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 peacetime, 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. Such work necessitates 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.

It is, however, quite feasible that small meetings 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.

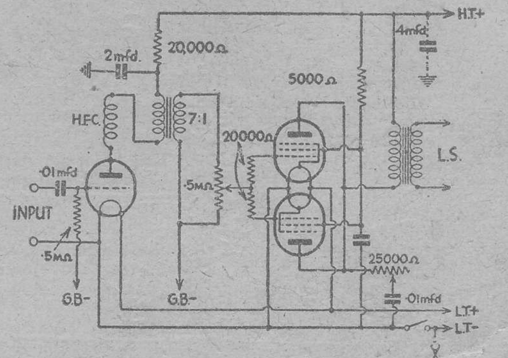

Fig. 1.—A simple two-stage amp addition o. more speakers
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should be available. eavily loaded, one of the amplifier
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voltage operator is in direct communication
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1, 2, 5, 6 microphone. Thus a warning
designed to give the high speaker to the
the minimum H.T. consumption a signal
with satisfactory quality.

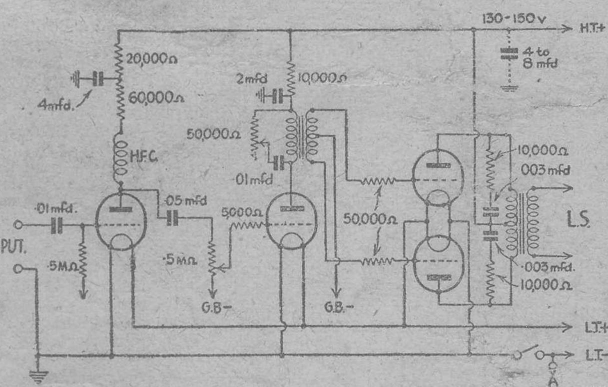


Fig. 2.—A three-stage amplifier, with mixed couplings, and a tone-controlled push-pull output stage.

Speakers

Cone speakers of the moving-iron or balanced armature types are not really suitable for P.A. work, however good they may seem for domestic purposes. In the first place, their effective area of radiation is not ideal and, secondly, it is doubtful if they would handle the output required without some form of appreciable distortion.

Horn types can be quite good, or pretty awful, so no hard and fast rule can be laid down about these. Those employing large units, such as some of the older models of S. G. Brown and Amplion, can often be utilised, as they are only expected to handle a reasonable input. These remarks apply, of course, to the diaphragm types, and not the more modern moving-coil instruments.

The chief trouble with any type of "long" horn

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 number and type 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 Det. and 2 L.F. type can be of some use if a power pentode, large "Class B," Q.P.P., or two super power valves in push-pull are used in the output stage.

With mains-operated receivers or amplifiers, a wider 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

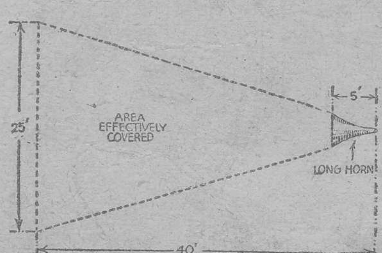


Fig. 3.—Details of the covering area of a loudspeaker.

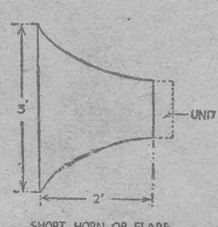


Fig. 4.—A short horn type speaker. Suitable dimensions are shown.

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 inside 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.

...ving-coil Units

...hese are divided into two classes, permanent magnet ...rised field ... one most widely used is the ... ty and lightness, and the ... t is required. ... r will do, providing it is

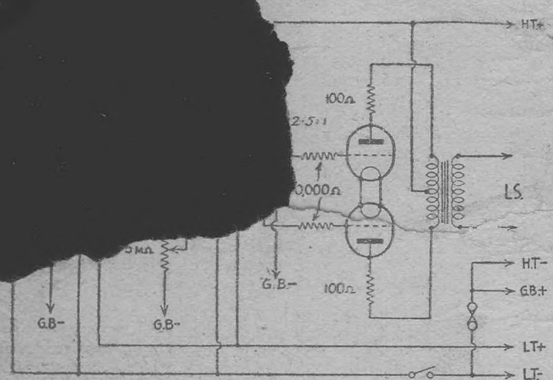


Fig. 6.—A simplified version of the circuit shown in Fig. 2.

fitted with a 7in. or 9in. 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.

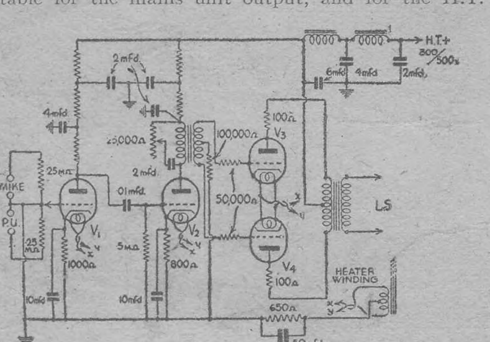


Fig. 7.—An ambitious mains amplifier with mixer input arrangement, volume and tone controls.

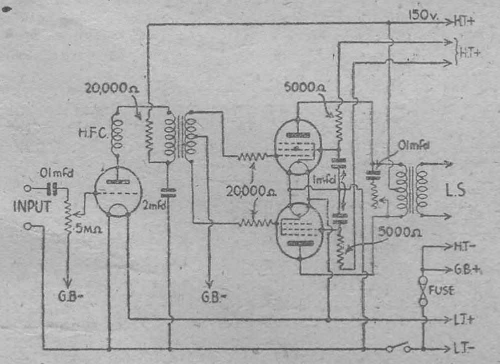


Fig. 5.—The use of two pentodes in push-pull will provide a much greater volume, and therefore this two-stage amplifier will appeal to many constructors.

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 3ft., tapering from 1ft. at the rear to 3ft. at the mouth. The horizontal

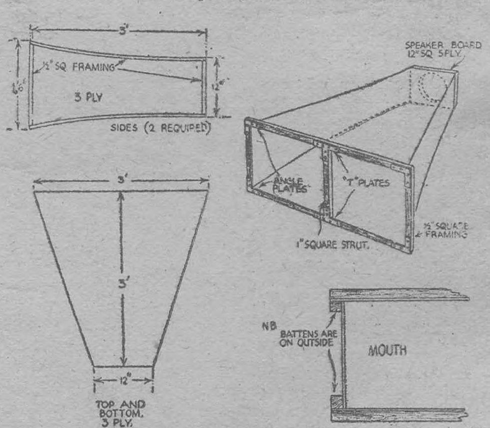


Fig. 8.—Details of construction of loudspeaker horns for open-air work.

mouth is 3ft. by 1½ft., thus giving a very reasonable coverage angle.

Two sheets of good three-ply, each 3ft. square, two sheets 3ft. by 18in., and about 25ft. of ½in. or ⅝in. square batten will be required.

Mark out and cut out the large triangular pieces from the square sheets, then cut out a sheet of paper to act as a pattern for the curved side-pieces. When these are cut out of the 3ft. by 18in. sheets, screw batten along all edges, starting at the 12in. end, and gradually bending the batten to the shape of the ply. If pine is used, no difficulty will be experienced, especially if the pieces have long grain.

Pieces of battening should now be fastened to the front and rear edges of the large triangular pieces, after which they can be screwed to the sides.

Bend the ply to meet the lines of the sides and see that all screws are driven right home. On *no account* use brads or nails.

When the four pieces are secured, square up the mouth and fit the right-angle metal brackets or plates at each corner to prevent any possible distortion of the opening. The centre 1in. square strut can then be fitted, this being held by the "T"-plates shown.

After a final clean up with sandpaper, paint can be applied, the colour being according to individual fancy, but flat black is preferable. The speaker board should be of 5-ply, having an opening to suit the speaker to be used.

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 workroom 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 communications—for "paging" 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 built in two parts, each with a power handling capacity of 750 watts.

Rack 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.

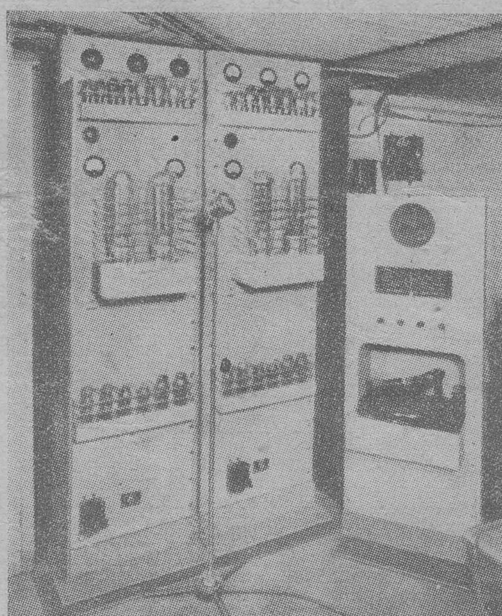
Wiring System

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.

With the exception of the speakers, the whole of this equipment is installed in a control room sunk into the ground below one of the main buildings and is manned 24 hours per day.

At all times, the operator is in direct communication with a "Jim Crow," housed in a special hut on one of 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.



The radio-gramophone panel and the 1,500-watt amplifier equipment installed in the underground control room.

NEW SERIES

Notes from an Amateur's Log-book

2CHW Tells of His Activities During the Past Month, and of the Progress Made with the Construction of His Receiving Station

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 restricted 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.

I picked up the cabinet, at a very reasonable cost, in a second-hand junk shop, and older readers will recognise it as one of the type which used to be called "American" pattern, owing, I believe, to their introduction of the long narrow panel so favoured by designers back in the 23's and 24's. It is 24ins. in length by 8ins. in height, and is fitted with a full lid, and a narrow opening runs the full length of the back to allow easy access to terminal strips or the exit of battery leads. A good clean, a little water stain and much wax and elbow grease, has transformed the very shabby article I first saw into a presentable cabinet, the appearance of which is still further enhanced by the panels I am using.

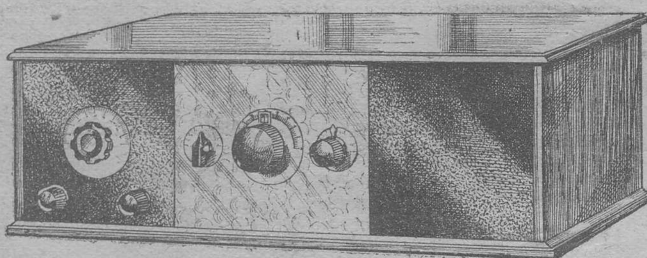


Fig. 1.—The cabinet with the H.F. unit and o-V-1 set in position. The blank panel on the right will be used for the L.F. amplifier controls, etc.

The aluminium panel of the o-V-o is 10ins. by 8ins., the latter being the height. By placing the set in the centre of the cabinet, I was left with two panel spaces each of 7ins. by 8ins., so this immediately set up thoughts of what could be made to work in conjunction with the Rx and combine with it to form a useful rig. The space on the left suggested a H.F. stage, and, after due consideration, it was decided to balance up the circuit by using the right-hand section for a two-stage L.F. amplifier, thus forming, in my opinion, the best arrangement apart from a superhet.

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 whom 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. .00015 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 coils 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 are 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.

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 mu characteristics of the valve, and it is for this that the 50,000 ohm potentiometer was required. An ordinary "straight" S.G. or H.F. pentode could be used —if components are very scarce—but some form of

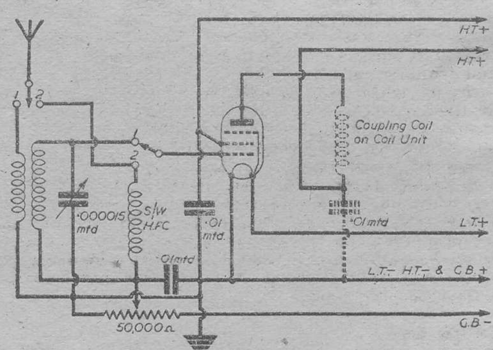


Fig. 2.—The circuit of the H.F. unit, showing the arrangement to provide a tuned or untuned aerial circuit.

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. Baseboard construction—the same as the other two sections—will be used, the panel being formed from one of the pieces of black crackle 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. Fortunately, the various windings were wound in sections side by side, so after stripping down the laminations and making a wooden block to fit inside the bobbin, it was not a difficult matter to pivot it on two nails which had been driven through two separate strips of wood. The latter were held in a vice in such a manner that the two nail points registered with the centres of the ends of the wooden block, thus allowing the complete transformer bobbin to rotate freely. The spool, by means of a twist drill fixed into its centre, was held in the chuck of a large twist drill which was used to speed up the winding or unwinding process. This may sound very Heath Robinson. Well, it was, but it was the best that could be done in the circumstances; after all, the main thing was to get the job done.

After this, the core area was measured, this was 1 by 1.33 ins. which gave a figure of 1.33 sq. ins. To determine the number of turns required for the new outputs, I divided 8 by 1.33 and this gave 6 which indicated that I should have to put on that number of turns for every volt I required in the outputs.

The two rectifiers I propose using are the H.T. 14 and the L.T. 7, both Westinghouse. The former requires an input of 80 volts and the latter 4 plus 4 volts, so the first winding consisted of 6 x 80 or 480 turns of 32 S.W.G. enamelled wire, whilst for the L.T. section 48 turns of 26 S.W.G. enamelled wire, centre-tapped, were wound on. On a no load test, the voltages are just a shade above those specified, but this will correct itself when the correct load is applied, i.e., when the rectifiers are connected. Next month, I will give the full constructional details of the complete unit, as I understand that these are now in great demand owing to the H.T. battery shortage, an item which, incidentally, has held up my listening activity a great deal.

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 rigging 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. coil 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—in 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.

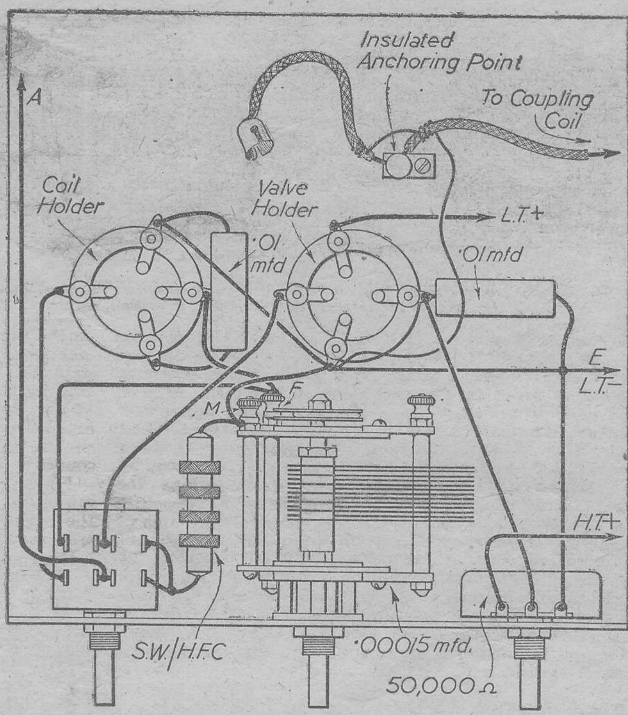


Fig. 3.—The wiring and component locating plan.

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: 39426.4 (the decimal point moved 2 places because 100=10×10).

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 .38624 by 100.

Answer: 38.624.

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 100, move the 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 .375 by 100.

Answer: .00375.

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 .235. In other words, we must find a number which when multiplied by .235 produces .95.

It is nearly always convenient to multiply the number in the divisor by some multiple of ten which will make it a whole number. Thus, in the example given, .235 x 1,000 produces 235. We must, of course, multiply the dividend also by 1,000, thus producing 950. Division is then carried out in the following way:

```
235)950.0(4.04254
    940
    ----
     10.00
      9 40
     -----
       60.0
       47 0
      -----
       1300
       1175
      -----
        125.0
         94 0
        -----  . . .
```

The same method is adopted if the divisor includes whole numbers as well as a decimal fraction. For example, divide 75.00625 by 3.125. Here we multiply the divisor by 1,000, producing 3125; multiplying the dividend also by 1,000 we obtain 75006.25. The division is then carried out in the following way:

```
3125)75006.25(24.002
     6250
     -----
     12506
     12500
     -----
         6250
         6250
         ----
         0000
         ----
```

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 .0000329, the *first significant figure* is 3, and expressed correct to one significant figure the fraction is expressed as .00003; to two significant figures .000032, and so on.

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 .000033.

Recurring, circulating or repeating decimals are denoted by a dot over the recurring figure; thus, $.30\dot{3}$ means .3033333 . . . and so on to infinity. Similarly, groups of figures in the decimal fraction may recur. Thus, $.\dot{3}\dot{9}3939$, or $.7353\dot{7}35\dot{3}$. 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 .007435 by 6.325.

```
Normal Method.          Contracted Method.
       7435                  7435
       6325                  5236
       ----                  ----
      37175                 44610
     14870                   2230:5
    22305                     148:70
   44610                       37:175
 ----------             ----------
 .047026375               047025
```

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:

```
   7435
   5236
  -----
  44610
   2230
    148
     37
  -----
.047025
```

Contracted Division

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

```
3125)31.625(.01012
     31 25
     -----
      3750
      3125
      ----
       6250
       6250
```

By observation 3 divides into 31 (the first two significant figures of the dividend) 10 times. Multiply the divisor by 10, producing 3125. Subtract this from the dividend, leaving 375. Now drop the five from the divisor, and it will be seen that 312 will divide once into the remainder 375. (If in other examples this shortened divisor divides into the remainder more than once—say 5 times—then the figure dropped is multiplied by 5 and the first figure ignored, whilst the second is carried on.) Deduct 312 from 375, leaving 63. Now drop another figure from the divisor, leaving 31, which divides twice into 63. We thus have:

```
1st division by observation  10
2nd    ,,    ,, contraction   1
3rd    ,,    ,,      ,,       2
                         ------
                         .01012
```

The position of the decimal point is, of course, fixed in the manner already explained.

The result is, of course, approximate.

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 $.5=\frac{5}{10}$, $.75=\frac{75}{100}$; $.375=\frac{375}{1,000}$ $.0375=\frac{375}{10,000}$ 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. Cancelling can then take place in the usual way. Examples:

$\frac{375}{10,000}=\frac{3}{80}$ (both numerator and denominator divided by 125).

$\frac{75}{100}=\frac{3}{4}$ (both divided by 25).

$\frac{5}{10}=\frac{1}{2}$ (both divided by 5).

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

Table of Decimal Equivalents

$\frac{1}{64}$	.015625	$\frac{25}{64}$	.390625	$\frac{45}{64}$	.703125
$\frac{1}{32}$	.03125	$\frac{13}{32}$	.40625	$\frac{23}{32}$	.71875
$\frac{3}{64}$	.046875	$\frac{27}{64}$	.421875	$\frac{47}{64}$	.734375
$\frac{1}{16}$	.0625	$\frac{7}{16}$	.4375	$\frac{3}{4}$	.7500
$\frac{5}{64}$	.078125				
$\frac{3}{32}$	.09375	$\frac{29}{64}$	.453125	$\frac{49}{64}$	.765625
$\frac{7}{64}$	.109375	$\frac{15}{32}$	.46875	$\frac{25}{32}$	.78125
$\frac{1}{8}$	.1250	$\frac{31}{64}$	.484375	$\frac{51}{64}$	.796875
		$\frac{1}{2}$	.5000	$\frac{13}{16}$	.8125
$\frac{9}{64}$	.140625				
$\frac{5}{32}$	.15625				
$\frac{11}{64}$	.171875	$\frac{33}{64}$	.515625	$\frac{53}{64}$	.828125
$\frac{3}{16}$	.1875	$\frac{17}{32}$	.53125	$\frac{27}{32}$	.84375
		$\frac{35}{64}$	.546875	$\frac{55}{64}$	.859375
$\frac{13}{64}$	.203125	$\frac{9}{16}$	.5625	$\frac{7}{8}$	.8750
$\frac{7}{32}$	.21875				
$\frac{15}{64}$	.234375				
$\frac{1}{4}$	.2500				
		$\frac{37}{64}$	.578125	$\frac{57}{64}$	.890625
$\frac{17}{64}$	.265625	$\frac{19}{32}$	.59375	$\frac{29}{32}$	.90625
$\frac{9}{32}$	.28125	$\frac{39}{64}$	.609375	$\frac{59}{64}$	.921875
$\frac{19}{64}$	.296875	$\frac{5}{8}$	.6250	$\frac{15}{16}$	.9375
$\frac{5}{16}$	.3125				
$\frac{21}{64}$	.328125	$\frac{41}{64}$	.640625	$\frac{61}{64}$	.953125
$\frac{11}{32}$	.34375	$\frac{21}{32}$	.65625	$\frac{31}{32}$	.96875
$\frac{23}{64}$	.359375	$\frac{43}{64}$	.671875	$\frac{63}{64}$	.984375
$\frac{3}{8}$	.375	$\frac{11}{16}$	.6875	1	1.0000

It should be noted that once the decimal equivalents of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, and $\frac{1}{64}$ have been memorised, it is an easy matter to find other fractional equivalents in this series. Thus for $\frac{3}{64}$ merely multiply .015625 by 3. Similarly as $\frac{1}{4}=.25$, $\frac{1}{8}=$ half of that decimal $=.125$.

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:

```
5/16 = 16)5.0(.3125        19/37 = 37)19.0(.5135 (recurring)
          48                          185
          --                          ---
          20                           50
          16                           37
          --                           --
          40                          130
          32                          111
          --                          ---
          80                          190
          80                          185
          ==                          ---
                                        5
```

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

$$\frac{4}{25}=\frac{16}{100}=.16.$$

$$\frac{23}{125}=\frac{184}{1000}=.184.$$

Converting Recurring Decimals to Fractions

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

$$\dot{.3}=\frac{3}{9}=\frac{1}{3}.$$

$\frac{1}{7}=\dot{1}4285\dot{7}\dot{1}4285\dot{7}\dot{1}4285\dot{7}$ . . . . .

$=\frac{142857}{999999}$ (one nine for every decimal place); 142857 divides or cancels into 999999 seven times $=\frac{1}{7}$.

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:

$$.6\dot{9}\dot{6} = \frac{696-6}{990} = \frac{690}{990} = \frac{23}{33}$$

$$.23\dot{7}4\dot{6} = \frac{23746-23}{99900} = \frac{23723}{99900}$$

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.

$92 + 2 = 94$; $92 - 2 = 90$.

$94 \times 90 = 8460$

2 squared $= 4 = \underline{4}$.

8464

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 1156:

```
  3 | 1156(34
    | 9
    | --
 64 | 256
    | 256
```

Find the square root of 54756

```
   2 | 54756(234
     | 4
     | -
  43 | 147
     | 129
     | ---
 464 | 1856
     | 1856
```

Find the square root of 39.476089:

```
     6 | 39.476089(6.283
       | 36
       | --
   122 | 347
       | 244
       | ---
  1248 | 10360
       |  9984
       | -----
 12563 |  37689
       |  37689
       | -----
       |  .....
```

(To be continued.)

Notes and News

Mr. Graham Leigh Porter, one of the senior engineers of Ferranti, Ltd., died recently after a long illness. Born in 1883 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, Merz and McLellan. In 1927 he joined Ferranti, Ltd.

* * * *

Mr. E. H. Welding, 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 .0001 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 .0003 mfd. pre-set 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.

Boy in training with the R.C.O.S. operates a pack wireless equipment in the field.

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 from the primary of the speaker transformer. This calls for a well-insulated extension line as the full H.T. voltage is applied to it, and the two wires should be well spaced to avoid capacity losses affecting the high notes. Moreover, the extension speaker or speakers must be provided with suitable matching transformers. The extension circuit shown in Fig. 2 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 speaker should be of the low impedance type. Capacity losses are negligible and twin cable can therefore be used, but it should be of substantial section to avoid ohmic losses.

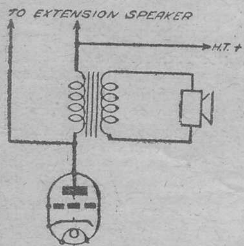


Fig. 1.—Taking the extension speaker lines from the primary of the speaker transformer.

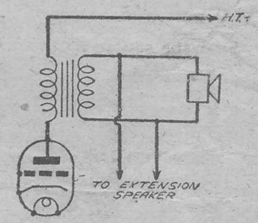


Fig. 2.—An alternative arrangement to that shown in Fig. 1.

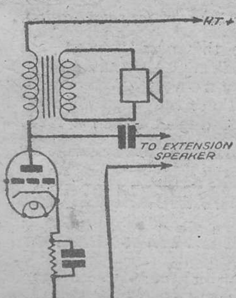


Fig. 3.—Using the speaker transformer primary as a choke.

Undoubtedly a better plan is that indicated at Fig. 3, where the primary winding of the output transformer is used as a low-frequency choke, and the extension circuit is taken through a 2 or 4 mfd. condenser. The H.T. voltage is isolated from the line, but spaced wires should be used to avoid capacity effects, and a speaker of high impedance or one fitted with a transformer must be used. A single-wire extension with earth return may be employed with this system, as 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.

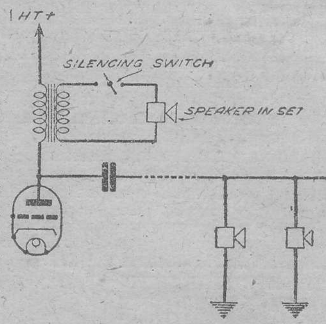


Fig. 4.—Using an earth return, showing the position of the silencing switch.

Remote Control

Although the arrangements indicated certainly permit extension 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 retune 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 electro-magnets, one of which opens the relay contacts when energised, the armature being latched in the "off" position by the armature of the second magnet. When, however, the second magnet is energised, 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 Arm" unit. A push-button and volume control is provided on each W.B. 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

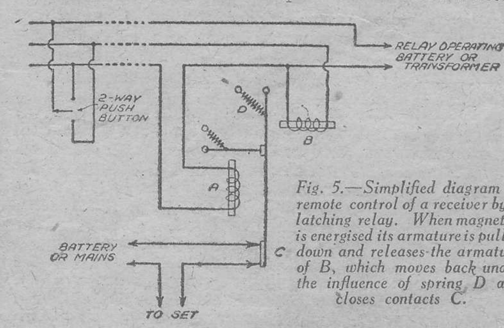


Fig. 5.—Simplified diagram of remote control of a receiver by a latching relay. When magnet A is energised its armature is pulled down and releases the armature of B, which moves back under the influence of spring D and closes contacts C.

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 or speakers, to which is attached a three-core cable, one lead of which feeds one side of speaker input, one which is a common lead to the 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 23/36s 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

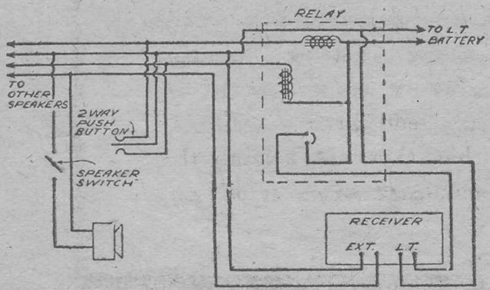


Fig. 6.—Connection for remote control of battery set using four wires only.

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 ingenious locating cam. When the relay is operated again the hinged 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 cam and 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

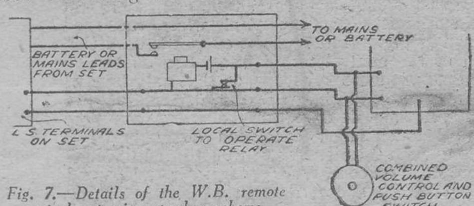


Fig. 7.—Details of the W.B. remote control extension speaker scheme.

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 mechanism.

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 as an adjunct to the fixed receiver may solve the extension problem in many instances. There are also mains transportables with frame aerials, and many other mains sets have mains aerial connections which permit of transportability 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 subsidiary receiver or receivers to be connected 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, the main receiver may be operated from the outdoor 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 earth 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. In addition to conferring the benefit of being able to plug a receiver into a socket in any room, this scheme has the further advantage that, if the aerial proper is erected outdoors and outside the field of electrical interferences, the lead-covered transmission line will not pick up any interference on the way to the receivers, and man-made static of 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 one system, each, of course, through its own transformer.

Although the communal aerial system is more expensive to install, it gives individual local control of listening—a very important matter in the case of separate and distinct flats when different families have different ideas as to what they wish to hear. The home

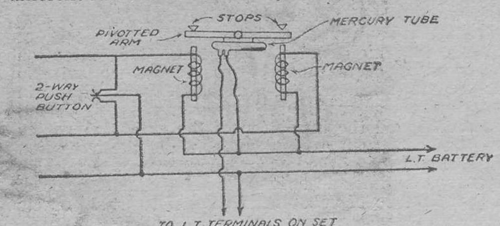
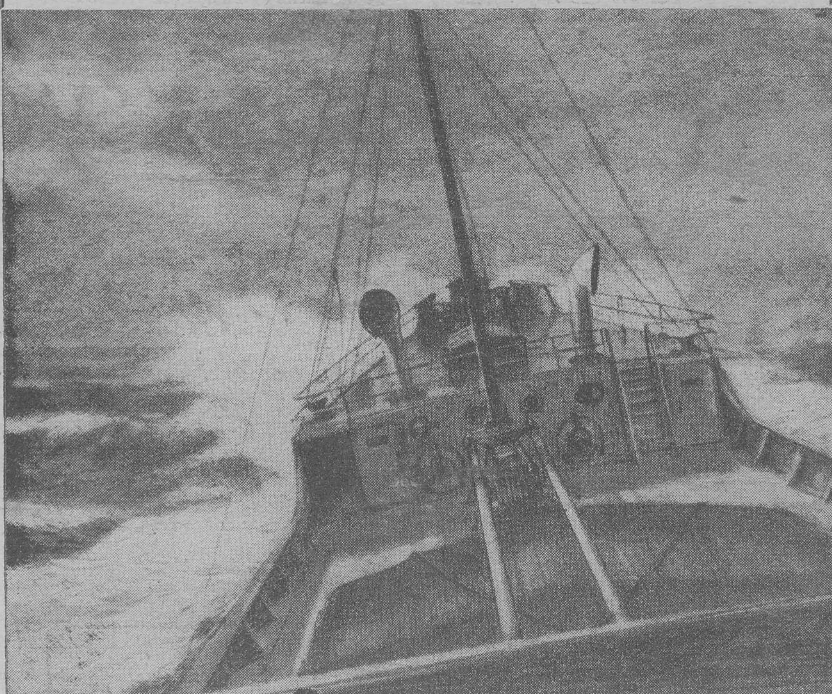


Fig. 8.—Basic scheme for mercury switch relay for remote control.

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.



Negative Feedback Amplifiers

A Simple Explanation of the Principles Involved and Some Practical Circuits

By FRANK PRESTON

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 anode circuit to the grid circuit of an L.F. or power amplifier. This is done in the case of a

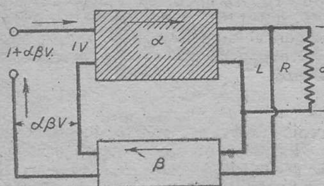


Fig. 1.—Diagram to explain degeneration. The upper, shaded, "box" represents the amplifier, and the lower "box" the feedback circuit.

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 the 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.

If this 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 appreciably better reproduction simply by incorporating negative feedback. This is not an excuse for making a poor amplifier and then improving it by adding degeneration, but it does mean that a "quality" amplifier can be made more cheaply by adopting degeneration than by almost any other means.

It must always be remembered that negative feedback does, essentially, reduce the amplification, or gain, and the output, and therefore it may be necessary to fit an extra valve in order to obtain the same maximum volume level as that provided before applying degeneration.

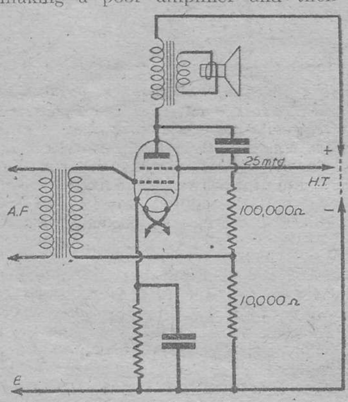


Fig. 3.—Voltage feedback, where a fraction of the output voltage is fed back to the grid circuit.

Underlying Principles

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 diagram 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 α volts (the Greek letter alpha as used here is a convention, and any other letter could be used). If it is also assumed that the gain or amplification of the amplifier is α times, it will be evident that in order to develop the output stated, the input should be 1 volt. 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 1 volt must be applied to the amplifier in order to give our "standard" output of α volts.

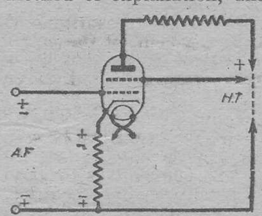


Fig. 2.—Series negative feedback. This consists merely of removing the by-pass condenser, normally wired in parallel with the cathode bias resistor.

The position is somewhat different when negative feedback is applied, and we can consider that our "negative feedback attenuator" has an amplification of β 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 α volts, the output must be α times β 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 give 1 volt input to the amplifier

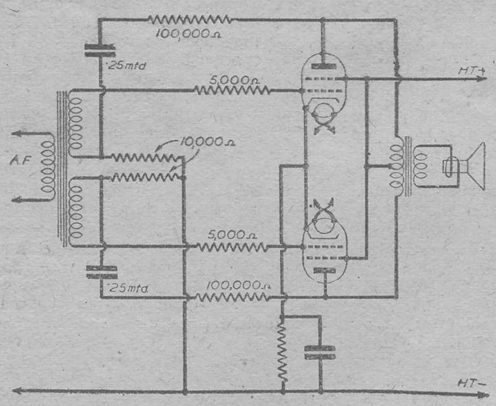


Fig. 4.—A voltage feedback circuit applied to a push-pull amplifier.

itself must be $1+\alpha\beta$ 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 α, and it can now be seen that the gain when applying negative feedback is α divided by $1+\alpha\beta$—since for the same output a greater input is required. If $\alpha\beta$ is appreciably greater than unity, as it is in practice, the gain with negative feedback is equal to $1/\beta$. And as β remains constant the overall gain must remain constant irrespective of the amplifier characteristics.

A Worked Example

A simple arithmetic example will demonstrate this.

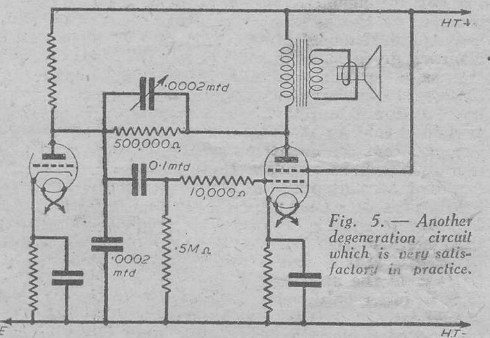


Fig. 5.—Another degeneration circuit which is very satisfactory in practice.

Suppose the gain of an amplifier without negative feedback is 5,000 times and that 10 per cent. of the output is fed back as negative feedback; find the gain in the latter case. Using the simple formula devised above, we can see that the gain is $\frac{5,000}{1+500}$; β is 1/10 and α is 5,000. When this is worked out the answer can be seen to be almost precisely 10. Now suppose that at a different audio-frequency the gain of the amplifier falls to 3,000 times. The overall amplification, with negative feedback, then becomes $\frac{3,000}{1+300}$ which again is almost exactly 10. 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-lead 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 an increased 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 tetrode or pentode 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 experiment; 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 desirable 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 .5-megohm resistor is joined between the anode of the output valve and the anode of the valve preceding it. The variable or pre-set condenser in parallel with the feedback resistor serves as a form of tone control; "treble cut-off" is emphasised by increasing the capacity of this condenser. This arrangement is a very convenient and effective one, and can easily be tried on any amplifier of the general type illustrated. For experimental purposes the fixed resistor shown as having a value of .5 megohm may be replaced by a variable component of 1 megohm maximum value.

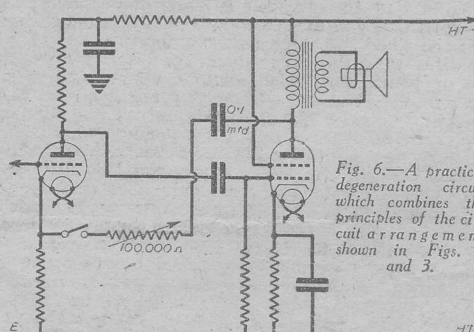


Fig. 6.—A practical degeneration circuit which combines the principles of the circuit arrangement shown in Figs. 2 and 3.

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

A Motor-controlled Device, Incorporating an Audible Indicating Arrangement

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 energised 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.

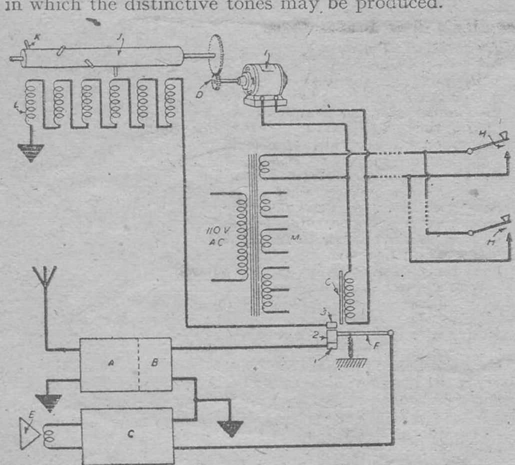
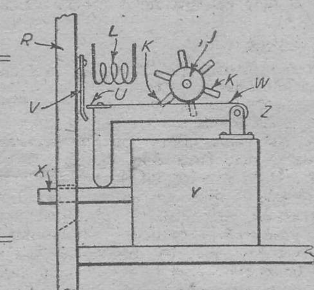


Fig. 1.—A schematic circuit diagram of the remote control system using a motor-driven cam.

In Fig. 1 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, one low voltage winding of which drives motor I and actuates the electro-magnet G 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

Fig. 2.—One method in which distinctive tones may be produced. The cams K are arranged to depress the receiver tuning buttons, and also pluck the musical reeds, as shown.



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 R is the front panel of the radio receiver. Y is the tuning unit, and X is one of the levers that is depressed for tuning purposes. J is the cam cylinder containing 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.

ON YOUR WAVELENGTH

By THERMION

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 in 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. Crooners, jazz-band leaders, musicians in general, poets, announcers, and many 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 unequivocably 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 those 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 800 words, and I assert with all the emphasis which cold print can lend that Joad is talking through his hat. I do not think that he has made any nvestigation into the subject, and was merely hazarding a guess. Yet his statement goes forth to all the 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 at their leisure the number of words in it of which they knew the meaning. Duly the dictionaries came back to me. I was not surprised to discover that each of my six friends had vocabularies of well over 5,000 words. It is my opinion that the average individual (male) over 20 years of age has a vocabulary of at least 3,000 words. The average individual under 20 has a vocabulary of 2,000 words. The female over 20 has a vocabulary of 2,000 words, and the female under 20 about 1,500. When Joad spoke of the average individual I did not understand what he meant. Obviously the age of the person will affect the extent of his vocabulary, and also it is well known that a female has a smaller vocabulary than a man, even as it is equally well known that women cannot spell so well as men. I cannot too strongly deprecate 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, and I hereby issue a challenge to Joad and Huxley to prove that there is such an individual.

I checked my own vocabulary with the Oxford dictionary and spent some time on it. I must confess that my vocabulary is somewhat exceptional, in that 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 inane on the question asked 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 professors in their particular sphere of philosophy can answer questions straight off concerning Socrates or Aristotle. Technical questions 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 Scottish 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 hardy 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

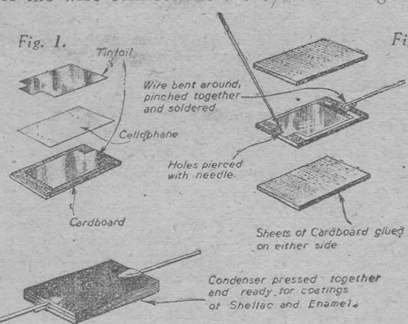
GOOD lad, Thermion!
An "Opposition shop,"
Competing with the B.B.C.
Will quickly put a stop
To a most mistaken complex,
That the "Brains Trust" are "the goods,"
Appointed by the gods themselves,
To teach we brainless duds!
P'raps we ain't got "heducation,"
And possess no high degree,
But Fate has made us realists,
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;
And that much of what professors spout
Is very largely spoof!
So we welcome "opposition"—
Let the "Brains Trust" take a rest,
For we know at "Thermion's Ltd."
Experience is the test.
Not simply theorising,
He'll answer me and you—
Unless by practice first he's proved,
The answer is—CAN DO!

"TORCH."

Practical Hints

Wire-end Condensers.

I HAVE devised the following method for constructing small wire-end condensers from thin cardboard, tinfoil and Cellophane. The thin cardboard used 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 cut out and a piece of tinfoil is glued to it. A piece of Cellophane and another sheet of tinfoil are 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 tags and cardboard with a needle, 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 pinched together firmly and carefully with pliers, so that the wire bites into the tinfoil and the cardboard. If a soldering-iron is available with a very small bit, a blob of solder can be placed to help fix together the tinfoil and wire, otherwise the joint is best left alone. 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 enamel 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, if constructed properly.—G. ELLIOTT (Gillingham).



An efficient method of making small wire-end condensers.

THAT DODGE OF YOURS!

Every Reader of "PRACTICAL WIRELESS" must have originated some little dodge which would interest other readers. Why not pass it on to us? We pay £1-10-0 for the best hint submitted, and for every other item published on this page we will pay half-a-guinea. Turn that idea of yours to account by sending it in to us addressed to the Editor, "PRACTICAL WIRELESS," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Put your name and address on every item. Please note that every notion sent in must be *original*. Mark envelopes "Practical Hints." DO NOT enclose Queries with your hints.

SPECIAL NOTICE

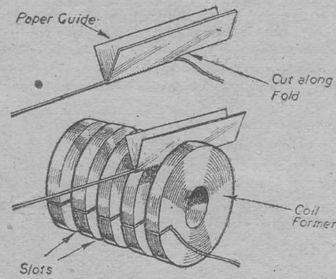
All hints must be accompanied by the coupon cut from page 192.

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 (Chelmsford).



When winding chokes this dodge will be found useful.

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 uses of this simple unit are as follows:

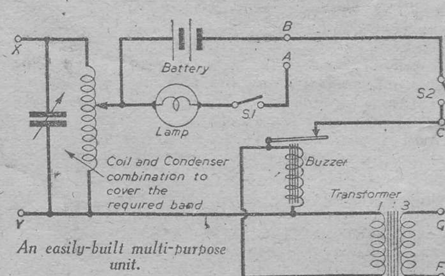
(1) H.F. Wavemeter.—Close S.2 and open S.1. It must now be used as an ordinary buzzer wavemeter.

(2) A.F. Oscillator.—Close S.2 and open S.1. An A.F. signal will be generated across terminals G and F.

(3) Continuity Testing.—Open S.2 and close S.1. Connect test prods across A and B.

(4) Morse Practice.—Open *both* switches. Join the morse key across B and C, and the 'phones across G and F.

(5) Crystal Set.—Open both switches. Join a crystal and 'phones in series. Join the crystal to X and the 'phones to Y. Join the aerial to X and the earth to Y. The unit now functions as a crystal set.



An easily-built multi-purpose unit.

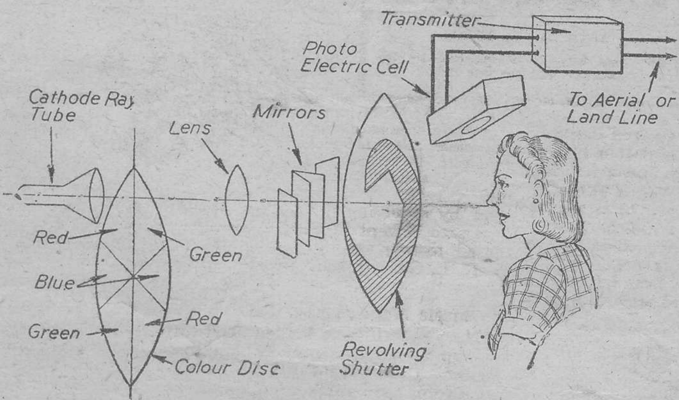
The components required are: A buzzer; a coil and a condenser to cover the required waveband; an A.F. 3:1 transformer; two switches; a battery; a lamp or a galvanometer; 7 terminals; 1 crocodile clip to connect the battery + to the coil; wire.

The actual unit was built up on a 7in. by 10½in. baseboard with a panel the same size.—T. PERKINS (Edmonton).

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 add colour or stereoscopic relief. Such experiments were, however, actually made by Mr. Baird as far back as 1928, when he showed television in colour to the British Association. A little later he followed this by an experimental demonstration of monochrome television in stereoscopic relief.



Schematic diagram of a colour television transmitter.

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 12ft. 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.

The first experiment was applied to his 600 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 150 sec., the scanning altered to a field of 100 lines interlaced five times to give a 500-line picture, successive 100-line frames being coloured green, red and blue. 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

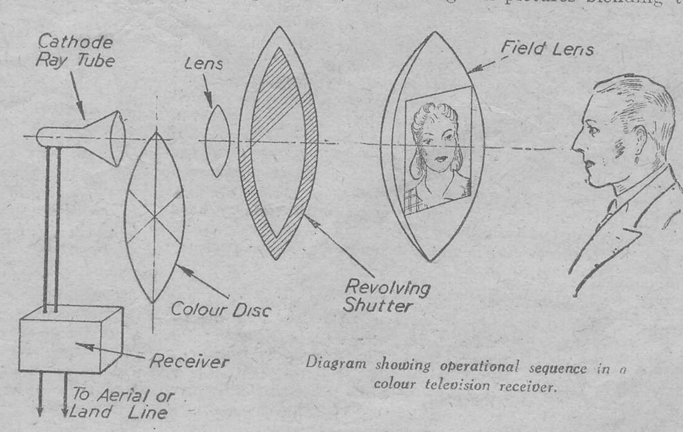


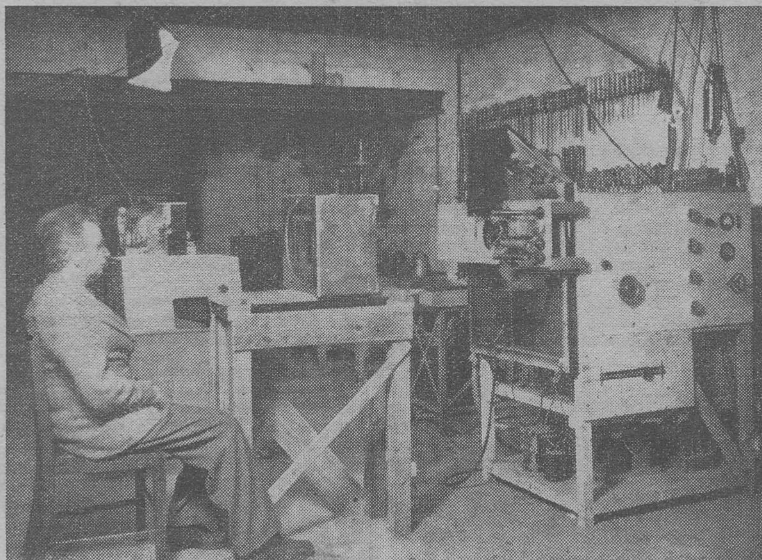
Diagram showing operational sequence in a colour television receiver.

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.



Mr. J. L. Baird in his workshop "looking-in" at his colour television receiver.

Morse-sending Machine

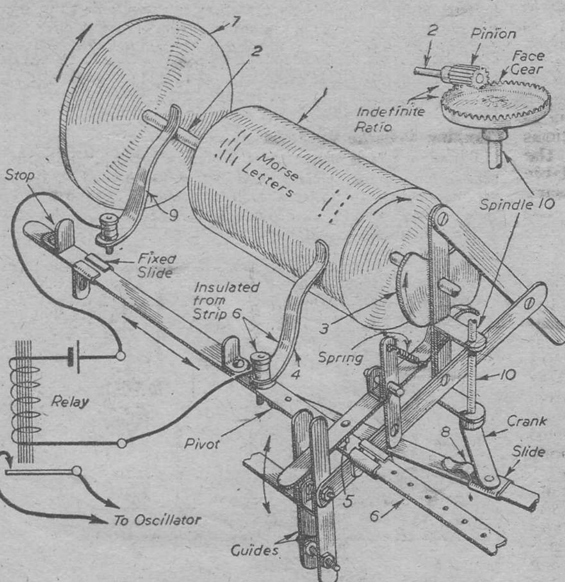
The Following Short Description of a Simple Morse-sending Machine Should Prove Interesting to Readers Studying the Subject

THE surface of the cardboard drum 1 should be divided into four segments; two opposite segments should be left clear, and two should have thirteen Morse letters on each. The Morse letters should be made by 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 gramophone, 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.



General arrangement of an ingenious Morse-sending machine.

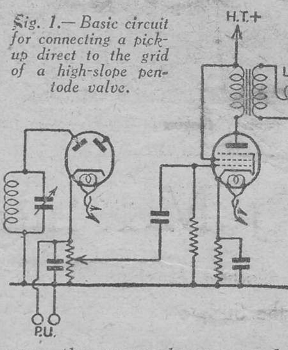
Using a Pick-up With Modern Receivers

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 is well known, and in the case of the simplest sets it is usually sufficient to shunt the pick-up 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 these pages from time to time.

Developments in receiver design have rendered it necessary to modify the pick-up arrangements 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 although 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 silencing the radio-frequency and intermediate frequency section 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.

Fig. 1.—Basic circuit for connecting a pick-up direct to the grid of a high-slope pentode valve.



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) give their normal output for a grid input which can be supplied direct from the pick-up. There are instances, therefore, where the pick-up may be switched direct 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 superhets employing a diode detector. Fig. 1 shows this arrangement.

The more general use of a diode detector presents further problems in connection with the feeding of the pick-up output into the receiver circuit, as it sometimes happens that the pick-up voltage available is not sufficient fully 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 pick-up may be connected to the grid circuit of the first low-frequency amplifier with a simple change-over 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 manual 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 this control, and steps similar to those already described taken to prevent radio break-through.

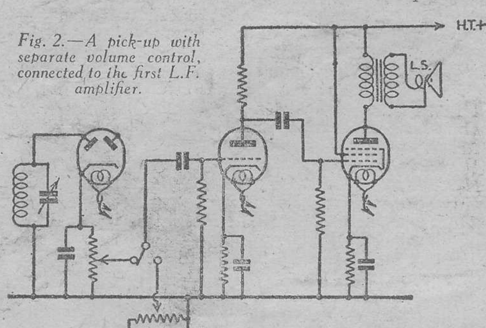
Special Cases

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 amplifying portion of the double-diode-triode valve, it may be employed as 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 gramophone, but it may fail to fulfil the other function 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

Fig. 2.—A pick-up with separate volume control, connected to the first L.F. amplifier.



found usually in straight T.R.F. sets employing an amplifying detector. In order to avoid the complication of two volume controls on the panel, the gramophone volume control may conveniently be ganged with the radio volume control, unless it is incorporated with the gramophone tone-arm or mounted on the motor board.

The other case where separate gramophone and radio volume control may be required is when the pick-up manufacturer recommends a total resistance for the volume control which is much smaller than that used for the normal radio volume control. In some cases, however, this difficulty may be overcome by shunting the pick-up by a resistance equal to that recommended for the volume control, and connecting the whole in parallel with the radio low-frequency volume control as suggested in Fig. 3.

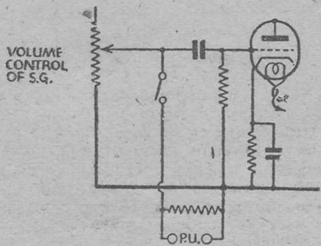


Fig. 3.—Method of avoiding two volume controls when a low-resistance volume control is required for a pick-up. The pick-up is shunted by a resistance to reduce effective load into which the pick-up feeds.

A Modern Method

Possibly the most interesting of the problems connected with gramophone pick-up switching is that which arises when the diode is followed immediately by the output valve, and yet an additional stage of low-frequency amplification is required for gramophone reproduction. In a number of cases the intermediate-frequency amplifying valve can be pressed into service, the pick-up voltage being applied to its grid, and the connections of the valve altered by suitable switching to permit the valve to act as a low-frequency pentode amplifier, resistance-capacity coupled to the output valve.

A very ingenious adaptation of the idea has been used in some of this season's commercial models. It consists of using the intermediate-frequency valve, which is a variable-mu screened pentode, for amplifying the pick-up voltage, but the pentode characteristic of the valve is not employed. Instead, the valve is made to function as a triode amplifier, its auxiliary grid or screen being used as the anode, and the radio-frequency and intermediate-frequency signal circuits being rendered inoperative by disconnecting the aerial and frequency-changer anode, shorting the frequency-changer control grid, and increasing the negative bias to the frequency-changer.

The basic circuit for this arrangement, in so far as the intermediate-frequency valve connections are concerned, is indicated in Fig. 4. It will be observed that the essential switching is comparatively simple, and consists of one single-pole switch and one single-pole two-way switch, which may, and should, be ganged together. Switch A, in the "radio" position, short-circuits the gramophone pick-up, but when moved to the "gramo" position removes the short circuit, leaving the pick-up connected between the I.F. valve grid and the earth line on the earth side of the A.V.C. by-pass condenser. It is now necessary to note the action of switch B. When this is in the "radio" position, the auxiliary grid of the I.F. valve is connected to the H.T. positive line via two resistances in parallel, R_1 and R_2, of which R_1 is comparatively small, and is the normal value for providing the correct screen voltage when the valve is used as the intermediate-frequency amplifier and is by-passed to earth via the condenser C_2, while R_2 is a high resistance of about 100,000 ohms. When switch B is moved to the "gramo" position, R_1 and C_2 are disconnected from the auxiliary grid, but R_2 remains in circuit and functions as

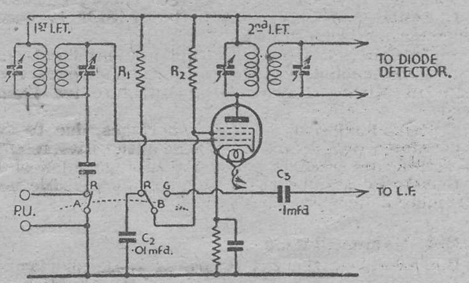


Fig. 4.—Method of using I.F. pentode as L.F. triode amplifier for gramophone reproduction.

the anode load of a triode; that is to say, the low-frequency amplifying valve consists of the cathode of the I.F. valve, its control grid, and its auxiliary grid acting as anode. A connection from the auxiliary grid via the condenser C_3 transfers the audio-frequency voltage developed across R_2 to the normal low-frequency volume control of the receiver, and from the slider of this component the signal is applied to the control grid of the output valve.

"THE OLD TOWN HALL"

"BEATING the Band" is now a national sport that is raising large sums of money for innumerable win-the-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 Keyes has already collected 12,000 pennies 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 camp and factories, men and women join in this money-raising game.

The Mayor of Greenwich recently received £3 7s. od. for his Spitfire Fund from a three-year-old boy named D. Moore, who had collected this sum in pennies on his toy drum.

A listener in Essex has collected 828 pennies 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 her 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 to-day which has to implore people *not* to send it money. Clay Keyes, who with his wife Gladys, is responsible for the show, is obliged to keep on reminding listeners that any money they raise 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 conductorette. 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!

For, with existing shortages of aluminium, nickel, steel, copper and plastics due to the Defence programme, a remarkable lot of 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!

Aluminium, nickel, steel, copper and plastics are the materials from restrictions on which radio is chiefly suffering—and in the order named.

Such shortages are due to three primary causes:

1. Actual shortages in the material itself, because of diversions to Defence uses.

2. Bottlenecks in production plants and shortages in fabricating machinery because of use of such plant equipment in other processes of manufacture for Defence needs.

3. Psychological or "scare" shortages, due to over-demands, by official and non-official authorities, resulting in setting up great hoards, and storage piles of raw materials for munitions far beyond any possible needs for many months to come.

R.M.A. Material Bureau

But whatever the *causes* are of these shortages in radio's key materials, the *realities* of the situation soon become apparent in the dwindling supplies on hand in factory stockrooms. And so radio engineers have got busy, looking for new materials to use, materials not involved in the Priorities situation. This flexibility of mind of the engineers in charge of radio design and manufacture has been one of the saving factors in the present difficult situation, which might have floored an older, more conservative industry. But radio engineers are mostly young or middle-aged men who have already witnessed such rapid changes in the art that they keep open minds for even the most radical substitutions.

An expert industry organisation for the study of radio materials and substitutes has recently been set up by R.M.A. in its Material Bureau. This has been launched under the direction of the R.M.A. Engineering Department, of which Dr. W. R. G. Baker is chairman, and has the co-operation of the principal engineers of the radio industry and of specialists in all fields bearing on radio materials. Two avenues of approach to the Material Bureau's problem were pointed out by Dr. Baker in his opening announcement: One, the more efficient use of normal material that may be available; the other, substitution of materials, with precautions against new shortages. Standardisation of types is involved in both divisions of the Material Bureau's work.

Material for Chassis

For example, with steel limited for chassis, radio engineers are now studying such substances as porcelain and metallised paper for chassis use. Porcelain, covered with a conducting sheet, would make a pretty heavy chassis, it is true. But porcelain is free of priority restrictions, and as one engineer remarked "There are unlimited tons of yellow dirt over in New Jersey which may some day become home radio receivers!"

Metal-coated paper fibre is also being studied, as coated by a new metallising process 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-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 stators 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 for midget 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 heretofore employed for formaldehyde manufacture has had to be diverted to explosive-making. Result, 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 mica particles and a stone-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 "substitutes for substitutes"—it is apparent that America is not going to lack for radio sets in 1942. Indeed, as a result of all these new components the radio industry and trade may have better products to offer than in the past.—*Radio To-day.*

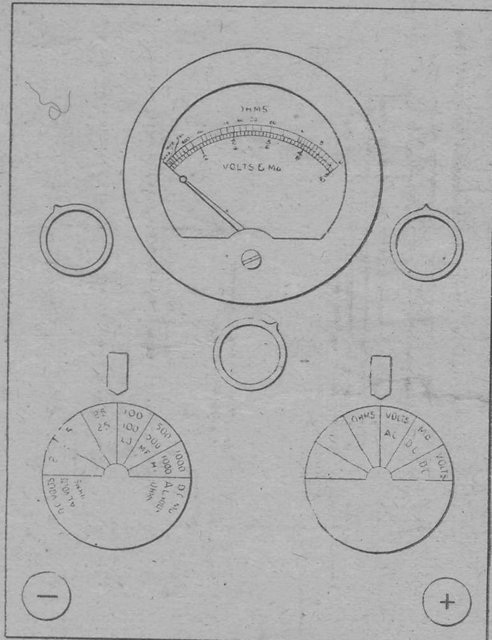
A Multi-ran

Constructional Details of a Se

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-day.

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 eminently 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-



Panel layout of the multi-range test meter.

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 the 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. Due to the fact that a standard 1 mA pattern meter rectifier,

such as those manufactured by Messrs. Westinghou was not available, a conventional "bridge" ty rectifier was made from four "oxide" washers from dismantled rectifier belonging to an A.C. batte eliminator, and while this has proved very successf it is recommended that the commercial article should employed if it can be obtained. However, for th readers to whom it may prove of interest I give partic lars of this home-made rectifier.

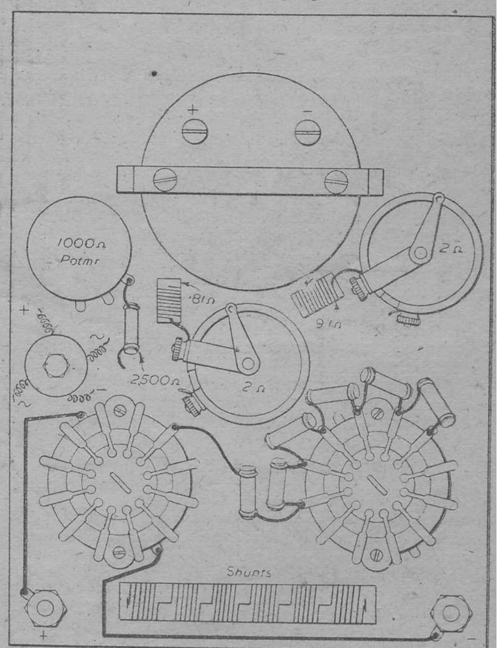
Constructional Details

All wiring is carried out in 20 G.T.C. wire, except th associated with the ohms range, which is in 18 G. wi The panel can be of ¼in. ebonite or plywood paint black, the whole meter being fitted in a wooden ca measuring 8in. by 6in. and 5in. deep (approx.), the being inside dimensions. The 3-volt cells are clipp to the bottom of the box by metal clips.

The .81 Ω, 9.1 Ω, 29 Ω and 290 Ω resistors are wou on small strips of paxolin sheet approximately ¾i wide, and are suspended in the wiring by their 18 wire ends. The shunt resistors are wound on a paxol strip 1¼in. wide, and this is secured by small angl brackets clamped under the screw fastening the wafe to the two switches.

Switches

Regarding the functions of the switches, it will seen that the two common points on the top "wafer of the selector switch are connected to the test terminal and the two common points on the bottom wafer the meter terminals. This switch simply connects th test terminals and the meter into the correct part the circuit for the particular purpose it is to be use



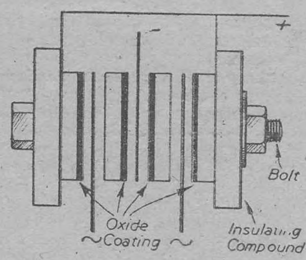
Rear view of panel showing how the meter and controls are locate

e Test Meter

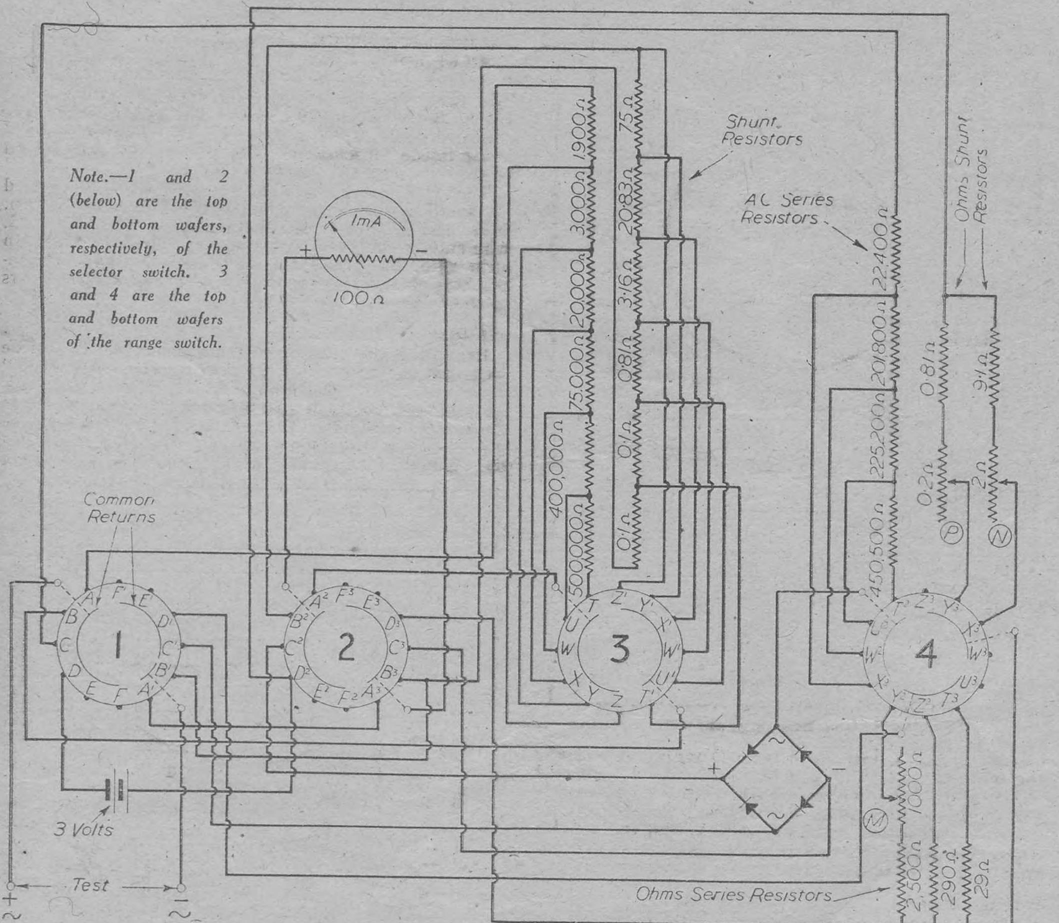
able Instrument for the Experimenter

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 T^2 to X^2, 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 Z^2, which is of 290 Ω, is put into series with the battery, and at the same time the resistors on position X^3 are shunted across the meter and zero



Constructional details of rectifier.



Wiring diagram of the Test Meter, the two multi-contact switches being shown in their independent sections.

which are connected on the Z^3 to T^3 and the Y^2 and Z^2 positions. With regard to the ohms ranges there are one or two points which may need further explanation.

High and Medium Ranges

On the highest range, that is the 0-200,000 ohms range, the resistors on the position Y^2, 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

reading is obtained when the test terminals are short-circuited by adjustment of the 2 ohm rheostat designated N.

Low Ohms Range

On the lowest ohms range, that is the 0-2,000 ohms range, the resistor on position T^3, which is of 29 Ω, is put into series with the battery, and at the same time the resistors on position Y^3 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 meter for the low range and multiply the scale by either ten or a hundred according to whether the meter is used on the medium or high ohms ranges. With further reference to the low ohms range it may be of interest to state that, due to the open nature of the meter scale on the lower resistances, if a 30-ohm resistance is tested, a reading is given on the exact centre of the scale, so that on this range the meter is very suitable for testing very small resistances such as switch contacts. It should be noted that, regarding these ohms ranges, the 3-volt battery should be capable of withstanding a maximum current drain of 100 milliamps which occurs on the lowest range without any appreciable voltage drop, and for the best results it is recommended that two 800-type batteries be used in parallel.

DETAILS OF SWITCH CONNECTIONS AND RANGES

SELECTOR SWITCH

D.C. Volts ... A, A^1, A^2, A^3 *are "made" to their appropriate commons.*

D.C. Ma. ... B, B^1, B^2, B^3 *are "made" to their appropriate commons.*

A.C. Volts ... C, C^1, C^2, C^3 *are "made" to their appropriate commons.*

Ohms ... D, D^1, D^2, D^3 *are "made" to their appropriate commons.*

RANGE SWITCH

POSITION

	T	U	W	X	Y	Z
D.C. Volts ...	1,000	500	100	25	5	2
D.C. Ma. ...	1,000	500	100	25	5	2
A.C. Volts ...	1,000	500	250	25	—	—
	T^3				Y^2	Z^2
Ohms ...	2,000				200,000	20,000

Selector Switch A^2 *is immediately below* A.
Range Switch T^2 *is immediately below* T.

D.C. Resistors

The series resistors on the D.C. voltage ranges were the normal type with ± 2 per cent. tolerance, which are quite easy to obtain. On the A.C. voltage ranges, however, it will be seen that the series resistors are not standard sizes, and it is quite easy to use carbon resistances slightly smaller in value than actually required, and then these are calibrated after connecting them in circuit and applying a known A.C. voltage to the test terminals by filing until a correct reading is obtained. The lowest range should be calibrated first, and the others in ascending order one after the other.

Regarding the D.C. shunt resistors, these were all hand-made from Eureka wire, using 22 G. for the 1 amp, and 500 ma. ranges, 30 G. for the 100 ma. range, 36 G. for the 25 ma. range, and 40 G. for other two lowest ranges. The shunt resistors on the ohms ranges were made also of Eureka wire, 36 G. being used for the 9.1 Ω fixed resistor, and 30 G. for the .81 Ω resistor. The shunt rheostats also used in conjunction with the shunt resistors marked P and N were old filament rheostats re-wound with Eureka wire, using 18 G. for P, and 22 G. for N. The 29 Ω series resistor on the ohms ranges was made from 36 G. Eureka wire, as also was the 290 Ω 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 111, February issue.)

Station	Call Sign	Mc/s	Metres	kW.
20-24-Metre Band (12.240-14.717 Mc/s)				
Moscow (U.S.S.R.)	—	12.240	24.51	20–100
Quito (Ecuador)	HCJB	12.460	24.08	—
Rabat (Morocco)	CNR	12.831	23.38	—
Moscow (U.S.S.R.) ..	—	13.210	22.71	20–100
Moscow (U.S.S.R.) ..	—	13.770	21.79	20–100
Geneva (Switzerland) ..	HBJ	14.538	20.63	20
Bandoeng (Dutch E. Indies)	PLJ	14.630	20.51	1.5
Moscow (U.S.S.R.) ..	RKI	14.717	20.38	20–100
25-Metre Band (11.700-11.900 Mc/s)				
Panama City	HP5A	11.700	25.64	2
Motala (Sweden)	SBP	11.705	25.63	12
Cincinnati (U.S.A.) ..	WLWO	11.710	25.62	75
Moscow (U.S.S.R.) ..	—	11.710	25.62	20–100
Winnipeg (Canada) ..	CJRX	11.720	25.60	2
Boston (U.S.A.)	WRUL	11.730	25.58	50
Buenos Aires (Argentina)	LRA3	11.730	25.58	10
Vatican City	HVJ	11.740	25.55	25
Guatemala City	TGWA	11.760	25.51	10
Lyndhurst (Australia) ..	VLR8	11.760	25.51	2
Moscow (U.S.S.R.) ..	RNE	11.766	25.50	20–100
Hsinking (Manchukuo) ..	MTCY	11.775	25.48	20
Saigon (French Indo-China)	FZR	11.780	25.47	12
Boston (U.S.A.)	WRUL	11.790	25.45	50
Tokio (Japan)	JZJ	11.800	25.42	50
Buenos Aires (Argentina)	CXA8	11.820	25.38	5
Moscow (U.S.S.R.) ..	—	11.830	25.36	20–100
Delhi (India)	VUD4	11.830	25.36	10
Wayne (U.S.A.)	WCBX	11.830	25.36	10
Perth (Australia)	VLW3	11.830	25.36	—
Lisbon (Portugal)	CSW5	11.840	25.34	10
Lyndhurst (Australia) ..	VLR7	11.840	25.34	2
Shanghai (China)	XMHA	11.853	25.31	—
Rio de Janeiro (Brazil) ..	PRF5	11.855	25.31	—
Hull (U.S.A.)	WBOS	11.870	25.27	50
Sydney (Australia) ..	VLQ2	11.870	25.27	—
25-Metre Band—*(continued).*				
Sydney (Australia) ..	VLQ7	11.880	25.25	—
Bound Brook (U.S.A.) ..	WNBI	11.890	25.23	25
Moscow (U.S.S.R.) ..	RNE	11.900	25.21	20–100
Chungking (China) ..	XGOY	11.900	25.21	35
Moscow (U.S.S.R.) ..	—	11.910	25.19	20–100
Rabat (Morocco)	—	11.940	25.13	—
Brazzaville (Fr. Eq. Africa)	FZI	11.970	25.06	—
Moscow (U.S.S.R.) ..	RNE	12.000	25.00	20–100
31-Metre Band (9.500-9.700 Mc/s)				
Moscow (U.S.S.R.) ..	—	9.500	31.58	20–100
Chungking (China) ..	XGOY	9.500	31.58	35
Bangkok (Thailand) ..	HS8PJ	9.500	31.58	10
Mexico City	XEWW	9.503	31.57	10
British Oversea Service ..	GSB	9.510	31.55	10–100
Moscow (U.S.S.R.) ..	RW96	9.520	31.51	20–100
Pretoria (South Africa) ..	ZRG	9.523	31.50	5
Hong Kong (China) ..	ZBW3	9.525	31.49	2.5
Schenectady (U.S.A.) ..	WGEO	9.530	31.48	100
Moscow (U.S.S.R.) ..	—	9.530	31.48	20–100
Treasure Island (U.S.A.) ..	KGEI	9.530	31.48	20
Calcutta (India)	VUC2	9.530	31.48	10
Tokio (Japan)	JZI	9.535	31.46	50
Motala (Sweden)	SBU	9.535	31.46	12
Suva (Fiji)	VPD2	9.535	31.46	—
Hsinking (Manchukuo) ..	MTCY	9.545	31.43	20
Moscow (U.S.S.R.) ..	—	9.550	31.41	20–100
Vatican City	HVJ	9.550	31.41	25
Bombay (India)	VUB2	9.550	31.41	10
Bandoeng (Dutch E. Indies)	YDB	9.550	31.41	1.5
Perth (Australia)	VLW2	9.560	31.38	—
Lima (Peru)	OAX4T	9.562	31.38	15
Hull (U.S.A.)	WBOS	9.570	31.35	50
Madras (India)	VUM2	9.570	31.35	10
Montevideo (Uruguay) ..	CXA2	9.570	31.35	5

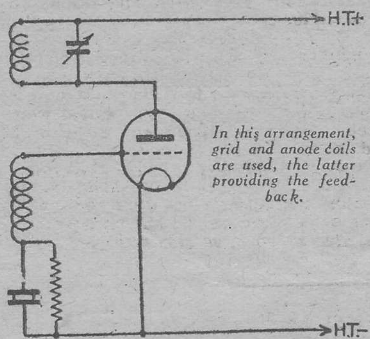
(To be continued.)

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 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 when 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.



In this arrangement, grid and anode coils are used, the latter providing the feed-back.

Fig. 1.—A simple quartz resonator.

Maintained Oscillations

The principle of the crystal control of frequency is not difficult to understand. A quartz crystal, specially cut to have certain frequency characteristics, is employed. From what has already been said it will be clear that an alternating voltage applied to such a crystal will cause it to vibrate, and if the alternating voltage were continually applied the "forced" vibration would 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 then be applied between the cathode 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 the anode-to-grid capacity of the valve. This arrangement forms 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.

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.

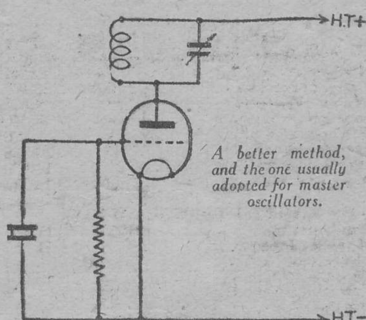
Crystals have, indeed, been employed in these ways in certain types of highly selective receivers, and are also now being used for controlling self-tuning receivers, more particularly that type of set in which the tuning condenser is rotated by an electric motor which is switched off as soon as a station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

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*

Those who have studied the question of amplifier design will know that perfectly linear response is essential to undistorted amplification, and although in this connection it is the linear response of one circuit with respect to changes in another circuit that is required, it is obvious, considering that the electrical transmission and reproduction of sound means the changing of mechanical pressures into electrical pressures and back again, that these properties of the Rochelle salt crystal might be of very great importance.



A better method, and the one usually adopted for master oscillators.

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

And, in point of fact, they are, for suitably designed Rochelle salt crystals form the basis of particularly high fidelity apparatus, including piezo-electric microphones and piezo-electric gramophone pick-ups. Similar crystal units are also used for loudspeakers of special type.

Construction

For microphones the crystals are cut to very thin plates only a few thousandths of an inch in thickness, and in many types two such plates are cemented together in order to render them sensitive to the pressure variations of speech and music, but insensitive to mechanical vibrations. For gramophone pick-ups, 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 generate an electrical pressure, the crystal is firmly secured, and the necessary connections are fitted at the points of support. For speakers, however, the plates, which are assembled as two-ply or four-ply units, are so secured that one corner is free, and the movement at this point 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 6,000, and above that has a slightly rising characteristic. As the crystal arrangement acts, to all intents and purposes, as a condenser, any capacity 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 4,500 cycles and is only about 11 decibels down at 8,000. Some greater attenuation at the two extremes of the range is obtained by reducing the total resistance of the volume control from the recommended figure of 500,000 ohms to 100,000 ohms.

Loud-speakers

Piezo-electric speakers fall into two different types; the first, which is intended mainly for reproducing the higher notes and is therefore used in conjunction with

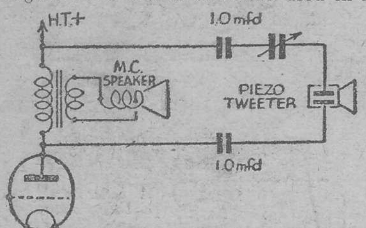


Fig. 3.—The simplest circuit for a crystal tweeter with tone control.

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 top-note reproduction, it must be remembered that sometimes a moving-coil speaker has a cut-off at about 4,500 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 under normal conditions has a reasonably uniform response between 1,500 and 12,000 cycles. Fig. 3 shows 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 6 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

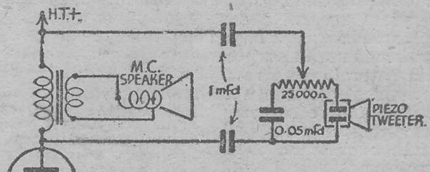


Fig. 4.—A better method of tone control for a moving-coil and crystal-tweeter combination.

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.R.E. Notices

MARKING his election as a vice-president of the Brit.I.R.E., Mr. McMichael addressed members of the Institution at the London Section meeting held on Saturday, December 13th.

Describing 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 the profession 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 officers, 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."

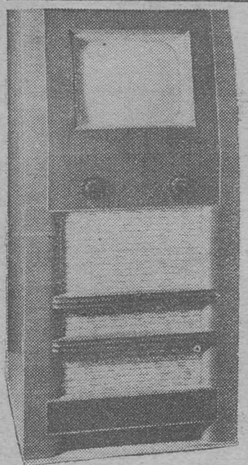
Mr. J. A. Sargrove, M.Brit.I.R.E., then read a paper on "Barrier-layer Photo-cell Applications."

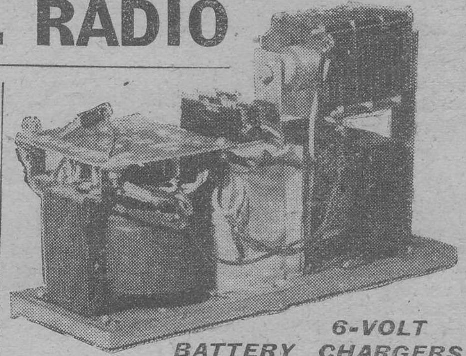
He began with a description of their construction and electrical characteristics, and explained some of their industrial applications. After a reference to their frequency response, he demonstrated a cell which fed a low-frequency amplifier to reproduce the note from a beat frequency oscillation and the output from a gramophone, using a cathode ray tube as the modulated light source. The paper was well received and evoked 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 27th, 1942, when a paper by G. Bernard 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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Automatic Grid-bias Explained

No Doubts Should Exist About the Method or Calculations Necessary to Obtain Automatic Bias After Reading This Explanatory Article

By L. O. SPARKS

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 as the majority of these are now out of print, and for the 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 $I=\frac{E}{R}$, this can be rearranged to show that $R=\frac{E}{I}$, and provided these two simple formulæ are remembered, all the snags are removed from any calculations connected with automatic grid-bias.

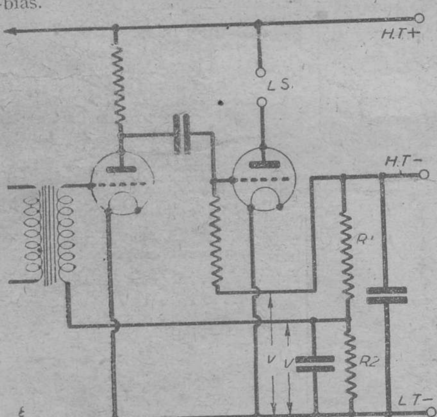


Fig. 2.—When two values of bias are required the resistor can be tapped at a suitable point to provide the lower value.

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 formulæ, E represents the Voltage, I the current in Amperes, and R the resistance in Ohms. For radio work, the ampere is too large, as the currents in such circuits are so small, so use is made of the *milliampere*, which is 1-1,000th of an ampere. In view of this, the formula has to be written $E=\frac{I\times R}{1,000}$ *when* the current is expressed in *milliamps*. To prove the original statement, suppose that a resistor of 500 ohms is connected in series with a circuit carrying a current of 10 mA's, what voltage drop will be produced across the resistor? Applying $E=\frac{I\times R}{1,000}$ we get $E=\frac{10\times 500}{1,000}$, which gives a figure for E of 5. In other words, 5 volts would be dropped by the resistor in the current conditions mentioned. It is obvious from this example that the amount of voltage drop produced in a circuit will depend on the *value* of the *resistor* and the *current*.

The above effect forms the basic principle of automatic grid-bias, and it will be seen that all the circuits described in this article depend on it for their operation.

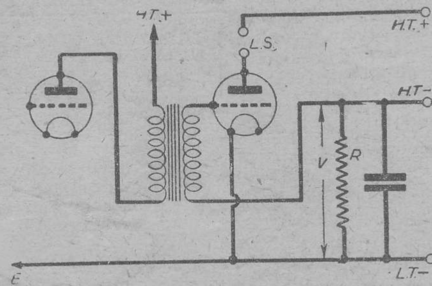


Fig. 1.—The basic circuit for automatic bias, the voltage drop V being produced across the resistor R.

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 milliameter 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 R 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. negative* side 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.

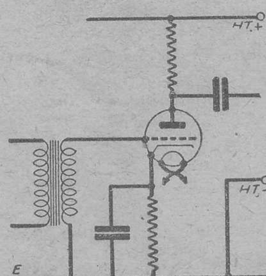


Fig. 3.—With an indirectly heated mains valve, a resistor is inserted in the cathode circuit.

If the latter is allowed to reach the grid of the valve, a form of feed-back 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.

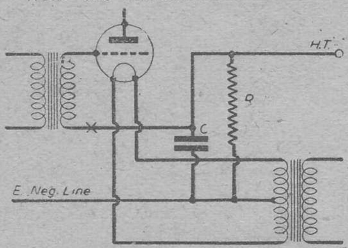


Fig. 4.—Directly heated mains valves use this arrangement. Note its similarity to Fig. 1. A decoupling resistor is sometimes inserted at X.

Tapped Bias Resistor

It is sometimes necessary to provide more than one value of bias for a battery circuit, and this can be achieved by using the method shown in Fig. 2.

Assume that two bias voltages are required, one of 6 volts and the other of $1\frac{1}{2}$ volts. It is necessary to know the *total* H.T. current consumption of the whole set; we will take this to be, say, 12 mA's.

For the 6-volt bias we get $E=\frac{I \times R}{1,000}=6=\frac{12 \times R}{1,000}$, or to find R we rearrange the formula to that shown in the first part of this article, namely, $R=\frac{6 \times 1,000}{12}$, remembering that we are using milliamps. The result is, R=500 ohms.

The resistor R, therefore, must equal that amount, but we also have to provide a bias of $1\frac{1}{2}$ volts, so applying the same formula we find that for that value we want a resistor of 125 ohms. This could be obtained by tapping the resistor R at a suitable point, but as this is not usually satisfactory, it is better to use two resistors. We have seen above that one of them must be 125 ohms and that the *total* resistance must be 500 ohms, so if we take 125 from 500, that will give us the value of the second resistor. This means that R.2 will be 125 ohms and R.1 375 ohms, the two together making our original 500 ohms.

Each resistor must be provided with its own by-pass condenser, as indicated on the diagram.

If a circuit called for a variable bias, then that could be supplied by using a suitable value potentiometer in place of the fixed resistor.

Mains 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 current 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 *valve under consideration*. If this happens to be a S.G. or pentode, then the screening-grid current must also be included.

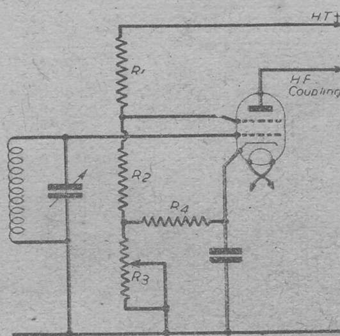


Fig. 5.—This circuit is widely used for H.F. valves, of the indirectly heated type, to provide variable bias for var. mu control.

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, and the H.T. negative line, this being almost identical to the original battery method.

T. and C. Radio College

New Radio and Mathematical Courses

THE Technical and Commercial Radio College, 29, Market Place, Reading (Principal, R. Heath Bradley), announce a new and revised series of courses intended for anyone connected with radio, television, or electrical work, especially those undergoing Army or R.A.F. radio training.

There are seven courses altogether, which are classified as follows: General Mathematics, Mathematics and Radio Calculations, Wireless Mechanics Course, Radio Mechanics Course, Radiolocation, Technical and Servicing Course, and Complete Radio, Television and Mathematics Course.

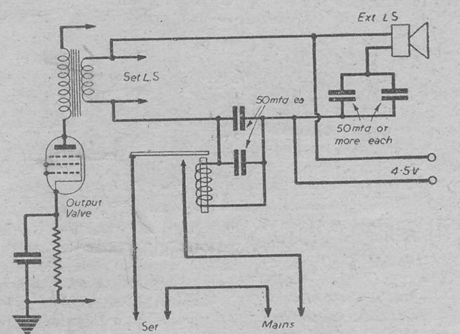
The Wireless Mechanics Course is specially intended for men who wish to pass the R.A.F. Trade Test for service as Wireless or Radio Mechanics. The Technical and Servicing Course should appeal to those wishing to become efficient service engineers, with a view to securing full-time or part-time employment, or starting their own business.

All the subjects covered by the new courses are dealt with very thoroughly; for instance, the lesson on Radio Calculations embraces: Applications of Ohm's Law; voltage dropping and automatic bias; wattage rating; potential dividers; variable-mu valve voltages; resistances in series and parallel; the mathematics of Alternating Current; simplified trigonometry, powers and roots; vector diagrams; sine curves; root-mean-square values; angular velocity; phase angle; reactance; impedance; resonance; condensers and inductances in series and parallel; filter circuits; decoupling and smoothing; loudspeaker matching; resistance-capacity coupling values; miscellaneous calculations.

The fees for any of the courses can be made by one cash payment, or by instalments, and all interested readers should write to the above address for further details of the courses.

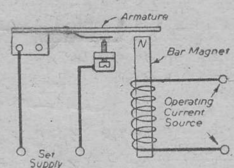
Simple Relay Switch

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



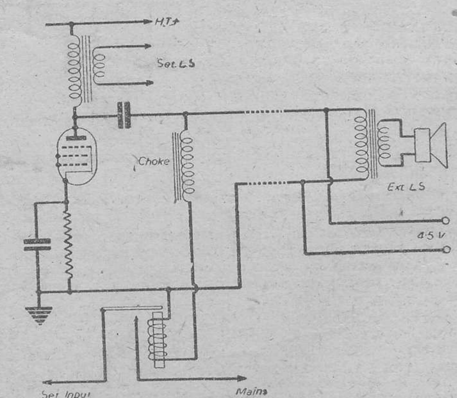
Circuit diagram of the low impedance extension.

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.



Details of armature and bar magnet.

I found a coil of about 300 turns of 24 s.w.g. enamelled 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 condensers 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.



Circuit diagram for a high impedance extension for relay switching.

177/78 missing

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 is that tuning is not so greatly affected by reaction variation. The fixed resistor R.1 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.

S.G. Reaction

Fig. 6 shows another reaction circuit which is worth a trial. In this case reaction is controlled by means of C.5, which has the same value as C.5 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.

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" (combination of the carrier wave and modulation frequency) applied to the grid is also indicated. It will be noted that the curve representing the input has as its centre a line drawn vertically from the bias point.

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 in the anode circuit of the penultimate valve and that the output valve was in good condition?*

5.—*Explain the action of an electronic or multiplicative 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.*

On each positive half-cycle of the input the grid is made less negative and there is an increase in the flow of node 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 imput.

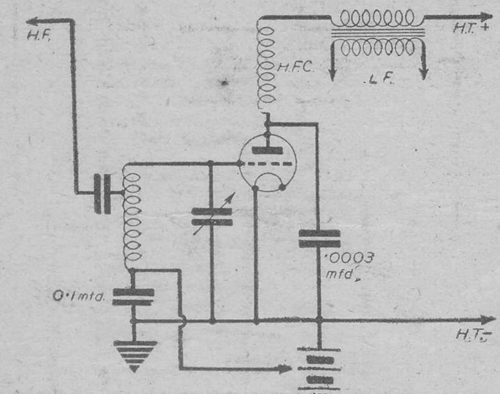


Fig. 1.—Circuit diagram for anode-bend detection.

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

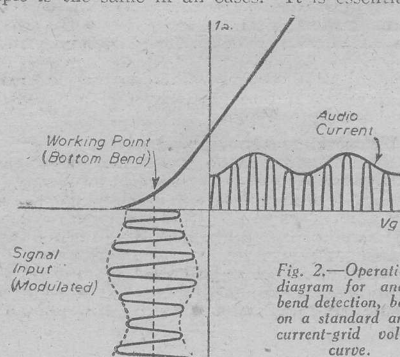


Fig. 2.—Operational diagram for anode-bend detection, based on a standard anode current-grid voltage curve.

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.

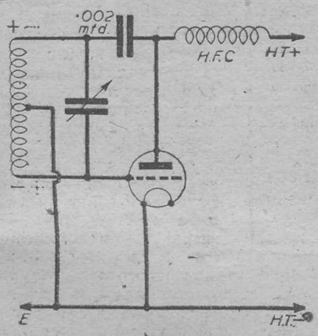


Fig. 3.—A simple form of oscillator circuit—the Hartley.

Thus, starting from D.C. negative, the valves should be in the order: detector, H.F., L.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 I.F. than to the L.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 receiver was 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. 4 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 volts 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:

$\frac{dIa}{dVg}$ divided by $\frac{dIa}{dVa}$, where the small letter "d" stands for "a small change in," and where Ia is anode current, Vg is grid voltage and Va is anode voltage.

The mathematical division can be represented as:

$\frac{dIa}{dVg} \times \frac{dVa}{dIa}$, inverting the second fraction and multiplying instead of dividing, as is standard mathematical procedure.

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 ($R=\frac{E}{I}$ 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:

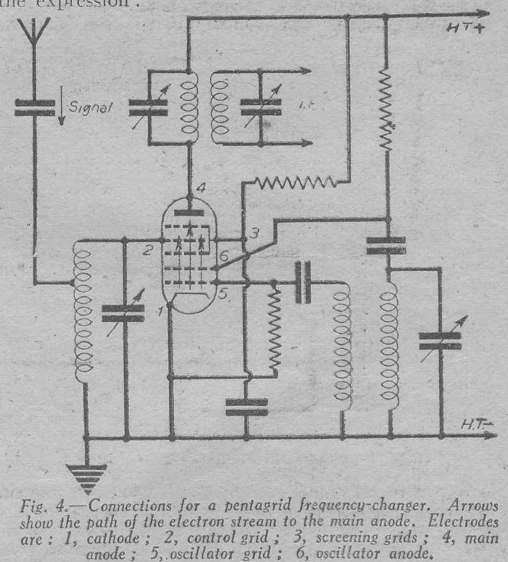


Fig. 4.—Connections for a pentagrid frequency-changer. Arrows show the path of the electron stream to the main anode. Electrodes are: 1, cathode; 2, control grid; 3, screening grids; 4, main anode; 5, oscillator grid; 6, oscillator anode.

$$\text{Amplification Factor } (\mu) = \frac{2.5}{1,000} \times \frac{8,000}{1}$$

Dividing the 1,000 into 8,000, the answer can be seen to be 2.5 times 8, or 20.

The particular example given applies to the MHL4, which is described as a medium-impedance triode.

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 Me There," both of which are sung in English on *Parlophone RO20506*. 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 Mascotte 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 (violin) and H. Robinson Cleaver (organ) on *Parlophone F1885*. A number of old favourites appear on this record—"Sleepy Lagoon," "Parlez moi d'Amour," "I'll See You Again," "Marcheta," "Babette" and "Charmaine." Ivor Moreton and Dave Kaye, those two wizards of the piano, also play a medley of popular tunes on *Parlophone F1886*. They are accompanied by string bass and drums.

Finally, I was rather attracted by "That Lovely Week-end" and "Shepherd Serenade," played by Geraldo and his Orchestra, on *Parlophone F1881*, and "Taboo" and "Fufunando," played by Edmundo Ros and his Rumba Band from the Cocoanut Grove, London, on *Parlophone F1883*.

Columbia

THOSE two famous piano duettists, Rawicz and Landauer, have made a recording this month of a Medley of Scottish Airs, introducing "Blue Bells of Scotland," "The Keel Row," "Charlie is my Darling," "Loch Lomond," "The Campbells are Coming" and "Auld Lang Syne" on *Columbia DB2062*. On the reverse side they give their arrangement of the famous highland patrol, "The Wee Macgregor." Vocal recordings of popular songs are supplied by Bing Crosby with "May I" from the film "We're Not Dressing," and "Love Thy Neighbour" on *Columbia DB2059*, Turner Layton with "A Sinner Kissed an Angel" and "The White Cliffs of Dover" on *Columbia FB2742*, and Celia Lipton with "Wrap Yourself in Cotton Wool" and "You're in My Arms," both of which are from the film "Get a Load of This," on *Columbia FB2737*.

If you like records for dancing, then "Some Sunny Day" and "I Guess I'll Have to Dream the Rest," played in strict dance tempo by Victor Silvester and his Ballroom Orchestra, will, no doubt, appeal to you. My last selection from the new Columbia records is an old favourite, "Lover, Come back to Me" and "Pavanne," played by Jimmy Leach and the New "Organolians," on *Columbia FB2735*.

H.M.V.

THOSE two radio duettists, Anne Ziegler and Webster Booth, need no introduction, and this month they have made a fine recording of "My Paradise" and "So Deep is the Night" on *H.M.V. B9247*. The name of another popular radio star, Leslie A. Hutchinson, better known as "Hutch," also appears in this month's new releases. He sings "You're in My Arms" and "That Lovely Week-end" on *H.M.V. BD982*. If you like a good laugh, then you should hear "The Cheerful Chappie," Max Miller, with his version of "She'll Never Be the Same Again" and "That's the Way to Fall in Love" and "When You're Feeling Lonely" on *H.M.V. BD987*. Lastly, there is an interesting selection of all the latest tunes played by a number of popular dance bands.

Decca and Brunswick

THREE popular women vocalists appear in the new releases. First is that popular film and radio star of "Hi Gang" fame, Bebe Daniels, who, appropriately enough, sings two songs from the film version of "Hi Gang," on *Decca F8012*. The songs are "I'm Singing to a Million" and "It's a Small World." Secondly we have another radio star, Vera Lynn, singing "When you come Home Again" and "You're in my Arms," on *Decca F8042*. Mantovani and his Orchestra supply the accompaniment for both songs. And finally we have Adelaide Hall, accompanied by Gerald Moore at the piano, singing "I Don't want to Set the World on Fire," coupled with "My Sister and I," on *Decca F8043*.

An interesting record of Soviet music is supplied by Lew Stone and his Concert Orchestra on *Decca F8053*. On one side of this record is "Song of the Steppes," with male voice chorus, and on the obverse "Song of Freedom," with mixed chorus. The English text for both of these recordings is by Nancy Head.

Ambrose and his Orchestra have made a number of recordings of popular dance tunes. I enjoyed his version of "That Lovely Week-end," with vocal by Anne Shelton, and "Under Blue Canadian Skies," with vocal by Allan Kane, on *Decca F8047*. An interesting combination who are making a name for themselves is The Royal Air Force Dance Orchestra, led by Sergeant Jimmy Miller. This band has made two records this month: "My Paradise" and "My Mother would Love You," on *Decca F8048*, and "Some Sunny Day," coupled with "A Sinner Kissed an Angel," on *Decca F8049*. Jimmy Miller sings the vocals in each case.

Singers of popular songs include Vera Lynn, accompanied by Mantovani and his Orchestra, singing "I Don't Want to Set the World on Fire" and "There's a Land of Begin Again," on *Decca F8028*; Adelaide Hall singing "Sand in My Shoes" and "Minnie from Trinidad," on *Decca F8031*; and Donald Peers with his version of "Lights Out 'til Réveillé" and "Marie Elena," on *Decca F8029*.

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* 03257; whilst the Inkspots give one of their typical renderings of "I Don't Want to Set the World on Fire" and "Hey Doc," on *Brunswick* 03260.

Also there is a new recording by Deanna Durbin, who, accompanied by Victor Young and his Orchestra, sings "Kiss me Again," from the film "Mlle. Modiste," and "My Hero," from the film "The Chocolate Soldier," on *Brunswick* 03267. Bing Crosby features two songs from his latest film, "Birth of the Blues," on *Brunswick* 03269. Accompanied by Jack Teagarden and his Orchestra, he sings the theme song of the film "Birth of the Blues" on one side and on the reverse "The Waiter and the Porter and the Upstairs Maid." In the latter song he sings in harmony with Mary Martin and Jack Teagarden.

Rex

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 Peterson with "Don't let your Dreams Grow Old" and "An Empty Chair and Memories" on *Rex* 10084.

Lee Green introduces a number of popular tunes with his pianoforte solo "Melodies of the Month, No. R.31," on *Rex* 10083. 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 "Sand in my Shoes."

Overloading

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

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, according to its design. Any attempt to force it to cope 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 controlled within the specified limits and thus prevent the valve or valves from receiving a signal greater than that with which the operating conditions and the characteristics of the valve can cope.

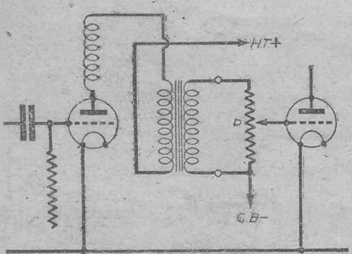


Fig. 1.—Where a transformer coupling is used, a potentiometer can be connected as shown here, to control input to valve.

In actual practice, the solution of the problem is not quite as simple; when a receiver or amplifier is designed the designer attempts to use certain valves and component values which will provide—under predetermined operating conditions—an amplification which will ensure the output stage being properly loaded when a given signal strength is applied to the input. In theory, this is quite a simple matter, but when it becomes a question of the input varying over a very wide range, as, for example, different items being broadcast, 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 now most popular.

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 preceding stages, it is still essential to provide an input control to allow volume to be regulated and the signal strength variations mentioned above to be adjusted within certain limits. Ignoring for the present resultant effects on the quality of reproduction, Figs. 1 and 2 show the simplest, and what might be termed the basic, arrangements for use with transformer and resistance-capacity coupled valves. With the former, Fig. 1, a potentiometer "P" is connected across the secondary winding of the transformer, the rotating contact arm being connected to the grid of the valve. As this arm travels towards the G.B. negative end of the winding so is less of the L.F. voltage developed in the secondary taken to the grid. A suitable value for the potentiometer is 0.25 megohm.

With a resistance-capacity coupling, the normal grid-leak is replaced with a potentiometer, one end of which is connected to the coupling condenser, the other end to G.B. negative and the moving contact to the grid of the valve. The value of the component in this case will depend on the value of the coupling condenser and the specified maximum value for the grid return of the output valve, in the majority of cases 0.25 megohm or 0.5 megohm will be satisfactory except in certain instances when large mains-operated valves are in use. To avoid any misunderstanding, it should be noted that with A.C. or A.C./D.C. circuits using indirectly heated valves the G.B. negative connections in Figs. 1 and 2 would be taken to the common negative earth line.

When the output stage consists of two valves in push-pull, the volume control should be incorporated across the grid circuit of the driver valve or a preceding stage.

Detector Stage

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. 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.

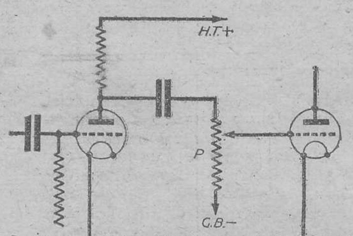


Fig. 2.

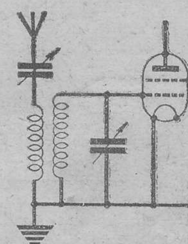


Fig. 3.

Fig. 2.—With an R.C. stage, the potentiometer replaces the usual grid-leak. Fig. 3.—Shows the simplest method by which the input to an H.F. and a detector valve can be controlled.

Assuming that operating voltages are correct, the bes way of controlling the signal input is the simple method shown in Fig. 3. This consists of a variable condenser "C" connected in series with the aerial, and it has the advantage of not only reducing the input but of also increasing the selectivity of the circuit. For medium- and long-wave receivers, a value of .0003 mfd. or .0002 mfd. would be satisfactory, but for S.W. circuits the capacity should be reduced to .0001 mfd. or to 50 m.mfds.

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 close to a powerful transmitter or, if more than one H.F. stage is in use, it becomes 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 aerial 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 disadvantages 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-mu-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 desired control is obtained by varying a negative bias applied to the grid of the valve via a potentiometer "P." 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, this component allowing the tuned circuit to be completed as regards H.F. currents.

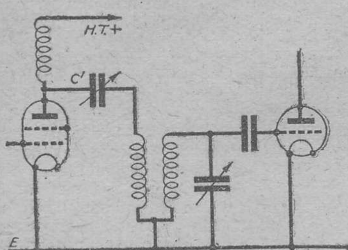


Fig. 4.—When tuned-grid coupling is used between H.F. and detector stage, the coupling condenser can be variable.

Like the detector stage, it is essential to see that the anode circuit of the H.F. valve receives its specified value of H.T. voltage, otherwise its input handling capabilities will be seriously reduced and its operating characteristics affected.

In General

From the remarks contained in this article, it is obvious that, in the interest of quality of reproduction and general efficiency of the circuit, it is vital to prevent any one stage from being overloaded, always bearing in mind the most powerful input signal likely to be received. To apply this, within reasonable limits in practice, it is best to design the circuit so that each stage has a certain factor of safety, i.e., so that any one stage is not working on its peak output the whole time. This applies in particular to the output stage; for example, when reproducing speech or soft music, 500 to 800 milliwatts would be sufficient for average domestic requirements, but let the speaking become robust singing and the soft music a fortissimo passage, then the output will quite possibly soar to three or four times the original figure.

In some circuits, more than one form of volume control becomes necessary, one being fitted in the H.F. and another in the L.F. sections, whilst in other cases it might be better to incorporate the control in the aerial circuit or the aerial and L.F. stages.

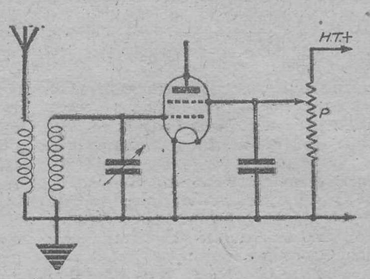


Fig. 5.—Controlling the screen voltage of an H.F. valve provides a method whereby its output can be varied.

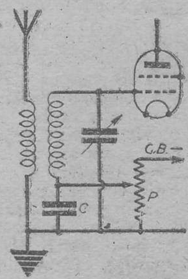


Fig. 6.—Variable-mu H.F. valves offer the most satisfactory form of pre-detector control.

PRIZE PROBLEMS

Problem No. 429.

SMITHERS was in the middle of constructing an amplifier from the parts he had accumulated in his spares-box, when he found that he was without a 350 ohm resistor. He had, however, one having a value of 500 ohms, and several others of various values. After referring to The Radio Engineer's Pocket Book, he found that he was able to connect another resistor in parallel with the 500 ohm and obtain a resultant resistance of 350 ohms. What value resistor did he connect in parallel?

Three books will be awarded for the first three correct solutions opened. Entries must be addressed to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 429 in the top left-hand corner, and be posted to reach this office not later than the first post on Monday, February 16th.

Solution to Problem No. 428.

The reactance of the choke at 50 cycles per second is 7,850 ohms, and at 10,000 c/s, 1,570,000 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 accordingly been forwarded to them: D. K. Johnson, "Maytree," Park Road, Beckenham, Kent; J. Manland, 14, Pole Street, Preston, Lancs.; A. J. B. Towell, 36, Emerson Avenue, Linthorpe, Middlesbrough, Yorks.

Personal Paragraphs

Mr. James H. Barnes, a D.F.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 is a past-president of the I.E.E. His main personal contributions to science have been in the field of lighting and vision.

BRITISH LONG DISTANCE LISTENERS' CLUB

Preliminary Details of the Response to Group Formation, and More News Concerning Members' Activities

THIS page has to go to press before we can expect to receive all the replies to the request put forward last month. However, the response has been quite good up to the time when these details are being written, but it is far too early to attempt to judge what the final result will be. If you have not yet sent in a postcard saying whether you are prepared to support a B.L.D.L.C. group in your town or area, please do so at once. In case some members were unable to obtain the February issue, we reprint below the full details about the new formations, with the request for a speedy reply.

To those members who have already responded we say "Thank you." We are pleased to note that all the replies contain an offer of 100 per cent. support, and that the writers are in perfect agreement about the suggestion being a very fine idea.

It is not possible for us to deal with all areas in this issue, but we give the names of those towns from which we would like members to get in touch with us so that we may take active steps to further their group formation. We cannot, at the moment, give the names of individual members or suggest local meetings, as it is necessary for quite a lot of preliminary work to be done before that stage is reached. The work and the time involved can, however, be greatly reduced if those members living in the towns mentioned below will send us a postcard by return. This does not, of course, apply to those who have already communicated with headquarters.

Weedon, Northampton.
Harlington, Nr. Doncaster.
Forest Gate, London, E.7.
New Malden, Surrey.
York.
West Bromwich, Staffs.
Rainworth, Nr. Mansfield, Notts.
Monkseaton, Northumberland.
Salisbury, Wilts.
Littlehampton, Sussex.
Bury, Lancs.
Willenhall, Staffs.
Framlingham, Suffolk.
Clapham Common, London, S.W.11.
Bedford, Bedfordshire.
Bridgwater, Somerset.
Willesden, London, N.W.10.
Harrow, Middlesex.
Heaton, Newcastle-on-Tyne.
Bromley Cross, Nr. Bolton.
Sheerness, Kent.
Long Eaton, Notts.
Cullercoats, Northumberland.
Penrith, Cumberland.

GROUP FORMATION

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 its members to take an active part in its operation if it is to further the interests of, and speak for, the many thousands of enthusiastic amateurs whose names appear on the ever-increasing roll of membership. This can only be achieved by the formation of Groups, and it is suggested that each town having twenty-four or more members should form its own Group. These Groups would have their own officials, elected by common vote, and they would arrange a programme of activities to suit their own requirements. In close contact with them would be Headquarters, which would act in a controlling and advisory capacity and provide help in such items as inter-Group fixtures, competitions, etc.

To avoid any misunderstanding, it is stressed here that such Groups would have to consist of keen, active members of the B.L.D.L.C., of which they would form a vital section and still retain all existing facilities. They must not be thought of as isolated, half-hearted radio clubs.

Act Now

WE must now know, at once, your views. Paper is scarce and the P.O. authorities overworked, so please don't trouble to write your opinion in letter form. Just send us a postcard showing your name, membership number and full address, and state briefly whether you support the idea, only do it now.

It is pointed out that the B.L.D.L.C. is a non-profit-making concern, there being no entrance fee or contributions of any kind.

Sponsored Programmes

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

"Re the article by 'Thermion' referring to the B.B.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.Ls.

"Another point I 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 readers have received verification cards from the following stations: PUS, 19,970 kc/s.; PPH, 11,930 kc/s.; CR7BE, 30.88 metres; and TG2, 61.9 metres.

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

"Wishing PRACTICAL WIRELESS continued success."

Steady Progress

MEMBER 7089, 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 0-v-2 medium and long wave Rx of 1932 vintage, which, when rebuilt using modern valves, gave passable results.

"I then built my first short-wave set, an 0-v-0, and on this set I logged my first short-wave station DJX.

"After that came two 2-valvers, one a det. receiver, and the other a det. L.F., both of which were failures. Somewhat discouraged, I returned to building 0-v-0 types, and as set followed set, I began to think about constructing something more powerful. Finally, I bought a Lissen Bandspread Three, which I still have. 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, an 0-v-0, tuning from 13-26 metres with bandspread, and an 0-v-1 for use on the medium and long waves.

"Now follows a short log of stations to which I listen regularly: WRCA, WRUL, WRUW, WBOS, WLWO, WGEA, WGEO, WCBX, TAP, FIZ. Besides these I have logged all W's except W6 and W9. At present I am experimenting with a new Super Tuning device which will be fitted on my one-valver."

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 looked out two old bell cells which are probably about three years old, and connected them to my receiver in parallel. Because I had previously used a bell cell for experimental work, I was not 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. I afterwards connected one new large bell cell, and although it may not be as good as a fully-charged accumulator, it gives good results.

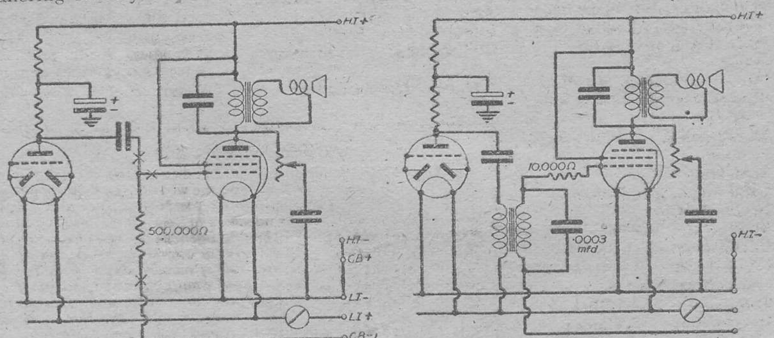
For a small battery set using two-volt valves, one bell cell of about 1.5 volts should last for many months, if the set is not used continuously half the day long; or for a large set two cells in parallel.

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 H.T. consumption will certainly not be increased by this method (but the stability will) and the valves should last longer—an economy all round!—D'ARCY FORD (Exeter).

"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 bit extra out of their favourite set, and it is for this reason I make the following suggestions, which, I think, might be of interest to your readers.



Figs. 1 and 2. Part of the original circuit of the **Push-button Four**, *and the suggested modification.*

The suggestion, is that of converting the resistance coupling into a parallel feed arrangement by the inclusion of an L.F. transformer. I have found that this arrangement gives just that extra punch that is so satisfying.

Fig. 1 shows the original circuit and Fig. 2 the suggested modification, the last two valves of the circuit diagram only being shown for simplicity.

In my own case, the L.F. transformer used was a good quality component (Ferranti, ratio 1–3), but in this system of coupling there is an absence of a steady current through the primary. I believe one of smaller construction could be used, without a lot of difference in performance. A smaller component might be preferable, on account of space.

I found the best position for the transformer was at the rear of the chassis, near where the battery leads pass through the former, this position being well away from the coil unit, and a slight rearrangement of one or two resistances only was necessary. No interaction should be experienced, especially if care is taken to well earth the screening shroud of the transformer.

With the modification described, it will be found possible to keep the manual control well towards minimum position, when reception will be up to normal, A.V.C. still operating. The full volume will be found most useful for distant reception, particularly on the short-wave band. With compliments on the new handy size of PRACTICAL WIRELESS.—R. L. GRAPER (Chelmsford).

Approval

SIR,—May I state that the make up of the new issue of PRACTICAL WIRELESS seems to me to be a 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. COBLEY (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 foundation stone 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.

The last paragraph in the Bonding and Screening in Aircraft seems to me to be a little confused. Should the last clause not read, "a reading between sections of the aircraft that shall not read in excess of 0.025 of a volt?"—J. S. CLEMENTS (Glasgow).

[*No. The test is concerned with proving whether a perfect electrical connection exists between sections, therefore, the resistance has to be measured.*—ED.]

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 bulbs for domestic lighting and less shading; some people have high wattage bulbs almost "blacked-out" with shading.

Also, some blued bulbs used in factories of the 60-watt type could be replaced with those of a lower rating and less blueing.—R. HOPE (Darlington).

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 1898 when the first wireless set was fitted in H.M.S. *Majestic*, which was then the flagship of the Channel Fleet. I suppose I cannot 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 1898 to 1902 we were using coherers, etc. In 1902 we started using magnetic detectors, and went on until about 1908 with them. In the meantime we had been trying crystals (then known as perikon detectors) and the audion valve. In 1908 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 zincite bornite 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: WNW, 264 m. (approx.), at R4; WTIC, 281 m. (approx.), at R4; CBA, 282 m. (approx.), at R6; WHM, 285 m. (approx.), at R6-7; WABC, 341 m. (approx.), at R6; WOR, 422 m. (approx.), at R5. All these were logged on New Year's morning between 12.30 a.m. and 4 a.m. These stations were received on my 3-valve RX, which already has 31 Yankees, 5 Canadians and 2 Cuban stations to its credit (all on the medium waveband).

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, Lancaster, asked for the identification of a station: this is Escalps Andorra (Pyrenees), on 25.35 m.

Some readers may like to know that Manila, Philippines, in 31 m. band, gives news at 15.00. Halifax, Nova Scotia, 48.94 m., is receivable as early as 20.30; it improves later when Sydney, Nova Scotia, is O.K. on 49 m. band. Georgetown, British Guiana, near 50 m., is a 100 per cent. readable; at 22.30 it relays the B.B.C., also ZOY, Accra, Gold Coast, at 19.45 on the 49 m. band. ZNR, Aden, Arabia, broadcasts in several languages on 24.76 m.; it's easily receivable in the early evening, also COK, Havana, Cuba, 25 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 16.00, when it relays the B.B.C. on 31 m. band. Singapore is a fair signal at the bottom of the 31 m. band, also XGOY, with news at 14.00 (this is probably the XGOA (?) referred to by R. W. Iball) and 22.15 near 50 m. Johannesburg has news at 20.05 near 50 m., but this is a poor signal. News from Vadalousk (?), U.S.S.R. at 12.45 on 20, 41 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 thank L. A. Webb for his kind help.—F. G. RAYER (Longdon).

Some Suggestions

SIR,—I am a regular reader of PRACTICAL WIRELESS and I am sorry it has had to be issued as a monthly journal. May I make a suggestion? I think the Universal Oscillator was a fine unit. Quite a number of us have built up sets either from published designs or experiment only with the aid of, say, a voltmeter, and I think more articles on measuring instruments, and similar units, would be invaluable. Give us scope to use originality in the outward appearance of the instrument, as with the Universal Oscillator. Mine looks quite commercial with its black-crackle finished panel and engraved nameplates fixed by 10 B.A. instrument head screws. A polished mahogany cabinet is used, surrounded by some half-round chromium beading—taken from an old car. The instruments I have in mind are: (A) An all-in multi-meter, on the lines of the one in "Practical Wireless Service Manual"; (B) A comprehensive valve tester with provision for reading mutual conductance by bringing the bias voltage down.

Finally, I wish to express my appreciation of the handier size of PRACTICAL WIRELESS.—A. HOLLAND (Camberwell).

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. Placing 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 10.0 a.m. until midnight, each day.

At the present time, WLWO operates on the following frequencies: to Europe, 15,250 kilocycles; to Latin America, 15,250 and 11,710 kilocycles.

Replies to Queries

Untuned H.F. Coupling

"Not wishing to purchase a two-gang condenser, I would be pleased if you would indicate other methods of coupling an H.F. valve to the detector, without using a second variable condenser. Also, what results could be expected compared with the normal H.F. transformer coupling?"—G. Stuart (Aberdeen).

AN untuned coupling could be used, but we do not recommend 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.T. supply. Across the grid circuit of the detector valve connect another H.F.C. or a .25 megohm resistor, the grid condenser and leak being joined to the grid in the usual manner. The two circuits are now coupled by means of a fixed condenser (.0001 mfds.), 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. We would advise the use of a two-gang condenser 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-spread tuning, but I find that on the 48-metre band the tuning is very flat. I have an aerial series condenser (30 m.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 separated from each other by a distance of 18ins. Do you think this is the cause of the trouble?"—E. S. Symonds (Cambridge).

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 simple "inverted L" type.

S.T. Circuits

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

THE S.T. series of designs were published by a contemporary of ours now no longer in publication, therefore we are unable to provide any prints, diagrams or information concerning them. We would advise you to communicate with The Amalgamated Press, Fleetway House, Farringdon Street, E.C.4.

Coil Data

"I have started 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 these. Having some good .0005 mfd. 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 94 metres, in three bands, for the aerial and oscillator coils, using 1⅜in. diameter formers?"—J. Smith (Brockley).

NO, we cannot undertake to provide constructional details for components to suit individual requirements. 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," wherein will be found much valuable data concerning such items.

Metal Rectifier Detector

"I read in 'Practical Wireless' some months ago about a reader who had a crystal set working without a crystal. He used, if I remember correctly, a metal rectifier, and as the idea appeals to me, I would like more details concerning the actual circuit." T. Bolton (Haltwhistle).

THE reader to which you refer was, no doubt, using a Westinghouse metal rectifier, but as it is impossible for us to give complete details about these components in this column, and as it is advisable to follow the makers' advice on such matters, we would suggest that you communicate with Messrs. Westinghouse Brake and Signal Co., Ltd., at Pew Hill House, Chippenham, Wilts, and request a copy of their booklet, "The All-Metal Way" (price 3d.), wherein will be found circuits, details, etc.

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. Hicks (Whetstone, N.20).

THE following makes and types could be used in place of those mentioned. For the H.F. pentode we would suggest a Marconi Osram MSP4, a Cossor MS pen, or a Mullard SP4. For the output pentode a Mazda AC/pen, a Cossor MP pen, or a Mullard 4VA could be used.

RULES

We wish to draw the reader's attention to the fact that the Queries Service is intended only for the solution of problems or difficulties arising from the construction of receivers described in our pages, from articles appearing in our pages, or on general wireless matters. We regret that we cannot, for obvious reasons:—

(1) Supply circuit diagrams of complete multi-valve receivers.
(2) Suggest alterations or modifications of receivers described in our contemporaries.
(3) Suggest alterations or modifications to commercial receivers.
(4) Answer queries over the telephone.
(5) Grant interviews to querists.

A stamped, addressed envelope must be enclosed for the reply. All sketches and drawings which are sent to us should bear the name and address of the sender.

Requests for Blueprints must not be enclosed with queries, as they are dealt with by a separate department.

Send your queries to the Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. The Coupon on page 192 must be enclosed with every query.

Modifying Specifications

"I have one of your blueprints, and I am experiencing some little difficulty in obtaining the specified parts, in fact, it would seem 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. Hollings (Hackney).

NORMALLY, all our designs are based on a solus specification, and we do not recommend the substitution of other parts. This policy ensured that the constructor obtained the same high efficiency from a design as we did with the original and enabled him to take advantage—if necessary—of our Free Service. Owing to existing conditions, however, it is now no longer possible to keep to a fixed specification of component parts, and it becomes necessary to make slight modifications in the wiring and layout to enable alternative types or makes to be used. Care should be taken to see that values are the same as in the original design, and that the various items are of reliable make. We cannot undertake to modify blueprints.

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 potentiometer in the H.T. feed to control the sensitivity of the valve.

O. L. (Bournemouth). We suspect the pick-up of being faulty. Try it on another receiver to prove whether this is so.

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.

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

F. 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 water pipe.

L. M. (Boscombe).—The coil unit is no longer produced by the firm concerned. We would suggest using separate coils.

T. H. (Glasgow).—We cannot trace a valve having the index letters given. A centre-tapped L.T. winding is advisable.

P. R. (Aldershot).—You did not enclose the circuit diagram, so we cannot make any recommendations. A transformer having a ratio of 3.5:1 would be quite satisfactory.

F. B. (Worthing).—It would seem that the bias is too low. On no account should the valve be operated when the purple glow is present. Grid-bias must always be applied, otherwise the emission of the valve will be ruined.

Classified Advertisements

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 Advertisement Manager, "Practical Wireless," Tower House, Southampton Street, London, W.C.2.

CABINETS

WE regret that, owing to all our employees having joined H.M. forces, we are unable to accept orders for cabinets except to callers. Limited stock only. We have a large stock of radio components.—H. L. Smith & Co., Ltd., 289, Edgware Road, London, W.2. Tel.: Pad. 5891.

LOUDSPEAKER REPAIRS

LOUDSPEAKER repairs, British, American, any make, moderate prices.—Sinclair Speakers, 12, Pembroke Street, Copenhagen Street, N.1.

LITERATURE, MAPS, etc.

AMATEUR Radio Handbook. Second edition now on sale. 328 pages, price 4s. —Radio Society of Great Britain, 16, Ashridge Gardens, London, N.13.

WEBB'S Radio Map of the World. Locates any station heard. Size 40" by 30", 4/6, post 6d. On linen, 10/6, post 6d. WEBB'S Radio Globe—12" model. Radio prefixes, zones, etc., 27/6.—Webb's Radio, 14, Soho Street, London, W.1. GERrard 2089.

RADIO SOCIETY OF GREAT BRITAIN invites all keen amateurs to join. Reduced war-time subscriptions. Send 1s. for latest "T. & R. Bulletin" and details.—16, Ashridge Gardens, London, N.13.

TALKIES FOR ALL! "Practical Sound Conversion for Amateurs," shows you how to adapt any silent projector to sound 5s. 6d. post free from F. G. Benson (PW), 88, Greenfield Avenue, Carpenders Park, Watford, Herts.

MORSE EQUIPMENT

FULL range of Transmitting Keys, practice sets and other equipment for Morse training.—Webb's Radio, 14, Soho Street, London, W.1. 'Phone: GERrard 2089.

NEW LOUDSPEAKERS

3,000 Speakers, P.M. and energised, 4in. to 14in., including several Epoch 18in.—Sinclair Speakers, 12, Pembroke Street, Copenhagen Street, N.1.

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CONDENSERS. T.C.C., .1 mfd., tubular, 350 v., **7/6** doz. T.C.C. 25 mfd. 25v., brand new, **1/6** each. (Dozens only.)
MAINS DROPPERS. .2 amp., suitable for Lissen, Pye, etc. Brand new, **3/9** each.
VOLUME CONTROLS. .5 megohm and 2 megohm, with switch, **4/-** each.
STAMPED ENVELOPE must accompany all enquiries.

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RADIO

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By **Alfred T. Witts, A.M.I.E.E.** All the information necessary for a complete understanding of the operations and working principles of this type of receiver, including an additional set of notes on the cause and prevention of frequency drift, and an enlargement and revision of the chapter on maintenance. Fifth edition. **5s.** net.

THERMIONIC VALVES IN MODERN RADIO RECEIVERS

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