construction but, of course, on more powerful lines is required for loudspeakers.

For microphones and pick-ups, where it is required to maintain a very high sensitivity to sound waves, the crystal and amplifier are so arranged that the output is transmitted to the cone by a driving rod and an arrangement of levers.

The electrical characteristics of these piezo devices are particularly illuminating. For example, the response of a crystal microphone is substantially uniform at all frequencies up to about 5,000, and above that has a slightly rising characteristic. As the crystal arrangement acts, to all intents and purposes, as a condenser, any changes due to the leads between the microphone and the amplifier will not affect the frequency response, but will only reduce the effective output.

An important point to note in connection with these microphones is that no volume control must be used between them and the first amplifying valve, or there will be a loss of low notes and one of the great advantages of this type of microphone, namely its level response, will be negatived.

Piezo-electric pick-ups, by reason of their lightness and the flexibility of the crystal element, need very little mechanical damping, and so have a wide frequency response. Taking the output at 1,000 cycles as the standard of reference, the response rises slightly at lower frequencies down to 25 cycles, but is substantially uniform up to 4,000 cycles and is only about 12 decibels down at 8,000. Some greater attenuation at the two extremes of the range is obtained by reducing the total capacity due to the leads between the microphone and the recommended figure of 300,000 ohms to 100,000 ohms.

Loud-speakers

Piezo-electric speakers fall into two different types: the first, which is employed mainly for reproducing the higher notes and is therefore used in conjunction with an ordinary moving-coil speaker, which is responsible in the main for the bass and middle register; and the second type which may be employed by itself or in conjunction with a moving-coil speaker. Dealing first with the type intended merely for high-note reproduction, it must be remembered that sometimes a moving-coil speaker has a cut-off at about 4,000 cycles, and in some cases a fairly pronounced resonance near 3,000 cycles.

It is possible, however, to restrict the moving-coil speaker to the part of the audio-frequency range below about 2,000 or 3,000 cycles, and to make use of the good high-note response of the piezo type of speaker for the higher frequencies. Such a speaker is termed a "tweeter," and a simple arrangement is that shown in Fig. 3, which is the simplest way of connecting up a tweeter of the crystal type, a small variable condenser being used as a tone control, its function being to vary the input to the tweeter. A still better arrangement is that shown in Fig. 4, which has the advantage that it produces a falling characteristic in the moving-coil speaker and thus avoids the high note peak already referred to, and therefore gives a uniform response over the whole frequency range of the complete combination.

No Magnets

The larger types of crystal speaker are quite suitable to use solus, and some are available which will handle inputs up to 8 watts. They may also be used in combination with moving-coil speakers in a similar way to tweeters, and various combinations in the form of dual speakers can be secured.

One point to be noted is that, unlike the moving-coil speaker, piezo speakers have no field magnets, either permanent or energised. They are more sensitive than moving-coil speakers, and are thus of considerable advantage for use with battery sets where limited output is available. Crystal speakers used solus need an L.F. choke connected in parallel with them—suitable types are supplied by the makers of the speakers—the object of the choke being to divert the L.F. output through the speaker while affording a passage for the D.C. component.

B.I.E. Notices

MARKING his election as a vice-president of

B.I.E. Mr. McMichael addressed the Institution at the London Section meeting held on Saturday, December 13th.

Discoursing the radio profession as the practice of the youngest branch of engineering, Mr. McMichael stated:

"The necessity for the existence of a professional body devoted solely to radio and allied engineering cannot be disputed in this age of specialisation." He referred to the need for specialisation in education in order to assist in planning and affording facilities for examination in radio and allied engineering, thus securing for these classes properly qualified material for employment.

"In the interests of the industry and of the profession, serious thought must continue to be given to the education of young people—our successors. The development of the industry will require a reservoir of young people properly taught the principles of the profession they are seeking to adopt."

"In all this work I am happy and, indeed, honoured to be associated. We have enthusiastic others, and a president who has given invaluable guidance. I, as a member, appreciate the distinction of being elected a vice-president at a time when I believe the Institution is assured of rapid developments in keeping with the great progress made by the British radio industry."

Mr. J. A. Sargrove, M.Brit.I.R.E., then read a paper on "Harmonic-layer Photo-cell Applications." He began with a description of their constitution and electrical characteristics, and explained some of their industrial applications. After a reference to their frequency response, he demonstrated a cell which fed a low-frequency amplifier to reproduce the note from a boat frequency oscillator and the output from a gramo-phonograph, using a cathode ray tube as the modulated light source. The paper was well received and invited an interesting discussion. These papers will be repeated in full in the Institution's Journal.

The next Midlands Section meeting will be held at the James Watt Memorial Institute, Birmingham, on February 11th, 1943, when a paper by G. Bremner Baker, Esq., will be read on "Thermionic Frequency Control."

Non-members wishing to attend these meetings must obtain tickets from Duke Street House, Duke Street, London, W.1.
LONDON CENTRAL RADIO

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Similar to above but in metal case for mounting. Price 19/6.


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ALL WAVE (100 kc. to 30 mc. in 6 wave bands). Dial directly calibrated in frequency. No graphs required. A.C. Main drive — 100 cycle output of good wave form available, from 0 to 5 volts.

Regulated complete with TAYLOR MODEL 65 output lead. Instruction book and frequency conversion table. £14:14:0

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Phone: Gerrard 2969
Automatic Grid-bias Explained

No Doubts Should Exist About the Method or Calculations Necessary to Obtain Automatic Bias

Judging by the number of queries received, and the solutions submitted for Problem No. 427, it is obvious that there are many readers still uncertain about the methods used to obtain automatic grid-bias. The subject has been dealt with in past issues but a benefit of those new to radio, the fundamental principle and the various methods are explained below.

How is it Obtained?

According to Ohm’s Law, the direct current flowing in a circuit is equal to the voltage divided by the resistance present. This is usually written $I = \frac{E}{R}$ and can be rearranged to show that $R = \frac{E}{I}$, and provided these two simple formulas are remembered, all the snags are removed from any calculations connected with automatic grid-bias.

If a resistor is connected in a circuit through which current is flowing, a voltage drop or a difference in potential is produced across the ends of the resistor. This statement can be written $E = I \times R$, when, as in the previous formula, $E$ represents the Voltage, $I$ the current in Amperes, and $R$ the resistance in Ohms. For radio work, the amperes are too small, so we are made of the milliamperes, which is $\frac{1}{1000}$ of an ampere. In view of this, the formula has to be written $E = I \times R$, when the current is expressed in milliamperes. To prove the original statement, suppose that a resistor of 50 Ohms is connected in series with a circuit carrying a current of 10 mA, what voltage drop will be produced across the resistor?

$E = I \times R = \frac{10}{1000} \times 50 = 0.5$ volts.

Applying $E = I \times R$ we get $E = 10 \times 0.005$ which gives a figure for $E$ of 5. In other words, 5 volts would be produced across the resistor if 10 mA current is flowing.

The value of the grid-bias, and it will be seen that all the circuits described in this article depend on it for their operation.

Battery-operated Circuits

In battery-operated circuits the automatic bias arrangement is of the simplest nature, as will be seen by reference to Fig.1. On examining the diagram it must be understood that the anode current path follows a line drawn from the filament through the valve to the anode, through the H.T. battery and back again to the filament. Assuming the valve shown to be the only one in the circuit under consideration, it would not matter whether a milliammeter was connected between the anode and the positive side of the H.T. battery or between the negative side and the negative L.T. line, as in both positions the meter would indicate the anode current. If, therefore, a resistor is connected between the H.T. and L.T. negative terminals, in place of the normal direct connection, a certain voltage drop will be produced across the ends of the resistor in the manner previously explained. The polarity of this voltage will be negative, with respect to the earth line, at the end nearest the negative side of the H.T. battery. Now, the negative side of the filament is connected to the earth line; therefore, as this has been made positive with respect to the H.T. terminal of the resistor, it means that the grid of the valve is rendered negative with respect to the earth or L.T. negative line. This state of affairs is exactly the same as that produced when a grid-bias battery is used, as the positive side of the battery is connected to the common negative earth line and the grid return is taken to one of the negative sockets.

Decoupling

So far, we have assumed the current flowing in the circuit to be a pure direct current. In practice, this is not so, as it actually consists of the mean anode direct current plus an alternating current component due to the low-frequency modulation.

If the latter is allowed to reach the grid of the valve in a form of feedback will be produced which would be quite capable of setting up L.F. instability. To overcome this, a fixed condenser is connected across the resistor, its object being to provide a low impedance path to by-pass the low-frequency currents, thus leaving, so to speak, a pure direct current to flow through the resistor.

The value of the condenser is important, When
considering bias circuits feeding L.F. valves the alternating current component is of low-frequency, but, when H.F. valves have to be biased the alternating current is of high-frequency. The reactance of a condenser increases as the frequency decreases, therefore, to provide a low impedance by-pass in L.F. circuits a large condenser must be used, whilst on the H.F. side much smaller capacities can be safely employed.

With the introduction of the modern electrolytic condenser, it is quite common to use 12, 25 or 50 mfd. condensers for L.F. by-passes. On the H.F. side, values of .01 mfd. to .1 mfd. will be quite satisfactory.

**Main valves**

The fundamental circuit with mains valves depends on the same principle as for battery valves, with the exception that when obtaining automatic bias with *indirectly* heated valves, the bias resistor is inserted in the cathode lead, as it is this electrode which completes the basis circuit. The arrangement is shown in Fig. 3, the value of the resistor being calculated in the same manner as before, but in place of the total H.T. current consumption being taken as the value for I (as in the battery circuit examples) one is only concerned with the H.T. or anode current consumption of the value under consideration. If this happens to be a S.G. or P.T.O. code, then the screening-grid current must also be included.

When directly heated valves are used, a slightly different circuit is necessary, and this is shown in Fig. 4. The resistor is connected between the centre-tap of the filament winding supplying the filament of the valve, negative line, this being almost identical to the original battery method.

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Simple Relay Switch

HERE is a simple relay switch for use with extension speakers for on-off switching of the receiver. It consists of an armature in the proximity of a weak bar magnet, but at such a distance that it just does not snap across on to the magnet. If a current is now passed through a coil wound on the magnet it will be found that in one direction the magnetism is increased sufficiently to draw in the armature. When the armature is actually in contact with the magnet there is sufficient force to retain it with no current flowing. But on reversing the current the magnetism of the magnet is counteracted sufficiently to release the armature. Thus, only an instantaneous current is required; also, the actual speaker leads may be used for operating purposes.

I found a coil of about 300 turns of 24 s.w.g. enamel wire satisfactory for use with a 4.5 volt dry battery. For the low impedance extension the coil may, alternatively, be shunted across the transformer with the condenser arranged to restrict D.C. to the coil. In the high impedance circuit the choke used must be of high impedance and low D.C. resistance. The primary of a mains transformer can be used successfully.—P. A. S.
to a marked degree by reducing the capacity of this condenser. The tuning condensers marked C.3 and C.4 are for band-spread, C.3 being the tank condenser and C.4 the band-spreader. The latter is of very low capacity and serves for fine tuning after setting the larger condenser to the centre of the particular band it is wished to "search."  

Potentiometer Reaction Control

A rather unusual reaction circuit is shown in Fig. 5, and it is one which has often been found very attractive. A tetrode or pentode valve is used, and the reaction winding and reaction condenser are fixed. Reaction control is then obtained by varying the voltage applied to the screening grid. It is actually the amplification of the valve which is varied. This tends towards very smooth control, and provided that a good, "silent" potentiometer is used in position R.2 the arrangement is often better than the conventional one. One advantage that tuning is not so greatly affected by reaction variation. The fixed resistor R.4 is merely a limiter to prevent the application of too high a screening-grid voltage and to allow the full range of the potentiometer to be employed.

The last feature of this circuit is the inclusion of two fixed condensers between the heater connections of the indirectly-heated detector valve and earth, which is joined to the centre-tap of the heater winding on the mains transformer. These condensers prevent mains noise, and should be mounted as close as possible to the valve holder.

8.0. Reaction

Fig. 6 shows another reaction circuit which is worth a trial. In this case, reaction is obtained by means of C.5, which has the same value as C.3 in Fig. 5, but is variable. The reaction circuit is, however, concerned with the screening grid instead of the anode. This method also gives smooth control and is not so likely to affect tuning. In effect, it is the same as using a separate valve for reaction, since the screening grid acts as an anode so far as reaction is concerned, while the filament, control grid and anode behave as a triode detector.

Most of the refinements described are equally applicable to either mains or battery valves, and are interchangeable in the two circuits illustrated. Where component values are not indicated they are the conventional values.

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Radio Examination Papers—4

Another Selection of Questions and Suitable Answers

1.—Anode-bend Detection

The object of all systems of detection is to remove the carrier-wave frequency from the modulated wave, leaving only the audio-frequency impulses; another name for detection is de-modulation. A circuit for anode-bend detection is given in Fig. 1, from which it will be seen that the output from an H.F. amplifier is applied to a tuning circuit in the grid circuit of a triode. The triode is biased comparatively heavily, so that the working point of the valve is at the point on the anode-current/grid voltage curve at which greatest curvature takes place. This is shown in Fig. 2, where the "modulation envelope" of the carrier wave and modulation frequency applied to the grid is indicated. It will be noted that the curve representing the input has as its centre a line drawn vertically from the bias point.

On each positive half-cycle of the input the grid is made less negative and there is an increase in the flow of anode current. On each negative half-cycle there is a reduction in anode-current flow. But the reduction is comparatively small because of the flattening of the curve to the left of the working point. And since the working point is generally very close to the cut-off point, there is a tendency for anode current to flow only in a series of pulses—one for each positive half-cycle. The effect of this is shown diagrammatically toward the right of Fig. 2. It will be noted that the height of the pulses varies in such a way that a line joining the upper tips of these upward loops resembles one side of the modulation envelope representing the input.

From Fig. 1 it can be seen that there is a smoothing condenser between the anode and cathode of the valve.

TYPICAL QUESTIONS.

1.—Explain, with the aid of diagrams, anode-bend detection.

2.—Draw an outline circuit diagram of one type of valve oscillator and explain briefly how it functions.

3.—How would you determine the most suitable sequence of valve-heater connections for an A.C./D.C. receiver?

4.—If it was found that reproduction from a mains receiver was distorted and very faint, what fault would you suspect, assuming that reproduction was normal with the speaker connected to the penultimate valve and that the output valve was in good condition?

5.—Explain the action of an electronic or multiplication frequency-changer valve.

6.—What is meant by the amplification factor of a valve? A certain valve is known to have a mutual conductance of 2.5 mA/volt and an anode impedance of 8,000 ohms. Find its amplification factor.

This smooths out the current pulses, so that we have an audio-current curve as shown by a heavy line. The curve represents an audio frequency of the same form as that originally applied to the carrier wave as modulation. Current variations in the anode load of the detector produce voltage variations across the load, and these can be applied to an L.F. stage or to a pair of phones.

2.—The Valve Oscillator

The circuit of a widely-employed valve oscillator as used in transmitters is shown in Fig. 3. This particular circuit refers to the so-called Hartley oscillator, where the tuning circuit is between the anode and grid of the valve. An earth connection is taken from a tapping on the tuning coil.

When the H.T. is switched on—assuming that I.T. has already been applied—there is a surge of current through the tuning coil, around which a magnetic field is rapidly built up. The field then subsides and the tuning condenser is charged; the tuning condenser discharges through the coil, building up another field. This continues, as explained in an answer to a previous question in this series. In the ordinary way, however, the oscillation would quickly die out, but the valve provides the means of sustaining it.

Since the grid and anode are at opposite potentials at any instant—due to their being connected to opposite ends of the tuning circuit—the grid becomes negative when the anode is positive, and vice versa. Thus, as the anode swings positive, the current through the valve is reduced by virtue of the grid being made negative. And as the anode swings negative there is an increase in current through the valve due to the grid becoming positive.

Because of this repeated reversal of events the tuning or oscillatory circuit is constantly being fed with pulses which cause the oscillation to be sustained. There are various other oscillator circuits, but the underlying principle is the same in all cases. It is essential that

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the anode and grid should be 180 degrees out of phase; in other words, that one should be positive when the other is negative.

3.—Sequence of Valve Heaters

In order to prevent electrical breakdown between the cathode and heater of an indirectly-heated valve it is important that the voltage between the two should not exceed a certain figure. It is not important at the moment to know what that figure may be, for the object should be to keep it as low as possible. When the construction of a valve is considered it will be remembered that the heater and cathode are separated by only the minimum of insulating material to ensure that the maximum amount of heat is transferred from the former to the latter.

In the case of indirectly-heated valves the bias voltage is obtained by inserting a voltage-dropping resistor in series with the cathode-earth lead. This means that the cathode is raised to a positive potential in respect of earth, to which the grid is connected. To make allowance for the conditions already laid down it will be seen that a valve which is lightly biased should be toward the negative end of the series-heater chain (assuming D.C. operation), whilst a valve which is comparatively heavily biased may be nearer to the positive end of the chain.

Thus, starting from D.C. negative, the valves should be in the order: detector, H.F., I.F., rectifier. With a superhet the sequence is generally: second detector, frequency-changer, I.F., L.F., rectifier. In some cases, a heavier negative bias is applied to the L.F. than to the I.F. valves, and then the positions of the two would be reversed in the sequence just given.

4.—Poor Reproduction

Since the set operated normally with the speaker connected to the valve preceding the output stage it is clear that the speaker was not at fault, and that the next valve was not in good condition up to the second-from-the-last valve. And since the output valve was not at fault there are two main possibilities: the anode load (resistor, choke or transformer) in the anode circuit of the penultimate valve may have been open-circuited, or the output valve may not have been receiving H.T. due to a break in the cathode circuit. In the first case, the open-circuited component may have been shorted by the speaker transformer.

The second possibility is more likely, and would probably be traced to a faulty bias resistor which had become open-circuited due to a flaw in the resistor, or due to its having passed too heavy a current at some time. There was probably some continuity through the resistor, for otherwise the speaker would not have responded at all, but this may have been in the region of several thousand ohms instead of a few hundred ohms, as is generally required.

5.—Electronic Frequency-changer

Valves of the pentagrid or heptode, octode and triode-hexode types are known as electronic frequency-changers, since the "mixing" of the local-oscillator and signal frequencies takes place within the valve. Fig. 3 shows, diagrammatically, a pentagrid valve in which the cathode and two grids act as a triode oscillator, while the cathode, control grid, screening grids and anode form a tetrode. And since all current passing to the main anode must pass through the grids acting as control grid and anode of the oscillator this current is modulated at the frequency of the oscillator tuning circuit. As a result, the main electron stream is varied in intensity, first by the oscillator and then by the control grid to which the signal frequency is applied. There is thus a "multiplying" effect because the variations brought about by the oscillator are virtually multiplied by those caused by the signal voltages on the control grid. The mathematical result of this multiplication process is somewhat involved, but it will suffice to state that one of the products of multiplication is a frequency equal to the difference in frequency between that due to the oscillator and that due to the signal.

6.—Amplification Factor

Stated very briefly, the amplification factor of a valve is the ratio of the power of the grid and anode in controlling the anode current. It is known that a small change in grid voltages has the same effect on the anode current as has a large change in anode-voltage. From this it is apparent that a valve can be used as a voltage amplifier.

The amplification factor is equal to the product of the mutual conductance and the anode impedance, as can be seen from the following simple calculation.

We can take the ratio mentioned above as: 
\[
\frac{dI_a}{dV_g} \div \frac{dV_a}{dI_a}
\]

which is inverted as:
\[
\frac{dV_a}{dI_a} \div \frac{dI_a}{dV_g}
\]

Thus, starting from the expression:
\[
\frac{dV_a}{dI_a} \div \frac{dI_a}{dV_g}
\]

it is apparent that a valve can be used as a voltage amplifier.

The mathematical division can be represented as:
\[
\frac{dI_a}{dV_g} \times \frac{dV_a}{dI_a}
\]

and we can see that the first expression is mutual conductance in terms of milliamps per volt, while the second is the anode impedance of the valve (\(R_a \text{ from Ohm's Law)}

Turning to the second part of the question, it can now be seen that the answer can be found by multiplying together the two figures given. It must be remembered, however, that the current must be in amps., so we get the expression:

\[
\frac{dI_a}{dV_a} \times \frac{dV_a}{dI_a}
\]
Impressions on the Wax

Review of the Latest Gramophone Records

Parlophone

This month Richard Tauber revives two of the songs that he sang in the film "Blossom Time." The record appears in the Parlophone Odeon Series, and the songs are "Once There Lived a Lady Fair," and "The Dearest Maiden Waits For Me There," both of which are sung in English on Parlophone RO 20506. If you missed the wonderful singing in this film, now is your chance to hear at least part of it.

Orchestral music of the light type is always popular and I have no hesitation in recommending the recording by the Orchestra Massicotte of "Volga, Volga!" a waltz potpourri of famous Russian airs which has a vocal refrain sung in Russian, and "Sphinx Waltz" on Parlophone F1884. Another record which I found rather soothing is the Waltz-time Medley played by Oscar Grasso (vocal) and H. Robinson Cleave (organ) on Parlophone F1885. A number of old favourites appear on this record," Scottish Lagoon," "Parlez nous d'Amour," "I'll See You Again," "Marcheta," "Balero," and "Charmanse," Ivor Moreton and Ray Evet, those two wizards of the piano, also play a medley of popular tunes on Parlophone F6886. They are accompanied by string bass and drums.

Finally, I was rather attracted by "That Lovely Week-end," and "Shepherd Serenade," played by Gerald and his Orchestra, on Parlophone F6881, and "Taboo" and "Fufunande," played by Edmundo Ros and his Rumba Band from the Coconut Grove, London, on Parlophone F683.

Columbia

Those two famous piano duettists, Rawicz and Landauer, have made a recording this month of a Medley of Welsh Airs, introducing "Blue Bells of Scotland," "The Keel Row," "Charlie Is My Darling," "Loch Lomond," The Campbells are Coming" and "Addy Lang Syne," on Columbia DB1829. On the reverse side they give their arrangement of the famous highland patrol, "The Wee Shaggy Leg." Vocal recordings of popular songs are supplied by Bing Crosby with "My Heart Toujours," "It's a Long Way to Tipperary," and "You're in My Arms," both of which are from the film "Get a Load of This," on Columbia FF2737.

If you like records for dancing, then "Some Sunny Day," and "I Guess I'll Have to Dream the Rest," will, no doubt, appeal to you. My last selection from the new Columbia records is an old favourite, "Love Yourself in Cotton Wool," on Columbia F1874, and Celia Lipton gives her arrangement of the famous highland patrol, "My Paradise," and "My Mother Would Love You," on Decca F6848, and "Some Sunny Day," coupled with "A Sinner Kissed an Angel," on Decca F1810. Jimmy Miller sings the vocals in each case.

Singers of popular songs include Vera Lynn, accompanied by Mantouw and his Orchestra, singing "I Don't Want to Set the World on Fire," and "There's a Land of Begin Again," on Decca F6828. Adelaide Hall sings "Sand in My Shoes," and "I'm Singing My Way to Trinidad," on Decca F5347, and Donald Peers with his version of "Lights Out 'til Reveille," and "Marie平均," on Decca F1823.

A number of interesting records have also been released by Brunswick featuring several famous combinations. The Andrew Sisters have recorded "I Wish I Had a Dime," and "Why Don't We Do This More Often," on Brunswick 03255, whilst the Inkspots give one of their typical renditions of "I Don't Want to Set the World on Fire," and "Hey Doc," on Brunswick 03219.


The Rex releases include recordings of most of the tunes of the moment. Vocals are supplied by Anne Shelton with "Kiss the Boys Good-bye," and "Wrap Yourself in Cotton Wool," on Rex 10089, and Joe Pettena with "Don't Let Your Dreams Grow Old," and "An Empty Chair and Memories," on Rex 10084.

Lee Green introduces a number of popular dance tunes with his pianoforte solo "Melodies of the Month, No. 14," on Rex 10097. This medley of tunes consists of "My Sister and I," "Kiss the Boys Good-bye," "I Don't Want to Set the World on Fire," "Yours," "It Always Rains Before the Rainbow," and "Said in My Shoes."
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OVERLOADING is one of the most prevalent troubles experienced with radio receivers and L.F. amplifiers. It manifests its presence in many ways, the commonest being distorted reproduction which, unfortunately, is not always recognised by the operator.

A thermionic valve, like any other delicate controlling device, can handle a certain load or amount of work, with a greater amount will result in it registering a protest in one form or other. The remedy seems obvious; arrange matters so that the input can be within certain limits. Ignoring for the present resultant troubles experienced with radio receivers and amplifiers, it forms the best starting point.

When a given signal strength is applied to the input, it is possible for the detector valve to be overloaded. This often happens when a receiver is used close to a powerful transmitter or when the anode of the detector only receives a very low H.T. voltage. The leaky-grid type of detector is sensitive to weak signals, but it cannot handle a very great input unless a reasonable value of H.T. is applied, and if it is allowed to be overloaded most unsatisfactory results will be produced, and, unfortunately, their cause is not always understood.

Although the majority of overloading takes place in the L.F. section of a circuit, due to the use of too many L.F. stages, too high gain per stage, or the use of an output valve not capable of handling the resultant input, it is possible for the detector valve to be overloaded. This, often happens when a receiver is used close to a powerful transmitter or when the anode of the detector only receives a very low H.T. voltage.

Detector Stage

The leaky-grid type of detector is sensitive to weak signals, but it cannot handle a very great input unless a reasonable value of H.T. is applied, and if it is allowed to be overloaded most unsatisfactory results will be produced, and, unfortunately, their cause is not always understood. When dealing with this system of rectification, it should be remembered that the actual rectification can be considered as taking place between the grid and filament circuits, and that amplification is also obtained between grid and anode.

The Output Stage

Commencing at the output end of a circuit may seem like working backwards, but this is the stage which has to handle the final load, and as it is where the trouble is so often present and as the remarks apply equally well to a receiver or amplifier, it forms the best starting point.

Assuming the output valve(s) has been selected to satisfy the general specification of the circuit, i.e., voltage and current supplies, speaker, output and the pre-excitation, the position of the receiver relative to the transmitter, the efficiency of the receiving aerial and local reception conditions, then the designer has to base his calculations on some arbitrary value for the input and incorporate one of the many manual or so-called automatic systems of control. At this stage another problem arises; where, in the circuit, shall the control be introduced?

The Solution to this depends to a great extent on the type of circuit: therefore, in this article, the general forms of manual control are discussed with relations to the circuits most popular.

The Necessity to Provide Efficient Control of the Input is Stressed in this Article, Which Also Explains the Best Methods to Adopt.

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Predetector Stages

When H.F. stages precede the detector, various ways are open to the designer by which efficient control can be obtained. In certain circumstances it is necessary to protect the H.F. stage(s) from overloading, and this is a fact which is not always sufficiently understood by the amateur. The average S.G. valve cannot handle a very large input, therefore, if the circuit is being used with a powerful aerial or as an interstage transformer, it is necessary to provide some form of input control. On the other hand, such steps are essential to limit the output from the H.F. circuit to protect the detector valve, as a high signal gain from the H.F. stage would be equivalent to a very powerful signal being applied direct from the aerial to the detector as previously explained. When the tuned-grid system of coupling is used, the method shown in Fig. 4 is quite satisfactory. Instead of using a fixed coupling condenser a variable one is substituted as indicated by " C." It will be realised that this is equivalent to the variable series condenser in Fig. 3.

An alternative arrangement is that shown in Fig. 5. In this circuit, the screening-grid voltage is varied by means of the potentiometer " P." Thus allowing a certain amount of control to be obtained over the amplification of the valve. The disadvantage of this arrangement are that the potentiometer is likely to have a shorter life than the variable condenser, the operating conditions of the valve are varied and, finally, there is always the possibility of the control becoming noisy.

In circuits normally using a S.G. valve, and which suffer from overloading on certain transmissions, the best way to reduce or, in many cases, eliminate the trouble is to replace the S.G. valve with one of the variable-num-type or, better still, a variable-mu H.F. pentode. These valves have a much longer grid swing and are thus able to handle a greater input. The circuit arrangement, suitable for H.F. pentodes or S.G.s of the V.M. type, is shown in Fig. 6, where it will be seen that the detector stage, the coupling condenser can be variable. The maximum bias voltage will depend on the type of valve selected, but the value of the potentiometer in the majority of cases can be 50,000 ohms. Note that the earthy end of the coil is anchored to the common negative earth line by means of a small fixed condenser, and the resultant resistance of 500 ohms. What value resistor did he connect in parallel?

Solution to Problem No. 428.
The impedance of the choke at 20 cycles per second is 1,500 ohms, and at 1,000 c/s, 1,395,000 ohms. The 4 mfd. condenser has a reactance of 796.2 ohms at 50 c/s, and 3.98 at 10,000 c/s. The following readers successfully solved Problem No. 427, and books have been awarded for the three correct solutions opened.

Personal Paragraphs
Mr. James H. Barnes, a D.E.C. of the last war, is Lord Mayor designate of Norwich for the coming municipal year. A member of the Radio Society of Great Britain, he holds a wireless amateur transmitting licence.

G. R. Thursfield, M.I.Mech.E., who has been a director of the Igranic Electric Co., Ltd., since its inception, has now been appointed managing director of the company in succession to the late G. A. Mower.

Dr. C. C. Paterson, who established and directs the G.E.C. Research Laboratories, has joined the board of the company. He has a distinguished record of scientific achievement and a wide knowledge of radio engineering. His main personal contributions to science have been in the field of lighting and vision.
PRACTICAL WIRELESS

March, 1942

THE British Long Distance Listeners' Club is now one of the largest radio clubs in the world. It is a representative power in the sphere of practical radio and, as such, it is essential for us all to take an active part in its operation if it is to further the interests of, and stand for, the many thousands of enthusiastic amateurs whose names appear on the ever-increasing roll of membership. This can only be achieved by forming groups, and it is suggested that each town having twenty-four or more members should act in a controlling and advisory capacity and provide help, etc., in the form of, and speak for, its own Group. These Groups would have their own requirements. In close contact with them would be Headquarters, which would arrange a programme of affairs to suit their requirements. Any new station that each town having twenty-four or more members should act in an advisory capacity and provide help, etc., in the form of, and speak for, its own Group. These Groups would have their own requirements. In close contact with them would be Headquarters, which would arrange a programme of affairs to suit their requirements. Any new station.

GROUP FORMATION

The following letter which we received from Cpt. K. J. Roberts, member No. 6679, gives some facts concerning the broadcasting of sponsored programmes by the B.B.C.

"Re the article by 'Thomson' referring to the B.L.D.L.C. going on the air with sponsored programmes, I have been asked by several United States hams to find out whether or not this is true, and the reply I received from the B.B.C. may be of interest to fellow hams and S.W.L.s.

"Another point raised on behalf of U.S. hams was the fact that the B.B.C. does not verify reception reports."

"I quote the B.B.C.: 'The B.B.C. is precluded by the terms of its Charter from broadcasting programmes sponsored by commercial firms for purposes of advertisement. The B.B.C. has means of obtaining official reports on their transmissions from all parts of the world and consider the issue of verification cards as useless."

"While writing I should like to know if any fellow reader has received verification cards from the following stations: PUS, 19,970 kc/s.; PPH, 11,930 kc/s.; CR7BE, 19,988 metres; and TUG, 61, 68 metres."

"I have received QSLs from all the above for reports sent in over many months ago."

"Wishing Practical Wireless continued success."

Steady Progress

MEMBER 7085, of Romsey, Hants, describes some of his activities, and although he had some setbacks with his early constructional work, he stuck to it, and now enjoys experimental work. Here is his letter:

"I was twelve when I entered the field of radio, then relatively unexplored.

"My first set was an o-v-o medium and long wave Rx of 1922 vintage, which, when rebuilt using modern valves, gave passable results.

"I then built my first short-wave set, an o-v-o, and on this set I logged my first short-wave station DJX, valvers, one a det, receiver, and the other a det. L.F., both of which were failures. Somewhat discouraged, I returned to building o-v-o types, and as set followed set, I began to think about constructing something more powerful. Finally, I bought a Leeds Bandspread Three, which I built here. My log with this Rx is about thirty-five stations, of these I listen to about twelve regularly. Also in use are two other sets, one a medium and long wave, and an o-v-o, for use on the medium and long waves.

"Now follows a short log of stations to which I listen regularly: WRCA, WBAL, WJW, WBB, WIOI, W2NO, WGEA, WGBO, W20X, TAP, FIZ. Besides these I have logged all W's except W6 and W9."

"At present I am experimenting with a Super Tuning device which will be fitted on my one-valve."

GROUP FORMATION

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March, 1942

PRACTICAL WIRELESS

Open to Discussion

The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

Dry Cells for Battery Sets

SIR.—Having recently been unable to get my accumulator charged in time, I have used two small bell cells which are probably about three years old, and connected them in parallel. Because of this I was surprised when I found that these two cells enabled me to hear the news, although I had to "close up" to the loudspeaker. My set uses standard two-volt valves, and although the two bell cells were not connected with a large bell cell, although it may not be as good as a fully-charged cell of about 10 volts should last for many months, if the set is used continuously half the day long; or for a large set two cells in parallel.

In cases where a set is used, say, mostly to hear the news, a bell cell should last twelve months or more, and this is surely an economy in the national effort. The only point to remember is that the grid-bias voltages will probably require to be reduced. May I remind those not used to bell cells that the centre terminal is positive. The R.F. consumption will certainly not be increased by this method (but the stability will) and the valves should last longer, in any event all round.

W. T. COOKE (Exeter).

Approval

SIR.—May I state that the make-up of the new issue of Practical Wireless seems to me to be much more satisfactory arrangement, also the fact that you can keep each issue interesting during present times, when the public is not permitted to know "what is new," deserves full marks. —H. L. COOKE (Bristol).

SIR.—Congratulations on the new issue of Practical Wireless. As I have had all the issues since No. 1, I must call myself a constant reader. "Think electrically," being a formation of one of your articles has added the spur to further knowledge on most subjects connected with radio. By selecting articles from each issue I have been able to amass an interesting and valuable volume. May success attend your excellent work.

J. S. SPENCER (Chelmsford).

Approval

"The Push-button Four"

SIR.—Knowing your much stressed policy to your readers in the past of adhering strictly to tested designs, I hesitated before forwarding this suggestion to you, as it involves one of your own designs, as above.

Expensive batteries used, say, mostly to hear the news, a bell cell should last twelve months or more, and this is surely an economy in the national effort. The only point to remember is that the grid-bias voltages will probably require to be reduced. May I remind those not used to bell cells that the centre terminal is positive. The R.F. consumption will certainly not be increased by this method (but the stability will) and the valves should last longer, in any event all round.

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J. S. SPENCER (Chelmsford).

Approval

"The Push-button Four"

SIR.—Knowing your much stressed policy to your readers in the past of adhering strictly to tested designs, I hesitated before forwarding this suggestion to you, as it involves one of your own designs, as above.

I did so, however, for the following reason: With the present scarcity of components (especially valves), the building of a completely new set is something of an undertaking. Therefore most amateurs, I think, are confined mainly to the components they have to hand, or those incorporated in the set being used. With the temptation of building a new set safely negotiated, there comes the urge of getting just that "extra punch that is so desirable. —J. S. SPENCER (Chelmsford).

Saving Electricity

SIR.—With reference to your comments in the January issue on the suggested curtailment of Broadcasting in order to save electricity and coal, I am of the opinion that a greater saving could be obtained if the general public began using lower wattage...
Who is the Doyen?

SIR—I have been much interested in reading in some recent issues of Practical Wireless, under the title of 'Who is the Doyen?' some claims by various people to this title, especially the most recent one by Edward C. Deavin, who apparently started in 1908. I think I can beat that, as my experience started in 1905 when the first wireless set was fitted in H.M.S. Majestic, which was then the flagship of the Channel Fleet. I suppose I can't claim to be exactly an amateur, but in the early days I am afraid we were all amateurs. At any rate, I started my radio career then and did not leave it again until 1934, four years after retiring from H.M. Navy.

During the first few years it was practically all amateur and experimental work. From 1905 to 1908 we were using coherers, etc. In 1902 we started using magnetic detectors, and went on until about 1905 with them. In the meantime we had been trying crystals (then known as 'percolon detectors') and the audion valve. In 1905 I was using electrolytic reception incorporating platinum points and chemically pure sulphuric acid, and making my own platinum points, etc. This was extremely good reception, but was not generally accepted on account of damage which could be done by the acid being spilled. I then switched over to zincate borndite crystals, and gradually improved, using this combination until the valve became the standard receiver about 1916.

There were many trials and troubles in the early days, and many peculiar things happened, but these have no place in this letter.—G. F. Howell (Portsmouth).

Medium-wave DXing

SIR—I must congratulate you on the new enlarged issue, and I am sure everyone will agree it is well worth the extra 3d. I took advantage of the Christmas holiday to do a spot of DX logging, and I have added six new medium-wave DX stations to my list. They are: WWV, 281 m. (approx.), at R; WTC, 281 m. (approx.), at R; CBA, 282 m. (approx.), at R6; WHM, 283 m. (approx.), at R6; WAC, 283 m. (approx.), at R; WOK, 422 m. (approx.), at R5. All these were logged on New Year's morning between 12.30 a.m. and 4 a.m. Three of them were received on my 3-valve KX, which already has 31 Yankees, 5 Canadians and 2 Cuban stations to its credit. Follows the band:

As regards the B.L.D.L.C., changing its title, I do not agree. The B.L.D.L.C. is an abbreviation to be proud of. I must say that since joining the club I have made the acquaintance of many new pen pals whose advice and information have been of the utmost help. I shall be very pleased to hear from any other members interested in medium-wave DXing.—Eric Wilson (Stockport).

S.W. Stations on the Air

SIR.—In the issue for August, last year, C. A. Marshall, 2CH (Stockport), asked for the identification of a station: this is Escorial Andorra (Pyrenees), on 25.35 m.

Some readers may like to know that Manila, Philippines, in 27 m. band, gives news at 12.45 on 20… Commonwealth, Sydney, Nova Scotia, 48.94 m., is receivable as early as 20.30; it improves later when Sydney, Nova Scotia, is OK on 49 m. band. Georgetown, British Guiana, near 50 m., is a top-per cent. readable; at 22.30 it relays the B.B.C., also ZOV, Acar, Gold Coast, at 20.45 on the 49 m. band. ZNR, Aden, Arabia, broadcasts in several languages on 1476 m.; it's easily receivable in the early evening, also CO5, Havana, Cuba, 28 m. band, a little later. There is also Bangkok, on 25.6 m., with news at 13.50. "All India Radio's" news ends at 20.00, when it relays the B.B.C. on 31 m. band. Singapore has a fair signal at the bottom of the 31 m. band, also XGOY, with news at 21.00 (this is probably the XGOA (?) referred to by R. W. Iball) and 22.15 near 59 m. Johannesburgh has news at 20.05 near 50 m., but this is a poor signal. News from Vladivostok (?) U.S.S.R. on 12.45 on 26, 31 and 54 m., and 17.30 on 31, 41 and 54 m. Tokyo provides an excellent signal with news at 22.00, 48 m. band. Times G.M.T., receiver, Det. L.F. on phones (see January issue of Practical Wireless).

I think L. A. Webb for his kind help.—P. G. Rayer (Longdon).

S.W. Station WLWO

To further improve the world-wide service of the present powerful short-wave station, WLWO, James D. Shouse, Vice-President in Charge of Broadcasting, The Crosley Corporation, Cincinnati, has announced that WLWO's European Transmissions of news and features in German, Spanish, French and English is being supplemented by similar programmes in Swedish, Finnish and Italian. This added service is part of one of the most pretentious projects ever attempted by the short-wave industry.

WLWO, operating at 75,000 watts, is one of the most powerful short-wave stations in the world, and also one of the first to offer a comprehensive foreign broadcasting schedule. Until July, 1941, this station broadcast exclusively to Latin America in Spanish and Portuguese but, because of the critical European situation, additional equipment was installed for European transmission. Plying greatest emphasis on impartial, unbiased news programmes, WLWO now transmits a total of twenty news programmes daily, supplemented by programmes of music, features and information. The station operates continuously from 10.00 a.m. until midnight, each day.

At the present time, WLWO operates on the following frequencies: to Europe, 15,250 kilocycles; to Latin America, 15,550 and 12,710 kilocycles.
Replies to Queries

Untaxed H.F. Coupling

"I have constructed a two-valve S.W. receiver incorporating band-spaced tuning, but I find that on the 4mK.hertz band the tuning is not flat. I have an aerial series condenser (30 mfd.) in circuit, but this does not appear to make much difference apart from the fact that it is impossible to tune below 40 metres without it. The aerial is of the twin horizontal type, each wire being 35 feet in length, and only 40-spaced from each other by a distance of 11/8 inches. Can you advise me as to the use of a twinning choke, or, failing this, a separate condenser to tune the selectivity will be poor. We would advise the use of a two-gang untuned H.F. Coupling transmissions, as very poor selectivity would be obtained. A choke between anode of H.F. valve and its H.F. supply. Across the grid circuit of the detector valve connect another H.F.C., or a 25 Regular resistor grid condenser and fuse being joined to the grid in the usual manner. The two circuits are now coupled by means of a fixed condenser (000 mfd.), which is connected between the anode of the H.F. valve and the grid end of the detector grid choke. The efficiency of this system compared with tuned couplings is very low, and, as mentioned above, the selectivity will be poor. Could you advise the use of a twinning choke, or, failing this, a separate condenser to tune the detector grid circuit.

S.W. Tuning

"I have constructed a two-valve S.W. receiver incorporating band-spaced tuning, but I find that on the 4mK.hertz band the tuning is not flat. I have an aerial series condenser (30 mfd.) in circuit, but this does not appear to make much difference apart from the fact that it is impossible to tune below 40 metres without it. The aerial is of the twin horizontal type, each wire being 35 feet in length, and only 40-spaced from each other by a distance of 11/8 inches. Can you advise me as to the use of a twinning choke, or, failing this, a separate condenser to tune the selectivity will be poor. We would advise the use of a two-gang untuned H.F. Coupling transmissions, as very poor selectivity would be obtained. A choke between anode of H.F. valve and its H.F. supply. Across the grid circuit of the detector valve connect another H.F.C., or a 25 Regular resistor grid condenser and fuse being joined to the grid in the usual manner. The two circuits are now coupled by means of a fixed condenser (000 mfd.), which is connected between the anode of the H.F. valve and the grid end of the detector grid choke. The efficiency of this system compared with tuned couplings is very low, and, as mentioned above, the selectivity will be poor. Could you advise the use of a twinning choke, or, failing this, a separate condenser to tune the detector grid circuit.

S.T. Circuits

"I have a set known as the S.T.300, and I wish to know if you could let me have a circuit diagram or any details about it."—T. Bolton (Haltwhistle).

YES, we certainly think that the aerial has a great deal to do with the flat tuning and poor results. It is of a type not to be recommended for S.W. reception, and we would advise you to dispense with one of the horizontal wires and convert the aerial into a "inverted L" type.

Coil Data

"I am starting building a S.W. superhet, and I intend tuning the circuits with 00015 mfd. variable condensers, but I now find that I am unable to obtain them. Having some good 0005 mfd. condensers, I have removed some of the plates, leaving seven fixed and five moving. Could you give me the number of turns required to cover 12 to 54 metres, in three bands, for the aerial and oscillator coils, using 1Jx5 diameter formers?"—J. Smith (Brockley).

NO, we cannot undertake to provide constructive details for questions, in the case in question, the time and space involved to give a satisfactory reply are additional reasons why we cannot deal with the matter, therefore we would advise reference to our book, "Chokes, Coils and Transformers," where will be found much valuable data concerning such items.

Metal Rectifier-Detector

"I read in "Practical Wireless" some months ago about a receiver with a rectifier and it seemed to be a simple circuit and working without a crystal. I used, if I remember correctly, a metal rectifier, and as the idea appeals to me I should like more details concerning the actual circuit."

T. Bolton (Halshambeadie).

The method for normal reception of medium- or long-wave transmissions, as very poor selectivity would be obtained. A suitable circuit arrangement would be: Connect a high-frequency choke between anode of H.F. valve and its H.F. supply. Across the grid circuit of the detector valve connect another H.F.C., or a 25 Regular resistor grid condenser and fuse being joined to the grid in the usual manner. The two circuits are now coupled by means of a fixed condenser (000 mfd.), which is connected between the anode of the H.F. valve and the grid end of the detector grid choke. The efficiency of this system compared with tuned couplings is very low, and, as mentioned above, the selectivity will be poor. Could you advise the use of a twinning choke, or, failing this, a separate condenser to tune the detector grid circuit.

Alternative Valves

"I have an A.C. receiver, in which is used various makes of valves, two of which I now have to replace. As I have been unable to obtain the same make and types, I wish to ask if you could tell me suitable alternatives. The two valves in question are Ever-Ready A 50A, an H.F. pentode and an A 70B, an output pentode."—C. H. (Watsonstowe, N.C.2).

YES, we certainly think that the aerial has a great deal to do with the flat tuning and poor results. It is of a type not to be recommended for S.W. reception, and we would advise you to dispense with one of the horizontal wires and convert the aerial into a "inverted L" type.

Modifying Specifications

"I have one of your blueprints, and I am experiencing some little difficulty in obtaining the specified parts, in fact, it seems that it is no longer possible to obtain some of them. Can you suggest suitable alternatives, or let me know if it will be in order to use makes other than those specified?"—W. Hallings (Hastings).

NO, we cannot undertake to provide constructional details for those components, i have removed some of the plates, leaving seven fixed and five moving. Could you give me the number of turns required to cover 12 to 54 metres, in three bands, for the aerial and oscillator coils, using 1Jx5 diameter formers. —J. Smith (Brockley).

Unfortunately we are unable to provide any prints, diagrams or information on how to modify the detailed plans of the receiver described in our columns, but we would advise you to communicate with the American Gnome & Signal Co., Ltd., at Pew Hill House, Kenilworth, Warwickshire, Erdington, Birmingham, and request a copy of their booklet "The Auto-Metal Receiver" in which is used various makes of valves, two of which I now have to replace. As I have been unable to obtain the same make and types, I wish to ask if you could tell me suitable alternatives. The two valves in question are Ever-Ready A 50A, an H.F. pentode and an A 70B, an output pentode. —C. H. (Watsonstowe, N.C.2).

The Coupon on page 192 must be enclosed with every query.

REPLIES IN BRIEF

F. P. (Cambridge).—No, we have not published a blueprint of a receiver using the coils mentioned.

H. K. (Mitcham).—Yes, it will be quite in order to use a potentialmeter in the H.F. feed to control the sensitivity of the valve.

L. M. (Boscombe).—The coil is a belted coil unit, but we would advise you to connect the band-pass coil unit between the two H.F. stages.

T. H. (Glasgow).—We cannot trace the valve having the index "6."—J. B. (Swindon).—It is a matter of opinion, but we would advise you to connect the band-pass coil unit between the two H.F. stages.

G. (Bolton).—No, we cannot trace the maker or any details of the component. The coil should be satisfactory.

P. R. (Wigan).—The aerial is too long. Cut it to 60 feet, and pay more attention to its insulation. The earth lead would best be taken to the telephone pole.

F. E. (Worthing).—It would seem that the bias is too low. On no account should the valve be operated with the proper glow in presence. Variations must always be applied, otherwise the emission of the valve will be ruined.
ADVERTISEMENTS are accepted for these columns at the rate of 2s. per line or part of a line. Minimum charge 4s. All advertisements must be prepaid and addressed to Advertising Manager, Practical Wireless, 301, Temple, London, W.C.2.

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By Alfred T. Wits, A.M.I.E.E. Second, revised edition of this book includes material on valves introduced since the first edition, together with an entirely new chapter on receiving valves and circuits and additional information on the aligned grid principles, output transformers and phase splitters circuits and new information frequency changes. 1046 net.

SHORT-WAVE RADIO

By J. H. Daynes, B.Sc. (Hons.), A.C.G.E., D.I.C., etc. Deals with the developments and progress in the field of short wave radio telegraphy, giving comprehensive descriptive and practical methods of applications. 10s. 4d. net.

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PRACTICAL WIRELESS

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VALVES are in short supply. Stock of British E.F. & A.V.E., 5s. Od. each, 17s. each. First come, first served.

TELEVISION zode valves. Unboxed, large box, 3 1/2 oz. overcoat, 5s. 6d. at 30s. bat, 15s. 6d. each. A.S. 200s. Special offer of 100 new metal-cased paper condensers, 300 v. working. All brand new and unused 1 mfd. 1/4; 1 mfd., 1/9; 1 mfd., 1/5.

REPESTORS. 10 watt, 100,000 ohms. With miniature enamelled alloy resistors, 1s. 6d. each.

VOLUMES, 1 ohm, 200 ohm, 600 ohm. 1s. 3d. each, 3s. 6d. doz.

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VARIABLE CONDENSERS. 0 and 3 mfd. Doz. cast frames in first-class condition 5s. each.

VAXLEY type switches, 2-way, 1/-; 2 fad. 2/-; 2-way, 5/-.

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B. &. CONDENSERS. Brand new, first quality components, .0001 mfd., 8d.; .0006 mfd., 9d.; .001 mfd., 10d.; .005 mfd., 1/- each.

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