SERVICING MIDGET RECEIVERS

Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

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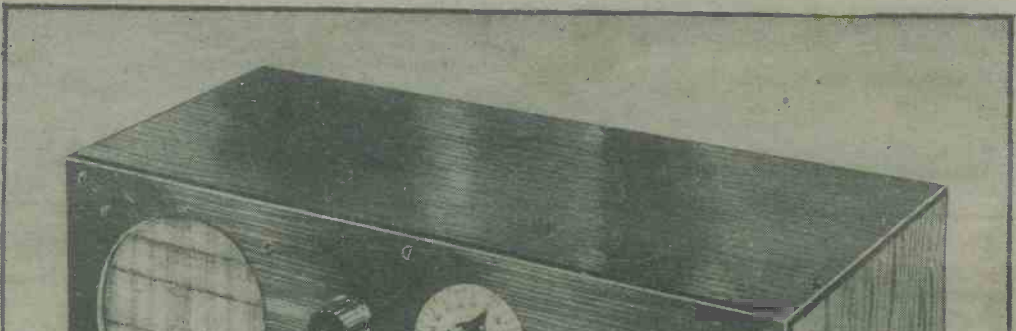

A Two-valve All-dry Receiver. Constructional Details are Given in This Issue.

Practical Wireless
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13th YEAR OF ISSUE
EVERY MONTH.
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Editor F. J. CAMM

Comments of the Month

By F. J. C.

On the Selection of Broadcasters

A SUNDAY paper recently waxed critical over the broadcast by Mr. Noel Coward. With those criticisms we agree entirely. We are opposed to the policy of the B.B.C. in selecting popular playwrights, novelists, sportsmen, in fact, anyone who happens to be in the public eye, to broadcast on subjects outside their own particular spheres. Especially when critical speeches are made about those who cannot answer back.

The opinions of Mr. Noel Coward on subjects outside the stage and play writing are of no greater value than those of the man-in-the-street. It seems to be the set policy of the B.B.C. to presume that because a man has written a successful novel, pot-boiler or otherwise, or because he happens to have written a successful play, or broken a speed record, that person is qualified to tell the world what is wrong with religion, education, how we should conduct the war, or why the birth rate is falling. The B.B.C. has a particular liking for those who, having studied economics or philosophy, yet have no practical experience in those subjects, but presume to know what is wrong with the Gold Standard, international currency, and to have the panaceas for all industrial ills.

The Judgment of Joad !

DR. JOAD, we learn, would solve the traffic problem by entirely abolishing private vehicles from the road (vide his talk to the Pedestrians' Association). We do not accept Dr. Joad as an authority on these matters, and if he had taken the trouble, as a philosopher should, to check his facts he would find that quite a high proportion of the accidents after careful sifting of the evidence are not due to carelessness on the part of the motorist.

Were Joad a motorist would he favour the abolition of all pedestrians from the road as a means of solving the accident problem ? Joad would have all the oil wells dried up to prevent wars and motoring ! Would he solve the coal problem by banning the use of coal ? One finds it difficult to believe that these are the views of one advertised as England's leading philosopher, for such views abrogate the most elementary principles of philosophy.

Miss Barbara Ward is another broadcaster whose views we have criticised, and shown to be lacking in practical experience.

When Mr. Priestley's Sunday evening postscripts were discontinued there was an unholy riot among his fans. One might almost suppose from the din created that a major calamity had overtaken broadcasting. Apparently because some people like these postscripts one man should broadcast them in perpetuity.

Because Mr. Priestley wrote a successful novel it does not necessarily qualify him to speak on a wide variety of topics. We are sure that he would be an authority, and most interesting, on the writing of novels, the ways of authors and publishers, or on some branch of literature. We do not accept him as an authority on the wide field of subjects covered by his broadcasts.

Mr. Noel Coward's broadcasts are subject to the same criticism. The somewhat pompous style would lead the listener to suppose that Mr. Coward is at least on the same plane as the Prime Minister. "The last time I spoke to you over the air was in 1943." One almost expected Mr. Winston Churchill to be speaking. Apart from the fact that the last broadcast has been widely criticised in this country, Mr. Coward does not seem to have been any more successful in his peregrinations abroad, for there have been many pointed criticisms, especially in the American press.

B.B.C. Presumption

WE do not know why the B.B.C. should presume that Mr. Coward's views on the various subjects upon which he has been permitted to broadcast have particular value. His plays have been most successful, but that does not qualify him to speak on these broader and deeper subjects—subjects which only Members of the Cabinet should be allowed to debate. Neither Mr. Coward nor anyone else can be in possession of Cabinet secrets.

It is simply monstrous that he should have been allowed to deal with the forgotten army and other matters concerning which there are adequate answers. The cobbler should stick to his last, the playwright to his plays, the novelist to his fiction, leaving facts, politics, religion, warfare and economics to those who are qualified to speak about them.

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Owing to the rapid progress in the design of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

ROUND THE WORLD OF WIRELESS

B.I.R.E. Meeting

AT a meeting of the British Institution of Radio Engineers (North Eastern Section) held at the Neville Hall, Westgate Road, Newcastle-on-Tyne, on December 13th, a paper on "Wave Guides" was read by T. H. Turney, Ph.D. (Member).

Sir Ernest Fisk

IT is reported that Sir Ernest Fisk, who is vacating his position as chairman and managing director of Amalgamated Wireless (Australasia), Ltd., has been appointed managing director of Electric and Musical Industries, Ltd. He is expected to take up his new duties on arrival in this country early in the New Year.

Death of Prominent U.S. Radio Engineer

MANY of our readers will learn with regret of the death of Stuart Ballantine, a few months ago, in America, at the early age of 46. Mr. Ballantine was a well-known radio engineer, technical writer and "ham," as well as holding the office of president of the Ballantine Laboratories, Boonton, New Jersey, U.S.A.

He commenced his radio career with the Marconi Company, when he was about 15 years of age, and during the 1914-1918 war he was in charge of the Radio Compass Laboratory at the Philadelphia Navy Yard. In later years he was responsible for many radio and electro-acoustic inventions (one of his most recent was the "throat microphone" for use in aircraft), and held over 30 patents. The late Stuart Ballantine's handbook, first issued in 1922, called "Radio Telephony for Amateurs," was for many years a standard textbook on the subject.

Television in U.S.S.R.

FROM a report on the trend of progress of television in the U.S.S.R. it is interesting to learn that, before the German invasion of Russia, R.C.A. television equipment was installed at the Moscow television station, although Russian apparatus was being developed by Soviet technicians. It had been planned to incorporate a huge television studio in the proposed new building of the Palace of the Soviets, and, it is understood, work will be resumed on this project, probably using imported equipment, as soon as the war situation permits. The public-hall type of television, using a large screen, seems to be most favoured for development in Russia.

Increase in Wireless Licences

UP to last month there were 9,600,000 wireless receiving licences in force in Great Britain and Northern Ireland—a quarter of a million more than at the corresponding time in 1943.

American Sets for India

ACCORDING to a report from India, radio sets totalling nearly 41,000 have been imported from the United States under Lease-Lend. Of these over 27,000 have been sold commercially.

Spotting the German Guns

WHEN the report of an enemy gun reaches a listening post in the forward area, a man on duty presses a button which starts the recording machine of a sound-ranging unit at H.Q. As the sound wave reaches each of the microphones, or resonators, spaced out along the hill, it is converted into an electrical impulse and passed along a telephone cable to the recording machine. At the recording machine the electrical impulse causes a wire to vibrate. There is a wire for each of the microphones, and an image of each of these wires is thrown on to a moving strip of sensitised paper. When one of the wires vibrates the vibration is recorded as a sharp zig-zag, which breaks an otherwise straight line. The distance between the zig-zags on adjacent microphone recordings represents a time difference.

A soldier of the 5th Army in Italy operating the wireless set which is used by the listening post in the event of the telephone cable being out of commission. Members of the unit are the only occupants of the village of Rioveggio, which is heavily shelled and mortared by the enemy.

Plotting the Position

THERE are an infinite number of places, at increasing distances away from the microphones, which will give the same time difference for the sound wave reaching the two microphones. If a line is drawn from a point midway between the two microphones through all the successive positions from which the sound could have originated, the result is a curve. In practice the curve is not employed, but a straight line which gives an average is used instead, and so, from the difference in time the sound wave takes to strike two adjacent microphones, a bearing line is obtained. Somewhere along this line lies the enemy gun. The use of a number of microphones gives a number of bearing lines, and where they intersect on the map is the position of the enemy gun. Air temperature, wind speed and direction affect the accuracy of the results, so an R.A.F. Meteorological Unit is attached to the sound-ranging troops to provide the meteorological information. If enemy shellfire cuts the telephone cable from the listening post to the recording centre the listening post immediately switches over to wireless, and gives the order for the recording machine to be started. As soon as the shell has landed the machine is switched off so as not to waste the sensitive paper. In this manner, enemy gun positions which are out of sight can be pin-pointed on the map.

B.B.C. Recording Service

"WHY 'B.B.C. recordings'?" the inquisitive listener may ask. "'Live' broadcasts sound all right to me!"

And so they are. But without the work of the B.B.C. Recording Service much "good listening" would be lost to listeners of to-day and to future generations.

Recording is used for three main purposes. Firstly, to record events as they occur, but to keep them for broadcasting at a suitable listening hour. The recent speech by the Premier at the Mansion House is a case in point. Mr. Churchill spoke in the middle of the afternoon. His words were broadcast "live" in the General Forces Programme, but a recording was made also, and thus millions of home listeners were able to hear the speech when it was re-broadcast at 9.15 p.m. Secondly, to secure records of voices and sounds which would otherwise be unobtainable. Thirdly, to preserve for posterity some of those things which characterise our life and times.

Recording is, therefore, a technical development of great importance, as much concerned with the convenience of listeners as with the convenience of those arranging and taking part in programmes.

Three Systems

THREE recording systems are used by the B.B.C. — disc, film and steel tape. Each has its advantages. The choice of system is determined by the availability of equipment and the treatment to be given to the recorded material in the completed programme.

Discs—discs cut by B.B.C. war correspondents on the midget recorders which they carry with them into action, by the B.B.C. mobile recording units on roads and sites in Britain and elsewhere, by the B.B.C. centres in all parts of the world—resemble the records you play on your gramophone, though they may be larger and are often single-sided. They are used extensively in all manner of programmes. Indeed, the turntables on which the discs revolve are as much a feature of studio equipment as the microphone itself. Of all the systems they are the easiest to edit. Editing, or "cubbing" as it is known, is carried out with the aid of apparatus which is almost uncanny in its application. A single note or word can be deleted by the experts.

Film and Steel Tape

FILM is a highly satisfactory method of recording, but editing is more difficult, and its use is reserved mainly for programmes of historic interest or outstanding importance, worthy of preservation in their entirety.

Steel tape, the development of the steel wire on which, towards the end of the last century, the Danish scientist Poulsen electrically recorded sound, is used for programmes of purely topical or ephemeral interest. Unwinding itself from one large spool on to another—something on the principle of the cinematograph—the tape is electrically magnetised as the recording proceeds. The editing of tape is more difficult and drastic than the editing of discs. It must be cut with scissors and the ends rejoined by welding. On the other hand, it possesses a valuable advantage—it can be "washed" or "de-magnetised," and used again.

So, by these different methods, the B.B.C. recording engineers capture programmes for faithful reproduction on demand to-day, to-morrow, a month, a year, or maybe a generation ahead.

Records Library

IN the recorded programmes permanent library are some 10,000 records, the voices and sounds which are typical of Britain to-day augmenting valuable records of the voices of other generations—Florence Nightingale, Tennyson, Gladstone and Sarah Bernhardt among them.

News-letter for Men of SEAC

AS from December 5th, the men of the Allied Forces stationed in the South East Asia Command are to have their own five-minute weekly News-Letter, every Tuesday afternoon. These News-Letters will be written by men of SEAC who are in London at the moment and amongst the first contributors will be Major Frank Owen and Squadron-Leader Charles Gardner.

Signals in a forward position in Holland send back news and positions of enemy forces.

Servicing Midget Receivers

This Article Outlines a Simplified Procedure for Fault-finding and Repairing Small "Universal" and "All-dry" Sets

WHILE it is never possible to carry out complete trouble-shooting by simple rule-of-thumb methods, it is found that the faults normally occurring in certain types of receiver are so standardised that the majority can be rectified without the need for full test equipment, and often without any extensive experience. It is not proposed to give instructions for tracing every kind of fault, but rather to outline a simplified test procedure which has been found to be effective in most instances.

We will first consider the popular midget receiver designed for operation from either A.C. or D.C. mains. This type of set is not fitted with a mains transformer, the valves are frequently of the high-voltage-heater types with the heaters wired in series, and H.T. smoothing is effected by using either a speaker field coil or a small iron-cored choke in conjunction with a couple of electrolytic condensers.

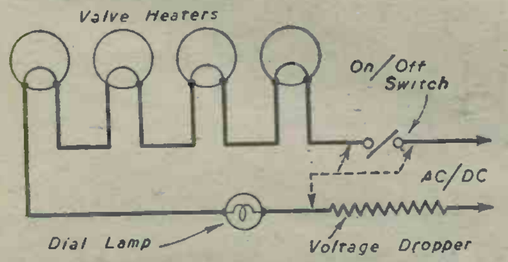


Fig. 1.—A representative heater circuit for a universal midget receiver. In this case it will be seen that a dial lamp is in series with the valve heaters and voltage dropping resistance.

Electrolytic Condenser

It may be taken as a general rule that the most frequent cause of trouble lies with the electrolytic condensers; these components appear to be inherently troublesome. This is not because of any particular weakness in their design and construction, but chiefly because the components used have to be of extremely small dimensions, and require to have a very high capacity. The universal midget receivers were, in the main, designed for cheapness in production, combined with compactness; hence many of the troubles to which they are heir.

Due to the heaters being in series, and to the fact that a transformer is not used, it is necessary to connect a series dropping resistance in the heater supply circuit. The resistance may be in the form of a so-called line cord or a wire-wound unit; the former is more popular because it takes up virtually no space, but the latter has certain advantages which tend to offset its greater bulk. For example, the line-cord is very easily damaged, either mechanically (by its being trodden on or badly kinked) or electrically, due to its being rolled up so that free radiation of heat is prevented.

Initial Tests

Suppose that one of these midget sets is completely "dead." Having switched on, the first step should be to see that the valves are "all right." If they are, the heater circuit is known to be complete. But if the heaters light very brightly, it may be that a portion of the voltage-dropping resistance is short-circuited. That is unlikely when a line-cord is employed, but with one of the usual types of resistance in which there is a wire winding on an insulated tube, a part may be shorted by a stray wire, especially if there are various tapping clips.

If the valves do not glow it may be taken that there is a break in the heater circuit. The break could be caused by a faulty on-off switch—this is very unlikely—or by the failure of the heater of any one of the valves; as the heaters are in series the failure of any heater would result in all valves remaining inoperative. In addition to the valve heaters, it is sometimes arranged that the dial-lamp bulb is also in the series circuit, as shown in Fig. 1. If there is any doubt about this, it may be well to test the bulb, with a battery, and to ensure that good contact is made with the holder. Alternatively, the bulb holder may be shorted out for trial.

Voltage Dropping

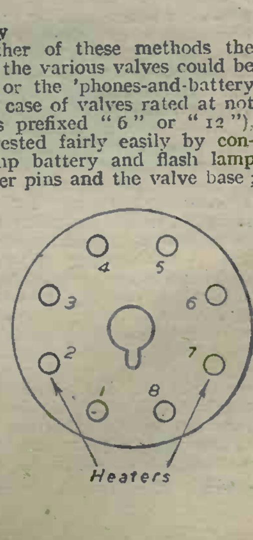
Before making any test of the valves themselves it would be wise to check the continuity of the dropping resistance, whatever its type. If an ohm-meter is available, a simple test can be made by joining together the two "receiver" ends of the line-cord and measuring the resistance between the other two ends. In the case of a wire-wound resistance, the same method of test can be carried out by connecting the "earthy" end of the mains lead of the "receiver" end of the resistance at the end opposite to that to which the other mains lead is already joined; this is shown by a broken line in Fig. 1. The resistance should normally be in the region of 600 ohms, but the exact value is clearly dependent upon the number and types of valves employed.

If a meter is not available (remember that a milliammeter can be used in series with a fixed resistance and battery), a fair test can be made by connecting a pair of 'phones or the speaker in series with a $1\frac{1}{2}$–$4\frac{1}{2}$ volt battery in place of the meter. The clear "click" in the 'phones when the circuit is made and broken would indicate continuity.

Checking Heater Continuity

As an alternative to either of these methods the continuity of the heaters of the various valves could be checked by using a meter or the 'phones-and-battery as described above. In the case of valves rated at not more than 12 volts (names prefixed "6" or "12"), heater continuity can be tested fairly easily by connecting a $4\frac{1}{2}$ volt flash-lamp battery and flash lamp bulb in series with the heater pins and the valve base;

Fig. 2.—Looking at the base of an international octal valve, the heater pins are usually Nos. 2 and 7, as shown. This is not always the case, but there are few exceptions.



if the bulb lights the heater is intact. The heater pins are generally numbers 2 and 7, as shown in Fig. 2. Should it be found that the heater of every valve is in order, it will be known that there is a fault either in the dropping resistance or in the wiring within the set; this assumes that the valve pins make good contact with their sockets, which can normally be expected if the set has "gone off" suddenly.

If one of the valves is found to be defective, the remedy is obvious. Should it be found that the defective valve is the rectifier, however, it might be just as well to make sure that the smoothing condensers are not short-circuiting, so putting the high-tension positive supply down to earth. This point is raised because cases have been known where the heavy load placed on the rectifier as a result of an H.T. short-circuit has resulted in the cathode and heater being disintegrated. Incidentally, such a happening would be prevented if a fuse were included in the positive output lead from the rectifier; this is a modification to be recommended and is shown in Fig. 3.

The condensers can be tested for short-circuit either by charging or discharging or by connecting them, in turn, in series between a dry battery and a flash-lamp bulb. If the latter method is adopted, see that the positive terminal of the battery is connected to the positive terminal of the condenser. The former method is far more reliable and consists of connecting a battery of not less than 20 volts across the electrolytic condensers (again remembering that polarity is important) and then discharging by connecting, say, a screwdriver across the condenser. If the charge has been held there will be a spark as the condenser is shorted. In making this test it may be best to disconnect one side of the condenser from the receiver to ensure that there is no likelihood of the condenser being in parallel with a resistance; it is also wise to hold the screwdriver by the insulated handle to avoid a minor shock.

Should a condenser be found to have an internal short-circuit, it should be removed and replaced before fitting a new rectifier.

Even if the condenser is not short-circuited and fails to respond to the above test it will be useless, since it will be known to have negligible capacity; a replacement will therefore be required. In connection with the replacement question, it is known that electrolytic condensers are extremely scarce and difficult to obtain. In emergency it may be possible to make the set operate reasonably well—although probably with a certain amount of "hum"—by using an ordinary "paper" condenser of not less than 4 mfd. and 250 volts working, instead of the higher-capacity electrolytic.

Another reminder: in fitting a new electrolytic take great care that it is connected correctly, with the positive terminal to the positive side of the H.T. supply. Metal-cased condensers often have one end red and the other black, the red indicating the positive terminal. Tubular condensers with flexible leads have a red lead for positive and a black one for negative. Tubular condensers with wire ends are generally marked with plus and minus signs—or at least with one or more plus signs at the positive end.

There is another point to remember in connection with electrolytic condensers. It is that they will pass a small current when the battery is first connected to them, even when the polarity is correct. In consequence, there will be a small spark as the battery connections are "made"; this should not be confused for an indication of short-circuit. To avoid possible damage to the battery if the condenser is short-circuited, the battery connections should remain in contact with the condenser terminals for only a fraction of a second: this will be quite long enough to allow a good condenser to attain a charge.

We have not so far dealt with the problem of replacing a faulty dropping resistance. First it is necessary to know the correct value, and this can be ascertained by adding together the heater voltages of the various valves and subtracting the total from a nominal mains voltage, say 230. By dividing the result by the valve heater current, plus the H.T. current (when this is passed through the resistance) in amps., the value of resistance required can be determined.

Line-cord resistances, when available, are normally sold by the yard, the resistance per yard being stated. There are two types, for .15 amp. and .3 amp. valve heaters. When the correct length of cord has been obtained, the ends should be bared very carefully to avoid damaging the resistance wire, which is in the form of an open spiral wound on asbestos cord. Bind the ends of the resistance wire tightly around the asbestos core and then fit into the mains plug and component terminals; do not attempt soldering, because this will generally lead to difficulties.

The open-wire type of dropping resistance will seldom need to be replaced, but it may be found that a resistance of this type can be obtained when a line-cord cannot. In that case, substitution is a practical essential. Determine the required resistance and then set one of the

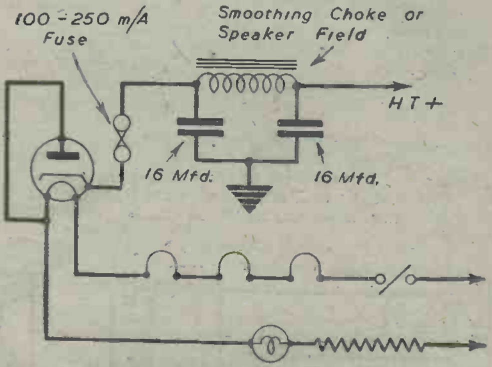


Fig. 3.—A typical rectifier and H.T. supply circuit for a midget set, showing position of a fuse to protect the rectifying valve.

tapping clips to this, or have that done by the dealer who supplies it if you are satisfied that he has a suitable meter for taking the measurement. Failing that, start with the full resistance in circuit, assuming that this is greater than the required value, and adjust a little at a time until the current passed by the heaters is correct. This can be found by breaking the heater circuit and inserting a low-resistance ammeter reading up to .5 amp. A.C. Remember that the resistance will become hot in use and should be so positioned that there is ample air circulation around it.

It may have been found in the initial tests that the valve-heaters and dropping resistance were all in order. The fault can then be presumed to be due to either the rectifier or the speaker. If there is a faint hum from the speaker, the fault is probably in the valve; if there is no sound whatever from the speaker, that is probably the cause of trouble. In making this statement the speaker transformer is considered to be a part of the speaker, for the primary of this is more likely to be defective than is the speaker itself. Very weak signals will also indicate that the rectifier is in need of replacement.

Another common cause of trouble with these midget sets is very poor reproduction of a "wavering" character. This is nearly always attributable to an open-circuited smoothing condenser. Try connecting a good 8 or 16 mfd. electrolytic in parallel with each of the smoothing condensers (or each section of a multiple condenser), in turn. The faulty condenser will be recognised by the fact that reproduction will be normal when the good condenser is in parallel with the defective one. The remedy is obvious, but it should perhaps be mentioned that when only one section of a multiple condenser is at fault, it will suffice to replace that section alone. Condensers used in the H.T. circuit should have a rated working voltage of not less than 250, and preferably of 350.

A Short-wave Two-valver

Constructional Details of an Efficient Battery-operated Receiver. By A. JOTCHAM

THE circuit (Fig. 1) is a plain detector resistance-capacity coupled to a pentode output. It will be noted that the H.T. does not flow through the headphones; thus reducing, to some extent, background noise, and the possibility of burnt-out 'phones. Four-pin S.W. coils, types CA11, 25 metres; CB, 20-45 metres and CC44, 100 metres are used. I wound an extra one for the 9-14 metre band.

Construction

The chassis, which measures 10in. x 5in. x 2½in. is of the inverted-box type, made of plywood and covered with perforated zinc. The chassis can be left plain or painted; the writer gave the woodwork a coat of battleship grey, the result being very satisfactory. The panel is 10in. x 7½in. three-ply, well rubbed down with glasspaper and then painted with a light stain. When this is dry, a little oil well rubbed in will give it a good finish.

The chassis layout is quite simple, and gives short wiring at all points. All parts, except the 2 mfd. condenser, are mounted on the top of the chassis. The on-off switch, tank condenser (or .00016 bandset) and 'phone plug are, however, mounted on the panel below the chassis.

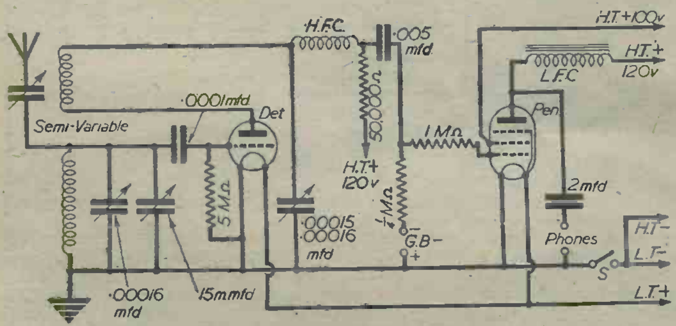


Fig. 1.—Theoretical layout of the Rx.

The panel ayout, as will be seen by reference to Fig. 3, is plain and simple. If, however, constructors use parts, such as dials, etc., not used in this Rx, they will have to lay out their panel to suit. The tuning

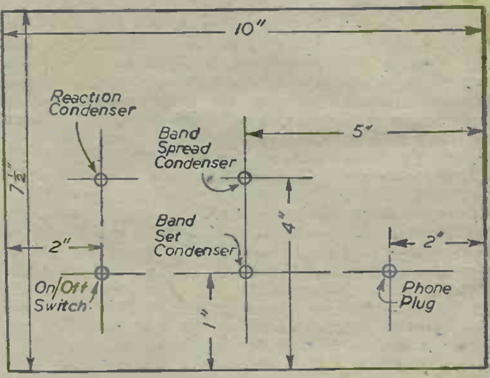


Fig. 3.—Drilling template for the panel.

unit is an ' Eddystone tuning unit," or a .00016 bandset with pointer knob, direct drive, and 15 mfd. condenser can be used with utility drive (Radiomart) for bandspread. With the Eddystone Tuning Unit the bandspread is mounted in the centre of the panel with the tank condenser below. The .00015 mfd. slow-motion reaction condenser is on the left, below the on and off switch, and on the right of the tank condenser is the 'phone plug, a midget " Radiomart " plug. The aerial and earth panel are mounted at the back on the left-hand side looking from the back.

Valves

The accompanying list shows the parts used in this receiver, but some constructors may use some parts they have by them, as long as the general wiring and the components are in good condition. I refer particularly to slow-motion dials and condensers. The two valves usedwere PM2HL, det. and Pen. PM22 or 22A Mullard, a PM1HL, or a PM2DX Mullard can also be used for det.; I find PM2HL best. All the fixed condensers, resistances and grid leaks are provided with wire ends. All the earth leads are taken to the zinc covering, the tank moving condenser plates connection and bandspread moving condenser plates are connected under the same earth bolt to the zinc. The moving plates of the reaction condenser are connected direct to the earth side of the Eddystone coil-holder (see Fig. 2). A 5 meg. grid leak is used and connected to earth instead of the usual connection to L.T.+.

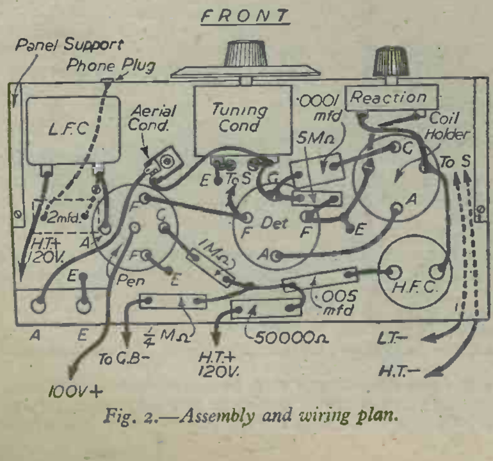


Fig. 2.—Assembly and wiring plan.

LIST OF COMPONENTS.

- **Tuning condensers: " Eddystone " Tuning Unit or .00016 bandset and 15 mfd. Bandspread.**
- **Reaction condenser: .00015 or .00016 mfd.**
- **Fixed condensers: T.C.C., Dubilier (wire ends).**
- **Coils, 4-pin: See text.**
- **1 5-pin, 2 4-pin valve holders; " Eddystone " (baseboard type).**
- **H.F. choke: " Eddystone," " Raymart."**
- **L.F. choke: Lissen HiQ, 80 henry, Telsen, Varley, etc.**
- **Grid leak: Erie, Dubilier, etc. (wire ends).**
- **Resistances: Erie Dubilier, etc. (wire ends).**
- **Aerial condenser: Any manufacture (stamp type).**
- **Valves: Mullard PM2HL, PM1HL, PM2DX. Output, PM22 or 22A.**

Notes on Coil Design

Paper Read Before the Institute of Practical Radio Engineers. By H. JONES

A CONDUCTOR of electricity through which a current is passing, a length of copper wire, for example, creates a magnetic field around it, and if the wire is wound into a coil this field becomes concentrated—stronger. In operation a back e.m.f. becomes evident, one tending to oppose the applied e.m.f., hindering its quick rise to a maximum. Should the applied e.m.f. be switched off, the back e.m.f. acts in the opposite direction, hindering or impeding the collapse of the current, the two actions being known as induction. When a coil creates a back e.m.f. in its windings it is called self-induction, but if it creates or generates or induces another e.m.f. in an adjacent coil close to it, it is called mutual induction.

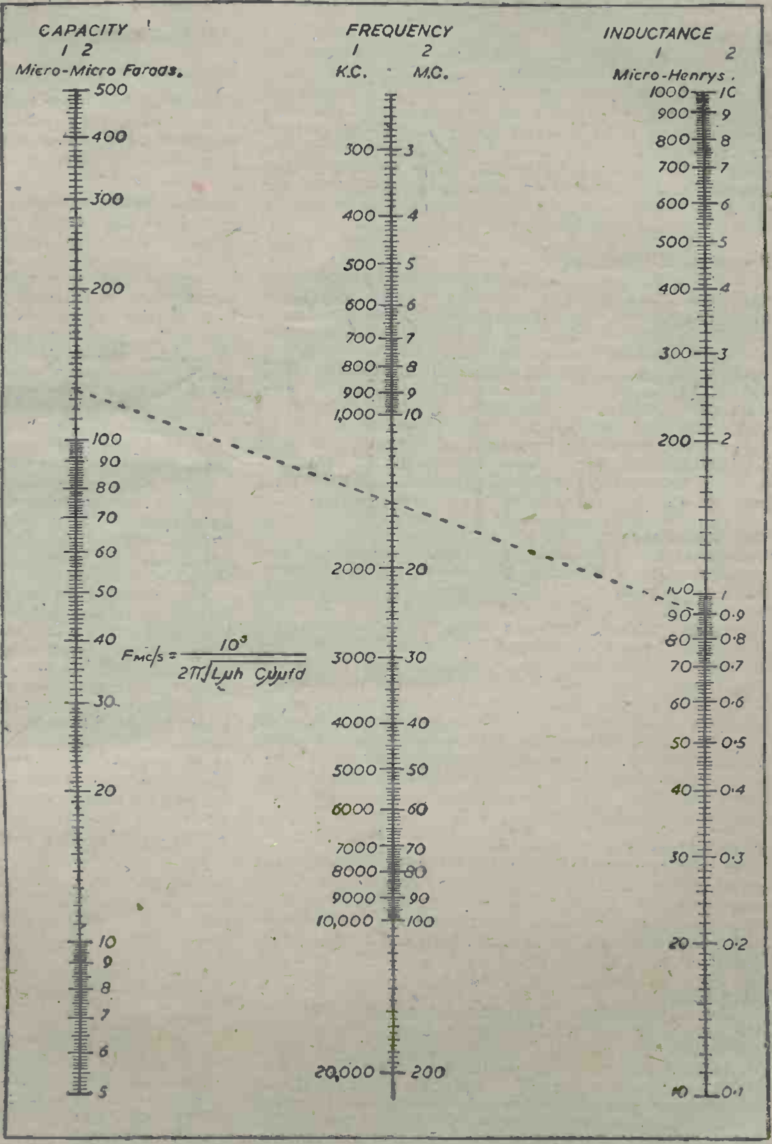
The unit of inductance is the *henry* (L). A coil is said to have an inductance of one henry if it induces in itself a back e.m.f. of one volt when the current is charging at the rate of one ampere per second, that is: L = back e.m.f. in volts, divided by the rate of change of current (I) in amperes. Two coils not electrically connected have a mutual inductance of one henry if the first coil induces in the second one an e.m.f. of one volt when the current is changing at the rate of one ampere per second; then L = back e.m.f. in the second coil, in volts, divided by the rate of change in amperes per second in the first coil.

Applied A.C.

When alternating current is applied to a coil the inductance effect is constant, because the value and the direction of the current flow is similarly changing all the time. If the frequency of the A.C. be increased, the back e.m.f. and the rate of current change will also increase—so will the inductance. Therefore, when current flows the strength of the magnetic field is a measure of the quantity flowing as well as the number of turns of wire making up the coil.

Oscillatory Action

Assume two coils coupled as primary and secondary as, say, an ordinary aerial tuner, terming the primary L_1, and the secondary L_2, and additionally assume a current to be flowing in L_1; then, by mutual induction, a current will flow in L_2, and the tuning condenser shunting it will become charged. If the current is shut off from L_1 the lines of force round L_2 will collapse back into it—the current falling, yet the charged condenser will then supply energy to the circuit as it discharges, but the lines of force will now tend to keep the condenser charged—in the opposite direction. At



A chart showing the capacity and inductance wanted to tune to a defined frequency or set of frequencies. A ruler lined across any two known shows the unknown on the remaining scale. The dotted line illustrates that a condenser of 125 mmfds. will tune to 15 megacycles with an inductance of 0.904 microhenrys.

the same time, L_2 will, due to the condenser discharge action, build up a magnetic field in the opposite direction, causing the circuit to act as an oscillator, but as soon as the current ceases to flow in this direction the condenser will again discharge through L_2, and be again recharged at the same polarity as in the first instance, the sequence of actions continuing, with decreasing values of current flow, until all the stored energy in the condenser is dissipated and the consequent oscillations are damped out. As the current changed in L_2 it, by mutual induction, generated a current in L_1, and as this coil is connected to the aerial, slight radiation must result; so that if the coil received alternating or high-frequency current continuously, L_2, and its associated condenser must produce sustained or continuous oscillations.

Frequency

The frequency of oscillation is thus entirely dependent on the inductance values of L_1 and the capitance values of (C), the condenser shunting L_2. Simply stated, the frequency $(f)=1/(2\pi\sqrt{LC})$, or $f^2=1/(4\pi^2LC)$. Therefore $4\pi^2LCf^2=1$. Thus $L=1/(4\pi^2f^2C)$, and $C=1/(4\pi^2f^2L)$, where f=frequency in c.p.s., L=inductance in henrys, $\pi=3.14$, C=capacity in farads. The frequency thus denoted is the natural or resonant frequency of the circuit, a condition that is obvious when $2\pi fL=1/(2\pi fC)$, that is: when $4\pi^2LCf^2=1$.

Frequency Limitations

Wavelength (λ) equals velocity divided by frequency, so that if transmitting or receiving is to be undertaken at predetermined frequencies, suitable values of L and C must be accommodated in the circuit used in order to assure resonance ranges and one or the other must be made variable. In general practice this, of course, is C, so that by the employment of a suitable coil and variable condenser, resonance, within the limit of the circuit constants, can be assured. If extended bands of frequencies are to be resonated, additional coils may be switched or plugged into the circuit or switching to an entirely different combination of L and C values resorted to.

Coil Capacitance

Coils possess self capacity, the amount depending upon physical construction and dimensions. This property, existent between turns, is in parallel with the windings, so that as the frequency is increased, $2\pi fL$ becomes larger and $1/(2\pi fC)$ becomes smaller, the self capacity tending to bypass the coil and thus effect the increases—as the frequency increases. Capacitances between coil turns are in series and thus may be viewed as $1/C_t=1/C_1+1/C_2+1/C_3$, etc., that is, space-to-space or capacity to capacity between turns and though regarded as a whole to be relatively low in value they need taking into account when very high frequencies are dealt with, as also must similar self-capacity effects existing between coils and earth potentials, connecting wires, etc., and termed stray capacities.

Coil Resistance

It is important, too, that the resistance of wire used to wind coils be as low as possible, as sharpness of resonance or coil Q is dependent on the ratio of $2\pi fL/R$ at resonance; therefore the lower the wire resistance in the coil as a whole, the higher will be the magnification factor, gain, or Q of it.

Skin Effect

The magnetic force lines around a coil are intense at the centre of the wire diameter, and as operational frequency is increased, the more marked is the effect, forcing the current to travel along the skin of the wire —impeding its flow, a condition capable of easement if as large a gauge of wire as is possible is used so as to present a good cross-sectional traverse to A.C. and yet offer a low resistance to D.C.

Design Formulae

Designers of coils have recourse to various formulae from which to compute constants, though many are involved and are dependent on form factors from other formulae. Nomographs, charts, tables, etc., are also used, the charts being devised with the assumption that if any two values of the required constants be known, the third aligns itself with it, by aid of a ruler, on the requisite vertical scale. Nevertheless, some knowledge of the relatively simple methods applied mathematically to coil design is necessary if one is to thoroughly understand the work, a very easy formula for this purpose being one where L (in microhenrys) $=(0.2A^2N^2)/(3A+9B)$, letting A= coil diameter in inches, N=number of turns, B=coil length in inches, from which, of course, the inductance value is got. Progressing: $L3A+9BL=0.2A^2N^2$, so that N can equal $\sqrt{L\left(\frac{3A+9B}{0.2A^2}\right)}$. B can equal $3AL+9BL=0.2A^2N^2$, and $9BL=0.2A^2N^2-3AL$, or $B=(0.2A^2N^2-3AL)/9L$, or $B=A\frac{(0.2AN^2-3L)}{9L}$. The number of turns per inch to which suitable gauges of wire will wind on a coil former is also available from wire manufacturers' tables, turn numbers usually being halved if coils are to be space wound.

Physical Considerations

Coil self-capacity is reducible if the winding turns are spaced, though little benefit is derived by doing so if the spacing is in excess of the wire diameter used. Coils to operate on very high frequencies are, in general, wound with well-spaced turns, while those for the usual broadcast bands are close-wound. Former sizes nowadays have become a standard 1 or 1.5in. tubes of presspahn, 1/16in. thick. Ultra short wave coils are usually wound from stout gauges of wire, bare, to have them self-supporting—without former. Winding lengths and former diameters are, if possible, made equal.

Broadcast band coils may be met with, with cores of iron dust and an insulating compound mixed, the permeability helping to attain a satisfactory high Q factor. Such cores are not usually seen in short-wave coils, though experiments in this direction or respect have recently been undertaken and encouraging results obtained. At this time, however, little is available for publication in reference to their physical makeup or electrical constants.

The checking of inductance against capacity must include provision for all strays. For example, with a tuning minimum of 18 mmfd. and estimated strays of a similar value, the minimum design range should be 36 mmfd. and this same figure allowed for in maximum coverage as well. Stray capacities have little effect on mid-frequency peaks of resonance—broadcast operational bands, but must be well considered in the design of short-wave coils, 30 mmfd. being an average allowance With, say, Acorn types of valve, and ultra-short wave design in hand, allowance for strays may be reduced to around 10 mmfd.

An Example of Design Computing

Assume that a coil is wanted wound on a 1 and 1/2 in. former, 1/2 in. in length, to be used with a 35 mmfd. variable condenser to tune to 4,500 kilocycles. The inductance can, if necessary, be got from a chart, and can be noted as 35 microhenrys. Checking by calculation: $f^2=1/(4\pi^2f^2C)$, letting $\pi=3.14$, C=capacity in farads, f=frequency in c.p.s., L=inductance in henrys. π^2 can arbitrarily be taken to equal 10:

$$L=\frac{1}{40\times(4.5)^2\times10^{12}\times(35/10^{12})} \text{ or } L=\frac{1}{40\times(4.5)^2\times35}.$$

By recourse to logarithms, resolving can be shown as:

No.	log.	No.	log.
4.5	0.6532	1	0.0000
4.5	0.6532		
40.0	1.6021	Therefore	0.0000
35.0	1.5441		4.4526
	4.4526		$\bar{5}.5474$=0.00003527
			=35.27 microhenrys.

Next, from formulae, L (in microhenrys) $= \frac{0.2A^2N^2}{3A+9B}$, A = coil diameter in inches, N = the number of turns wanted, B = the length of the winding in inches. So that $3AL+9BL=0.2A^2N^2$, and $N^2=(3AL+9BL)/0.2A^2$.

Therefore $N=\sqrt{L\left(\frac{3A+9B}{0.2A^2}\right)}$. Substituting figures:

$$N=\sqrt{35.27\left(\frac{4.5+4.5}{0.2\,(1.5)^2}\right)}=\frac{9}{0.450} \text{ or } 900\div45=20$$

$$=\sqrt{20\times35.27}=\sqrt{705.4}.$$

By logs.: No. log.

No.	log.
705.4	2 | 2.8484
26.56	1.4242

Therefore $N=26.6$, the number of turns required.

For a medium-wave coil designed to resonate between 200 and 600 metres, shunted with a 500 mmfd. condenser, the following constants are good approximations: Allowance for strays, 60 mmfd. Minimum to maximum capacitance allowance being thus 60 to 560 mmfd. Inductance value, 185 microhenrys. Former, 1.5in. diameter. Length of winding, 1.05in. Turns, 76 of No. 30 S.W.G. enamelled wire, close wound.

Shielding

Shielding with small diameter covers lowers the effective Q of encased coils, as also does shunting a high Q coil with a low-resistance diode detector valve, and while formulae are available for the computation of designs to function beneath covers, in all reality, shield cans should be of such dimensions that coil Q is the same with the shield on or off. Such a condition is, of course, not always possible to secure, though it is decidedly one to be striven for. Finally, it is worthy of note to state that the most carefully computed and well-planned design may need practical "cut and try" adjustments before being finally passed on for multiple production.

Television Practice—2

The Image Dissector, Electron Multiplier, Iconoscope and Cathode-ray Tube

By S. R. KNIGHT

The Image Dissector

THE image dissector, developed by Farnsworth, was one of the first practical all-electrical systems of scanning to be employed for television purposes. The operation of the instrument is something after the nature of the cathode-ray tube, and will be best understood after a consideration of Fig. 6. The whole device, with the exception of focusing coils, is housed in a large exhausted glass bulb, the internal electrodes being the cathode, anode, and collector electrode, mounted along in that order. The cathode is not a cathode as it is known in ordinary thermionic valve nomenclature, but consists of a translucent slab of insulating material the surface of which is coated with a photo-electric material. A lens system is so arranged that a sharp image of the scene to be televised is focused on to the translucent cathode, each elementary area of which therefore gives out an emission of electrons proportional to the light intensity falling on that particular part of its surface. The anode A is maintained at a high positive potential with respect to the cathode and so the electrons escaping from the cathode are attracted down the length of the glass tube towards it. Now the focusing coil that surrounds the device carries a direct current which produces a practically uniform magnetic field running parallel with the horizontal axis of the tube, the intensity of this field being adjustable by changes made to the direct current creating it. With a particular adjustment made to this current, in relation to a given anode voltage and the various physical conditions of the tube, electrons emitted from a particular point on the cathode will be focused to a fine spot on a particular part of the anode as Fig. 6 shows, this result being achieved in spite of the fact that not all the electrons emitted from a particular point on the cathode will move directly across to the anode parallel with the lines of magnetic flux. Those electrons which are emitted directly parallel to the flux lines experience no force whatsoever from the field and so move directly to the anode, but others which are emitted with a radial component of velocity are acted upon in such a manner that they follow helical paths which ultimately intersect the direct path to the anode. With certain conditions all electrons emitted from the same spot on the cathode converge at the same point on the anode irrespective of their initial direction or velocities; in other words, there is formed at the anode plane a distribution of electrons which is a replica of the light intensity upon the cathode.

This electronic reproduction of the scene being televised is now scanned in a special way which consists of a displacement of the image with respect to the anode aperture, a small hole in the centre of the anode through which a certain number of electrons may pass to the

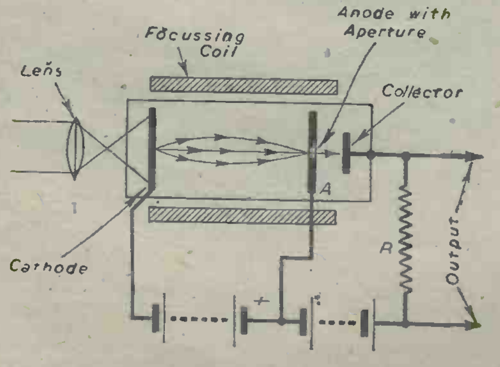


Fig. 6.—The Farnsworth Image Dissector.

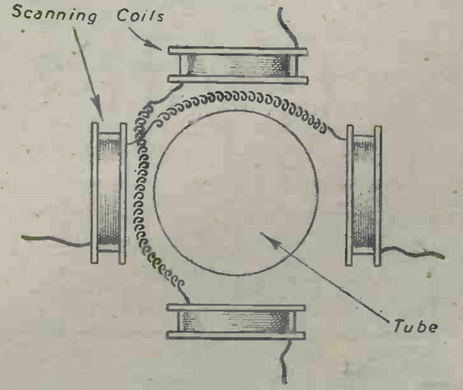


Fig. 7.—How the scanning coils are mounted around the Dissector tube.

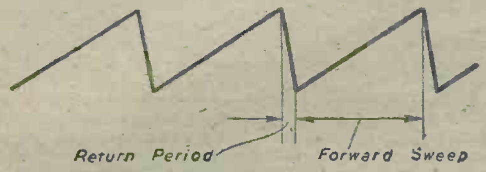


Fig. 8.—A typical saw-toothed wave such as is used for scanning in the Image Dissector.

collector plate. If the electron image present at the anode plane is moved systematically sideways and upwards across the anode aperture, the number of electrons passing through to the collector plate will vary from instant to instant according to the light intensity at that part of the cathode image supplying the electrons at that particular time. The way in which the electron image is moved in this particular way will be better understood after time-base circuits have been dealt with, but briefly it is accomplished by a pair of magnetic coils, distinct from the focusing coil we have been discussing, which are mounted on either side of the tube in the manner depicted by Fig. 7. When a current is passed through the vertically mounted coils the electron image is moved up or down, while a current through the horizontally mounted coils causes it to move to the left or right. By applying to the vertical coils a saw-tooth wave of current of the type shown in Fig. 8, having a frequency equal to the number of times per second the image is to be scanned, and a similar wave to the horizontal coils having a frequency equal to the number of sweeps, or lines, per frame times the number of frames per second, the electron image is moved across the aperture in a series of parallel strips, all lying side by side, and making up in all the complete area of scene being transmitted. (See Fig. 4 of article 1.)

The succession of varying voltages set up across the resistance R by the changes in the electron numbers getting through the anode aperture to the collector electrode represents the electrical equivalent of the light and shades of the televised scene and are thus capable of amplification and transmission in the ordinary manner.

The Electron Multiplier

The anode aperture of the image dissector must be small for reasons outlined at the end of article 1. The smaller it is the better from the point of view of overcoming aperture distortion, but below a certain size a difficulty is encountered in that hardly sufficient electrons manage to get through to the collector plate to set up large voltage variations across R. High amplification after this stage serves little purpose as ordinary valve noise generally swamps the little signal there is. This difficulty is overcome by using a system of electron multiplication based on secondary emission, in order to increase to a practical amount the number of electrons developed by the dissector.

A typical form of electron multiplier is shown in Fig. 9 being built directly into the scanning tube. Here two plates are mounted to face one another, their inner surfaces being coated with a material which will give out a large number of secondary electrons when subjected to primary bombardment. (A and A_1). Between these plates is mounted a tube, or circular anode, carrying a small positive potential, about 90-100 v. Now an oscillator, generating an R.F. potential at a frequency in the region of 50 megacycles per second is connected to the multiplier electrodes A and A_1 and is so adjusted that the frequency is such that a half cycle occurs in approximately the same time that the electrons are in transit from A to A_1. Electrons passing through the anode aperture of the image dissector and entering the multiplier department at the instant when the electrode A_1 is just beginning to run positive are attracted to it with an increasing velocity and on striking

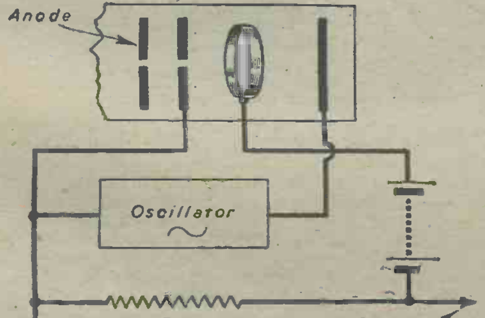


Fig. 9.—A typical electron multiplier used to magnify the normally small output of the Image Dissector.

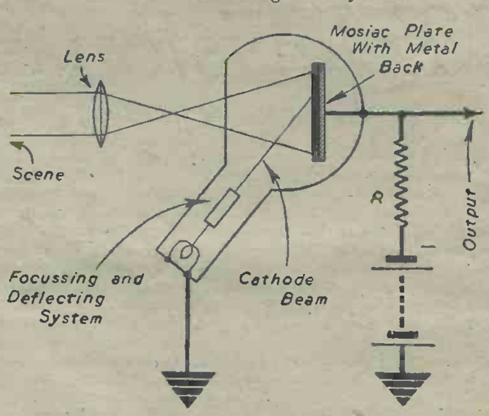


Fig. 10.—The Iconoscope.

it release a large number of secondary electrons. The oscillator frequency being adjusted so that one half-cycle corresponds to the electron transit time, these secondary electrons are emitted at exactly the instant that the electrode A is beginning to move positive with respect to A_1 and so they themselves move across to A where more secondary electrons are released which then begin to move towards A_1. This process goes on at a great rate and in a few millionths of a second the original electrons entering the multiplier chamber through the anode aperture have multiplied themselves a thousand-fold. The circular anode collects a large percentage of these electrons and develops a voltage across a resistance R (Fig. 9) which is passed on for conventional amplification. By suitable design and set-up an output is obtained from this type of electron multiplier that is proportional to the number of electrons initially passing through the anode aperture of the dissector, and many times more great, which is exactly what is required. Valve noise in the amplifier stages do not now swamp the signal.

There are several varieties of electronic multipliers in existance, some of which do not require an oscillator, though basically their operating principle is similar to that of the one outlined above.

The Iconoscope

The Iconoscope, developed by Zworykin, is the basis of the modern television scanning camera. A simple diagram of the device is shown in Fig. 10, where it will be seen to consist essentially of a large exhausted bulb containing a cathode and focusing electrode (as in a cathode-ray tube) and a mosaic screen built up of isolated photo-electric globules on an insulating glass or mica base. This latter component is of first importance to the efficient working of the iconoscope as a whole and special precautions must be observed in its manufacture. The insulating base is covered with minute globules of photo-electric material, each globule being carefully insulated from its neighbours. They are not externally connected to anything, but each of them forms a very small condenser in conjunction with a metal plate which is mounted close against the other surface of the insulating base. It is upon this condenser principle that the working of the instrument depends.

By a system of lenses the image of the scene to be televised is focused sharply on to the mosaic plate. Under this condition each globule emits electrons from its surface according to the amount of light affecting it, and so each globule becomes positively charged with respect to the back plate, this charge building up to a value proportional to the light intensity creating it. A stream of electrons is now directed on to the mosaic screen from the heated cathode, being focused to a fine spot by means of the focusing anode, C.R. tube principle. This stream of electrons is caused to scan the mosaic plate by means of vertical and horizontal deflecting fields actuated by saw-toothed waveforms of the variety used for the image dissector previously described, thus covering the mosaic area by a series of parallel horizontal paths that are spaced by an amount equal to the diameter of the electron beam spot.

As the cathode-ray beam scans across the globules in turn the negative charge that has been lost by each of them as a result of photo-electric emission is replaced by the electrons carried in the beam; thus is each tiny globular condenser discharged by the cathode ray. As each discharge occurs a current flows through the resistance R (Fig. 10) equal to the charge built up upon each particular globule and consequently proportional to the illumination upon each particular globule. Thus there is developed across R a voltage which is varying in accordance with the light intensity of each strip of the image as it is scanned. This varying voltage can now be amplified and transmitted as the television signal.

The iconoscope has an advantage over the image dissector in that electron multiplication is not necessary. The current passing through R during each globular discharge is comparatively large because the number of electrons moved round the circuit is equal to the total number emitted photo-electrically by a globule since the previous scanning. If the picture area is scanned completely 25 times per second, then the whole of the photo-electric emission of a globule over a period of at least 1/25th of a second is utilised, instead of only the emission during the very small instant of actual scanning. Leakage between globules and other factors modify this argument slightly, but the output from the iconoscope is very much greater than that from the image dissector not employing electron multiplication.

Cathode-ray Tubes

The design and principle of cathode-ray tubes have been discussed at some length in fairly recent issues of PRACTICAL WIRELESS, therefore it is not proposed to go deeply into the subject here. Needless to say, future television receivers will depend almost exclusively upon the cathode-ray tube as the reproducer of the transmitted images. The light spot which is focused on to the fluorescent screen is varied in intensity by the magnitude of the received signals, at the same time that it is caused to scan the surface of the screen in a series of lines and frames after the manner of scanning already discussed. Both electrostatic and magnetic scanning is employed, saw-toothed waveforms producing the necessary movements. The deflecting waves at the receiver are synchronised exactly with those at the transmitter by methods to be described later, and so the position of the cathode spot on the screen of the receiver tube is always in the same relative position as the picture element being scanned at the transmitting camera. Thus the result is an exact replica of the scene being televised.

Cathode-ray tubes used in television receivers are just the same as those used in oscilloscopes and the like, though they are generally larger and operate at much higher voltages. The fluorescent screen generally has a light persistence (after glow) that is just less than the time taken to scan one frame of the picture. This gives the best compromise between flicker and blur due to excessive persistence.

(To be continued.)

NOTES ON NEWS

London-Athens Wireless Circuit Reopened

THE London to Athens and London to Paris wireless circuits have been reopened for Press traffic only, according to a recent announcement by Cable and Wireless. The circuit to Athens had been closed since 1941.

"The New Spy"

"THE New Spy" broadcast on December 1st, was a dramatisation of the work of the Intelligence Service written by Donald Stokes and based on his book, "Men Behind Victory." It brought out in many different ways the risks run by the men and women of the Intelligence Service and also showed clearly how easily enemy agents are able to assimilate material for reports to their homeland from the slightest fragments of talk let drop by unthinking citizens.

"The New Spy" is the second in a series of broadcasts based on "Men Behind Victory." The first, "Immortal Mission," the story of the "Liberty" ships, was broadcast on September 15th.

"Big Ben"

THE chimes of Big Ben heard over the radio immediately evoke memories of London to exiles abroad, for to all of them Big Ben means Britain, and more particularly London, bringing the capital to mind as no other sound can. In the years of war, Big Ben has become much more than this; it has been the voice of freedom to many millions of people in occupied countries.

The history of this big clock, the most famous, though not the largest in the world, was told in a broadcast on December 19th. Many new facts about it were brought to light; listeners heard why it is called Big Ben, and such intimate details of its private life as how it is regulated, when it stopped, how the sound of its chimes are broadcast, and many other details of great interest to those people—and their number is legion—to whom the voice of Big Ben is the voice of London and of the British Empire.

Don't Send Your Scripts

SOME time in the New Year, in "Monday Night at Eight," the B.B.C. Variety Department hopes to stage a weekly competition with a money prize. This contest, which will be announced at the microphone, will take the form of a request to script writers to submit a four-minute sketch to suit the style and personality of some particular broadcaster whose name will be given at the time. The prize-winning sketch, if suitable, will be played by the star artist in "Monday Night at Eight."

That is the scheme, but details are by no means settled. In the meantime please do not send scripts in connection with this competition until an official announcement is made.

Direct Disc Recording—4

(*Continued from page 59, January issue*)

IN the previous article we saw that the groove size relative to the "land" should be of the order of 60/40 for a standard type of 96-100 grooves per inch with no modulation. This condition allows of the use of an amplitude of cut giving a good signal to noise ratio, at the same time leaving an ample margin of safety between grooves and giving a reasonable playing time.

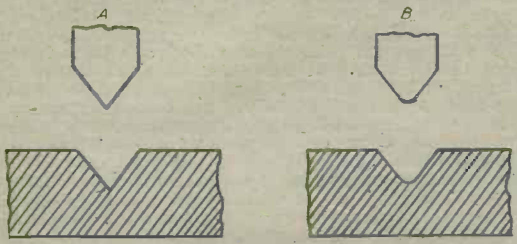


Fig. 1.—A, a good cutting edge and the resulting clean cut. B, a dulled cutting edge and the poor resulting groove.

The depth of cut should be of the order of 0.0025ins. and the radius at the bottom of the groove 0.0015 to 0.0025ins., while the wall angle should be of the order of 88-90 deg., depending, of course, upon particular type of stylus used.

If the stylus is inserted in the cutter head correctly and assuming that all other adjustments are correct, the swarf removed when cutting should come off in a straight, bright, thread, about the thickness of a coarse human hair. It will curl up slightly at the back of the cutting stylus and throw off towards the centre of the disc, lying some two or three grooves ahead, or behind as the case may be, of that being cut, and depending to a great extent on how great is the electrostatic charge of the disc. If antistatic dope is being used, or if a gelatine-coated disc is being used such as the "Simplat," then no trouble will be experienced with the swarf sticking at all, it will throw off some 2ins. towards the centre and may be safely left to pile up for about 15 seconds, when it can be lightly brushed to the centre with a camel-hair brush, and allowed to form again, the operation being repeated several times during the cutting of the disc.

The great point to watch, whether cutting inside to out, or outside to in, is that the swarf should throw off in a strong clean thread as already explained.

Some form of measuring must be undertaken to ascertain that the cut is of the required depth. Some writers suggest the use of a micrometer with which to measure the thread removed, giving a measure of the depth. It should be obvious that this method is quite

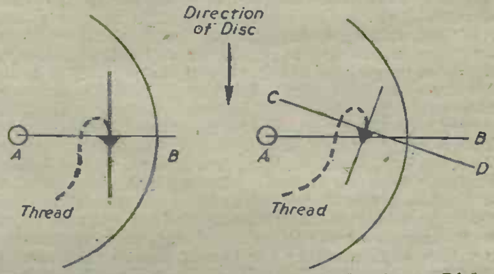
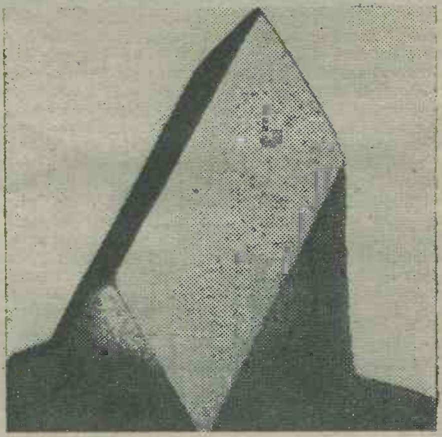


Fig. 2.—Left, the correct angle of stylus face. Right, the slight bias sometimes used to throw thread to centre.



Sapphire, half side view.

Fig. 3.—Left, steel cutter, showing sharp tip. Centre, sapphire showing rounded tip. Right, side view of steel cutter, showing highly polished sharp tip.

unreliable, as the thread removed will have three faces, none of which is the same, even though the two walls should, strictly speaking, be equal; and it will hardly be possible to be sure that one is measuring the distance from the top of the thread to that part which corresponds to the bottom of the groove.

The more usual and correct method is to use a microscope of at least 60 magnifications and to make certain that it is held in the same position and at the same angle each time comparisons are made. With this examine the groove, making sure that the correct groove width of 60/40 has been obtained. A microscope with hair lines fitted at a distance of 0.006ins. will make this quite simple.

Under these conditions the depth of cut will be correct, always providing, of course, that a perfect stylus has been used for the cut. This point will also be checked by an examination of the groove walls and bottom.

Before going on to discuss the actual stylus, one or two examples of incorrect cutting might be given to indicate how important it is to have this operation correct before even attempting to make a recording. For obvious reasons it is impossible to give all type of faults to be met with, just as in the following examples it would be incorrect to say that any one fault is always due to cause mentioned and no other, or combination of others.

If the thread breaks into pieces, looking dry and brittle, or if it comes away "kinky," then the cutting stylus is a "dud" or the angle is incorrect. A dull grey appearance of the thread, with a rough surface noise on playback usually indicates a dull stylus; whilst a crumbling swarf indicates a badly worn stylus, the cut being useless.

It is usually safe to say that the quieter the cut the quieter the playback, although there are occasions when a high-pitched whistle on cutting appears to have no effect on the playback. On examination of the groove it will be found that the bottom is a mass of minute serrations, due probably to the fact that the playback needle does not reach the bottom of the groove, or that if it does the playback equipment is not capable of producing such a high frequency whistle, or is attenuated in the high frequency end.

A high-pitched whistle usually indicates an incorrect cutting angle, with sometimes a dull stylus to accentuate it. We, of course, assume that the blank in use is beyond reproach.

The Stylus

The stylus is to the disc as the cutting tool on a lathe is to the material being cut. Upon both of them depends the whole question of a good or a bad job. Only the best should be used, which in the long run will prove the cheapest, even though not in first cost.

There are two main types in common use—the sapphire, used by the professional recordist, and those seeking the best possible results; and the steel in its several forms, for general use. The reader must not, however, think that first-class results cannot be obtained with a steel cutter, they can and very often are. Indeed, for many applications they are to be preferred to the sapphire, particularly where the operator is not an expert, or for certain classes of mobile recording where the chances of cutter head jumping are met with. In all cases the shape, size and general adjustments must be correct before even the perfect stylus will produce good results.

Let us deal with the steel cutter first. There are several types produced with varying cutting edges and shapes to suit different types of cutter heads. The most common is the straight-shanked type with a V cutting-edge, which should cut out a V-shaped wedge as shown in Fig. 1. It will be obvious that as the cutter is used considerable heat is generated due to the friction developed in cutting into the material, and that in the course of time the cutting edge will become dulled, until eventually a radius will be developed similar to that shown in Fig. 1 B, and instead of cutting a clean groove will tend to "gouge" out the material. A rough spot will be formed on each side of the cutter at the point where it enters the coating material, which on playback will show up as background noise.

The best steel cutter must, therefore, be of a high-grade hardened composition with a highly polished cutting edge. Before the war the author imported a Swiss-made cutter which put all other makes to shame. However, a very great improvement has been made in the making of steel cutters in this country and it is now possible to purchase really first-grade cutters at a reasonable price. It is only fair, however, to the reader to warn him that there are cheap and badly finished cutters on the market which he should avoid at all costs. It is important that each cutter in a batch should be consistent in finish, as there is nothing more annoying than to have to "set up" each time a new cutter is fitted, except of course for the usual check cut for correct angle and depth. This consistency can be obtained, as it is the author's experience that in a batch of 50 steel cutters used in the past few weeks only two were put on one side as doubtful. One of these was rejected owing to the flat on the shank being out of true and thus throwing the cutter at an angle. This flat is put on the shank in order to facilitate the correct insertion of the cutter into the chuck holding it. The fixing screw then has a flat surface to grip on instead of the round shank, and is thus better able to hold the cutter in position, also, of course, the cutter is almost certain to be inserted and held at the right angle.

Whilst mentioning this point it would be as well to mention the habit of some recordists to insert the cutter with a slight bias towards the centre of the disc, instead of being at right angles to the groove being cut. (See Fig. 2.) This is not a good habit as it must naturally make for an unequal groove, which, if carried too far will distort the groove and completely spoil the cut. The excuse for using this method is that it helps to throw the swarf towards the centre; up to a point it does, but it is usually quite unnecessary as the curling of the thread at the back of the cutter, already mentioned, is quite sufficient to assist the natural tendency of the thread to throw inwards. The cutter should be inserted so that the face (that is the part which meets the disc) is at right angles to the centre line of the groove which is being cut. If it is necessary to help the swarf to throw to the centre it is much better to set the whole cutter head so that the cutting stylus is just slightly ahead of a line drawn from the centre of the disc to the outer edge. This problem will be more fully discussed when we come to setting up the actual cutting mechanism.

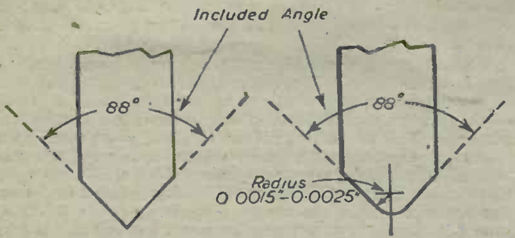
A well-made steel cutter with a high polish is capable of producing really first-class work, with a resulting background on playback that leaves little to be desired. The price of the steel cutter is low when compared with the sapphire, or the other types of cutters such as Stellite, but of course the life is much shorter. The table indicates the approximate prices and expected life of the various classes of cutting stylii.

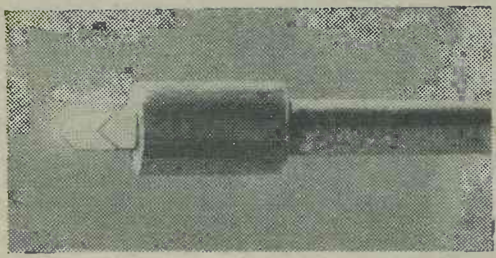
Whilst it is not considered good practice to use a steel cutter for more than one single 12in. disc if a "master" is being recorded for subsequent pressings, it is possible to cut two or three sides before wear becomes apparent. Each stylus will vary to a certain extent and it is quite possible for one to become dull in the middle of a disc, with an immediate increase in surface noise, so that it is well worth while making a rule never to use a steel cutter for more than two full 12in. sides at 78 r.p.m. or one side at 33⅓ r.p.m. even if it appears to have a good cutting edge.

One other non-jewel type is coming more into favour, especially for the broadcast transcription discs, that is Stellite, a metal alloy which is very hard indeed, and also expensive. It is usual to have a brass or duralumin-ium shank with a tip of Stellite, which can be resharpened several times. It is not possible to obtain quite such a highly polished cutting edge as with a sapphire, or as with a normal steel, but the life is much longer than the latter type and due to its great hardness it is less likely to be dulled whilst cutting than the steel, and thus lends itself to the long playing transcription discs rather better. It is also possible to manufacture this type with a slightly rounded tip, which has certain advantages to be discussed later.

Without question the stylus *par excellence* is the sapphire, either the natural gem, or the synthetic, usually the latter. It is capable of giving the quietest cut of any type, has the longest life of any, and can be resharpened some half-dozen or more times. It is more costly than other types in its initial cost, but the cost per disc is even less than the usual steel type, providing, of course, that it is not damaged before the end of its useful and normal life. This is the only point against its general use; bad handling such as being lowered on to the disc too quickly, will chip it owing to its brittleness, so that only those persons fully trained in the art should be allowed to use sapphires. For the home user one or two spoilt sapphires will either cure "ham handedness" once and for all, or will indicate the need for sticking to steel cutters. Photomicrographs of steel and sapphire cutters and their cutting edges, etc., are shown in Fig. 3.

The finish of the modern sapphire cutting stylus is a work of art and although by no means the "mumbo jumbo" that a lot of people would have us believe before the war, it does call for really skilled operators





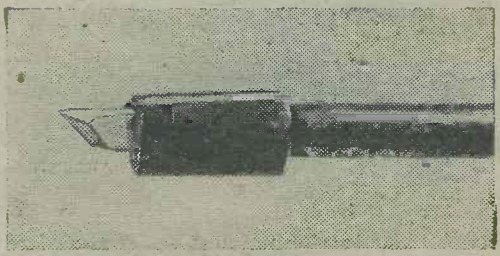


Fig. 4.—A steel cutter and a sapphire cutter. Below, sapphire, showing angles of heel. Right, side view of sapphire.

to produce a perfectly finished article. It may be of interest to readers to be given some idea as to how this is accomplished on a semi-mass production principle.

Sapphire blanks are first ground down to the correct size and rough shape in special machines, using diamond dust and some form of lubricant such as Vaseline. The blank, now the correct size and shape, except, of course, for the actual cutting edge, etc., is handed over to the skilled operators who fit it into a specially made chuck; this chuck is then held by hand against a guide bar which ensures that the sapphire is always at the required angle whilst being "lapped." This lapping is done on copper and satinwood wheels, the sapphire blank being held up against the side of the wheel which is revolving at high speed, and which is smeared with, first, a coarse diamond dust, and finally a finer grade of diamond dust, with a lubricant of Vaseline on the satinwood wheel. Gradually the cutting edge takes shape and the faces are polished up until the final desired shape is procured when the sapphire, still in its chuck, is put under a shadowgraph projector and an enlarged image projected on to a screen upon which is a card marked with the exact outline of the correctly shaped sapphire; should the sample not quite come up to the required standard it is returned to the lapping wheel, but if it is considered correct it is passed on to another operator whose job it is to round off the tip to the required radius of 0.0025in. or whatever figure has been decided upon for the particular production. The shadowgraph is again used to ensure that this rounding-off process is correctly carried out. Finally, the finished sapphire is set into its duraluminium holder with a high-grade shellac. A very small circular heating coil, or element, held in a handle the shape of a pair of pliers is fitted over the end of the holder; the sapphire, held with tweezers, is inserted into the cavity already made in the holder and which is filled with shellac. The heat liquefies the shellac during the insertion of the sapphire and is then taken off, when the hardened shellac firmly holds the stylus. This operation has to be carefully carried out as, of course, the sapphire must be inserted in the correct relationship to the flat on the holder and must be perfectly straight.

The author has frequently been asked why a diamond cutter is not used, on the assumption that as it is the hardest jewel it would give best results with the longest life. No diamond is capable of taking such a high polish as a sapphire, which is polished with diamond dust.

All types of stylii have varying frequency response, as also to a lesser degree will any two of the same type. The angle of the "heel" affects this frequency response to some degree and varies with each type of cutter, being dependent upon the amount of support which the cutting edge requires, which again will be dependent upon the type and strength of the material of which the cutter is made.

This backing up of the cutting edge, or heel, has another function, which is to conduct away from the cutting edge the heat generated in cutting due to the friction set up, which is quite considerable, especially at the higher speeds on the outer parts of the disc, of the order of 200 or more feet per minute at 78 r.p.m.

Figs. 3a and 4b show the shape and sizes of typical steel and sapphire cutters with the included angle which will affect the wall angle of the groove cut, and which must be taken into consideration when designing the "perfect" playback needle or stylus.

Type of stylus	Cost, each	Life	Remarks
Steel ..	5d. to 1s.	15 minutes	Thrown out at end of life.
Steel alloy	3s. 6d. to 5s.	2 hours	Can be re-sharpened.
Sapphire, usual synthetic	7s. 6d. to 12s. 6d.	4–6 hours	Can be re-sharpened.
Natural stone	£1 upwards	8–10 hours	Can be re-sharpened.

The above figures should be treated on a comparative basis rather than a definite statement of fact, although they are in all cases a minimum, and are naturally subject to quite large variations. Prices are pre-war basis for good quality manufactures.

Short-wave Radio—6

A Good 4-valver. Ganging Difficulties. Points to Watch when Using an H.F. Pentode as a Detector. Suitable Reaction Circuits. By 2CHW

(*Concluded from page 50, January issue*)

SCREW the pre-set condenser half home, and adjust the switch to the untuned position, and then proceed to tune the receiver in the normal manner. (There will be no need to touch the tuning condenser on the H.F. unit at this stage.) For test purposes select transmissions normally received, and it should be found that the reaction circuit will be more "lively" owing to the reduction in damping. Trying each coil in turn, adjust the new aerial series condenser and the one in the receiver (if such is fitted) until the best all-round results, i.e., selectivity and volume, are obtained. Leaving those condenser settings as they now are, repeat reception tests on all bands, but when a transmission is tuned-in switch the H.F. unit over to "tuned," and, after making sure that a suitable coil is in the H.F. coil holder, tune the unit by carefully adjusting its tuning condenser. Selectivity should be improved and reaction may have to be eased off a shade. If the signal is too powerful for the detector correct by using the H.F. volume control, which, so far, should have been at its maximum setting. When changing the coil in the receiver do not forget to also fit a suitable coil, one having the same frequency coverage in the H.F. unit.

The circuit as it now stands constitutes what can be described as a highly satisfactory "straight" arrangement, capable of giving good all-round results. If so desired, there is no reason why the three separate circuit sections, i.e., the H.F. stage, the detector and the L.F. or output stage, should not be assembled on a baseboard or chassis common to all instead of individual units. If this procedure is adopted it will be wise to pay attention to the location of the H.F. stage with respect to the detector, to avoid long leads and, at the same time, to avoid getting the components (chiefly the two coils) too close together, otherwise interaction may take place, and thus produce instability. Careful placing of the parts and/or wise use of screening will, however, remove any cause of trouble, but do not fix any screening which may be used too close to either of the coils. Keep the metal, at least, a distance away from the coil(s) equal to half or three-quarters the diameter of the coil former.

As mentioned before, there is a limit to the amount of L.F. amplification for satisfactory response bearing in mind the great necessity of securing a reasonable signal-to-noise ratio, and it is for this reason that only one stage of L.F. has been incorporated. There are, however, times and conditions when a slight signal boost would be an advantage. When a transmission is coming in well, and when atmospherics are at a low level, an extra L.F. stage will enable a loudspeaker to be used in place of headphones; therefore, a 4-valve line-up is well worth considering, providing the circuit is such that the extra L.F. stage can be cut if so desired.

A 4-valve Circuit

A typical arrangement is shown in Fig. 1, where it will be seen that all the features of the first three valves already described have been incorporated, thus allowing the additional stage to be added with the minimum of alteration. The one exception is that the third valve, which was an L.F. pentode, is replaced by a triode of the L.F. type, and the pentode moved along to take up its position in the new output circuit. It should also be noted that the S.W. H.F.C., which was in series with the H.T. feed to the anode resistor of the detector, has

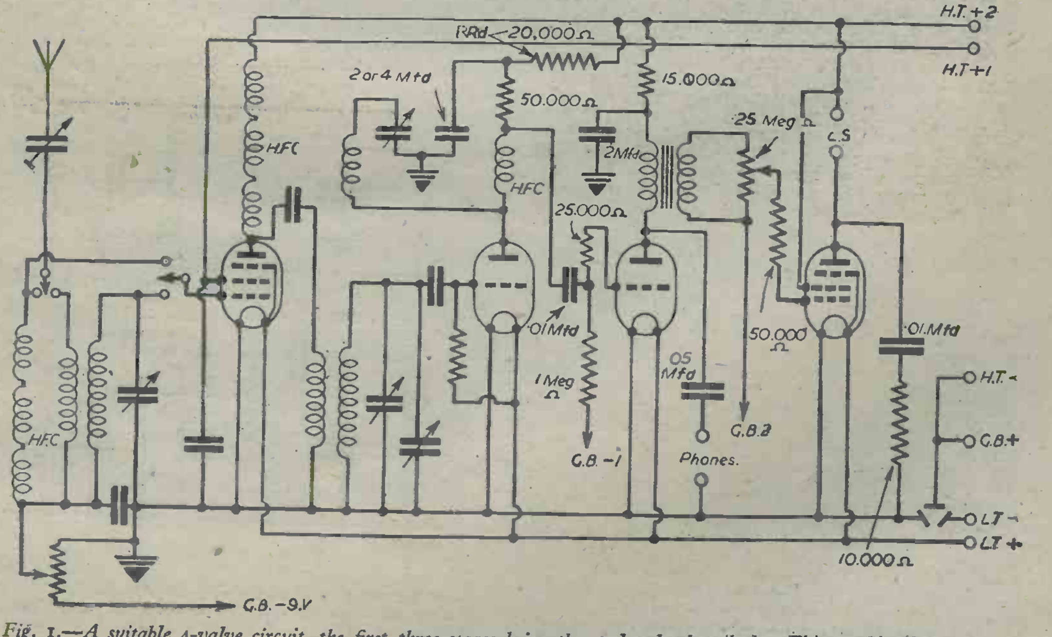


Fig. 1.—A suitable 4-valve circuit, the first three stages being those already described. This combination is capable of giving good all-round results.

been removed, and in its place the decoupling resistor Rd has been connected, together with a suitable by-pass condenser. Grid-stoppers are included in the grid circuits of V3 and V4, and further anode decoupling embodied in the anode circuit of V3. These little items are very essential to ensure complete stability, particularly if an H.T. eliminator is used. Across the grid circuit of V4 is connected a potentiometer having

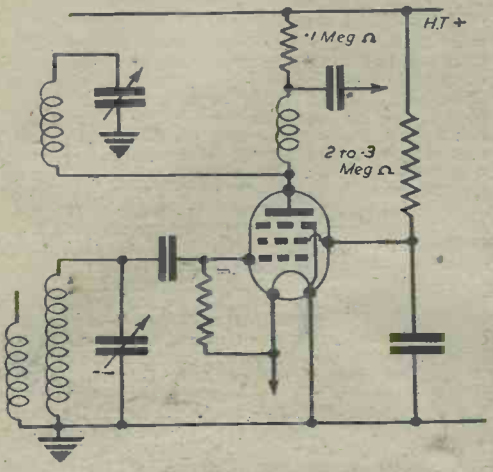


Fig. 2.—Skeleton circuit showing how an H.F. pentode is used as a detector.

a value in the region of 0.25 megohms to act as a final volume control when all the valves are in use. When the 'phones are being used, i.e., from the output of the third valve, adequate volume control can be obtained by careful manipulation of the H.F. volume control and the reaction condenser. For the coupling between V3 and V4 an L.F. transformer is shown, as this allows the L.F. valve in V3 position to receive a greater anode voltage than would be the case if R.C. coupling were employed, and, at the same time, the primary of the transformer forms quite an effective L.F. choke to allow a choke-filter output circuit to be obtained for the 'phones. The ratio of the transformer should not be too high; one having a ratio of 3 : 1 will be ample. Should L.F. instability in the form of "motor-boating" take place make quite sure that the decoupling condensers are satisfactory, and try reversing the connections to either the primary or secondary of the L.F. transformer.

Ganging

While the ganging of the tuning condensers in a two or more tuned circuit receiver simplifies tuning considerably, and while it is more or less quite a simple matter to take advantage of such methods in a normal dual range receiver, it is not so easy when dealing with the frequencies embraced by the usual S.W. band. Whereas, on the medium or long waves a slight difference in capacity of the individual sections of a ganged condenser can be tolerated, the same variation between the tuning of two circuits in a S.W. receiver would be very detrimental for the reasons explained in the first articles of this series. This means, therefore, that the tuned circuits must be accurately matched or balanced, and, bearing in mind the capacity which can be produced by wiring, etc., considerable care must be taken in the selection of components and their layout. In any two coils having the same rating as regards frequency coverage with a given tuning capacity, it is highly probable that the total capacity across each, when they are wired in a circuit, will not be identical. Many designs make use of small low-loss pre-set condensers or trimmers connected across the tuned winding and fixed to the coil formers. With these it is possible to secure a very close matching as the total capacity across each circuit can be adjusted to a value common to all. Should it be a matter of reducing the capacity of one coil in particular, rather than increase it to the pre-determined matching value, it is possible to make minute adjustments by increasing the spacing between two of the adjacent turns on the coil, but this is sometimes awkward if slotted formers are used.

With the 4-valver shown in Fig. 1 the tuning of the aerial circuit will not be as critical as that of the H.F. coupling; therefore, if preliminary tests (with the band-spreader disconnected) prove that the two main tuning condensers keep reasonably well in step over all ranges, or that there is a fairly consistent difference in their settings, they could be ganged, any differences being corrected by adding across the condenser having the higher reading, or across the coils used in that circuit, a small trimmer condenser which can then be adjusted until the higher reading component has to have its dial reading reduced to that of the other condenser. It would be advisable to fit band-spreaders to both "tank" or band-setting condensers, but, unless one is prepared to go to extra fine limits to obtain perfect matching, I suggest that it would be best to arrange the band-spreaders as separate individual controls, thus allowing them to take care of any slight variations in the tuning of the two ganged circuits.

An alternative arrangement, and one which is quite widely used, is to gang band-setters, and also gang band-spreaders, after, of course, the necessary steps have been taken to ensure accurate matching, and then employ a very low capacity trimmer across one circuit, to enable final adjustments to be made. The trimmer, in this case, takes the form of a small single moving vane (two fixed) type of variable condenser, and it is mounted as a panel control.

Making Use of the H.F. Switch

For those who do not wish to go to the trouble of carrying out the work involved for ganged circuits, the tuned-untuned switching arrangement incorporated in the H.F. stage will prove of great help in simplifying matters. For example, if the switch is set to the "untuned" position, one will be solely concerned with the band-setter and band-spreader across the H.F. coupling, so far as tuning the receiver. When the desired transmission has been tuned in, the switch can then be thrown over to its "tuned" position and the aerial circuit tuned in the normal manner.

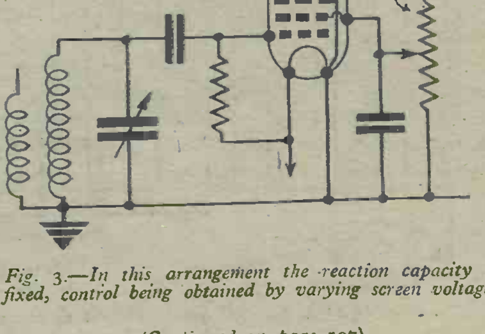


Fig. 3.—In this arrangement the reaction capacity is fixed, control being obtained by varying screen voltage.

(*Continued on page 107*)

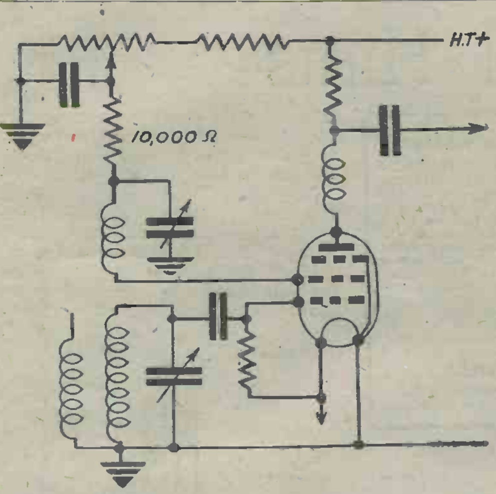


Fig. 4.—Using the screen as an anode for reaction feed-back. Dual control by variable condenser and screen potentiometer.

H.F. Pens as Detectors

An H.F. pentode of the "straight" type forms a very efficient leaky-grid detector, and for those who wish to try one in place of the more usual triode, the following items will help to avoid the snags which can be encountered.

To secure a reasonable degree of amplification when resistance capacity coupling is used, the load resistance must be high compared with the impedance of the valve. For example, with triodes, the load can be four to five times that of the valves' impedance, provided other conditions are satisfactory. With an S.G. and H.F. pentode, whose impedances are very much greater than that of a triode, it is not feasible to attempt to secure the same ratio, as the resultant high value of the anode load resistor would produce such a great drop in the applied D.C. H.T. voltage that operating conditions would be upset. When considering an S.G. or H.F. pen. as a detector, one is faced with the problem of L.F. coupling, inasmuch that it is very desirable to provide a satisfactory load, but, at the same time the anode of the valve must be maintained at a suitable positive potential with respect to its filament or cathode. The obvious solution would seem to be to use an L.F. transformer whose primary would offer little D.C. resistance. Unfortunately, however, the inductance of the average primary is not sufficient bearing in mind the high impedance of the valve, therefore, the best alternative is to use an L.F. choke having a very high inductance, plus a comparatively low D.C. resistance, and make an L.F. choke coupling. This is identical with resistance capacity, as regards circuit connections, with the exception that the L.F. choke replaces the anode resistor. To improve matters, a resistor having a value in the region of 0.25 megohms can be connected across the choke.

A suitable choke, i.e., one having an inductance of, say, 300 H, is likely to be somewhat bulky compared with the usual run of L.F. transformers, and more so with respect to R.C. coupling, and this combined with cost is, I suppose, really responsible for the more general use of R.C. coupling between an H.F. pen. detector and its L.F. or output stage.

With R.C. a satisfactory value for the anode load resistor seems to be in the region of 100,000 ohms for a battery operated valve, and slightly higher with one of the mains type. This high value makes the reaction circuit and the value of the screen voltage somewhat critical, but it is possible to secure most satisfactory results with a little care. The overall gain is certainly better than when a triode is used, therefore, in a circuit of the 0-V-1 type, a pentode detector has much to recommend it provided that little extra care is taken during initial adjustments. The screen is best fed through a series resistor from the main H.T. positive line, and decoupled or by-passed to earth through a fixed condenser having a value of 0.5 mfd. to 0.1 mfd.

Reaction

Using the normal type of capacity controlled reaction, a suitable detector circuit is shown in Fig. 2. An alternative arrangement, in which the reaction capacity is fixed, is shown in Fig. 3, the necessary control being obtained by varying the voltage applied to the screen. Another system is really a combination of those shown in Figs. 2 and 3, and it is depicted by Fig. 4. With this method the screen is used as an anode so far as the reaction circuit is concerned, the amount of feed-back being controlled by the reaction condenser and the potentiometer which also varies the screen voltage.

Theatre Organ Broadcasts

AS from Boxing Day, theatre organ music will once more be included in Home Service "Music While You Work" programmes. It will be heard at fortnightly intervals over a period of several months.

Theatre organ music was used in the early days of "Music While You Work," but was eventually discontinued as it was found that, particularly in noisy workshops, it tended to hinder rather than stimulate production.

Recently a trial was made to test if organ music was suitable for "Music While You Work." The managements of such specialised works as Messrs. Hoover, Ltd., Messrs. Rowntree and Co., Ltd., the Bristol Aeroplane Co., The Spirella Co. of Gt. Britain, Ltd., Royal Ordnance Factory, and Messrs. J. Lyons and Co. co-operated with Wynford Reynolds, organiser of "Music While You Work," the B.B.C. Engineering Department and H. Robinson Cleaver, the theatre organist.

Test Programme

THE test programme was broadcast "live" and listened to by a special deputation of sound installation representatives, organists and others. The factory managements, representing ninety-two thousand workers, reported on the audibility of the broadcast in quiet and noisy workshops, the suitability of the items played and their effect upon the workers.

The result of the experiment was the decision to broadcast a carefully selected programme of theatre organ music once a fortnight for several months. The organist to be heard in the first of these programmes on December 26th was Reginald Porter Brown.

Mr. H. S. Bennett

MR. H. S. BENNETT, M.I.E.E., has joined the Philco group of companies as telecommunications manager and technical adviser to the chairman and managing director. Prior to joining Philco he was assistant director of the Ministry of Supply, from whom he obtained his release to take up the Philco appointment.

Mr. Bennett has had considerable experience in communications work. From 1911 until 1926 he was the manager of the Hong Kong telephone system, and from then until joining the Ministry of Supply he acted in an advisory capacity to the Telephone and General Trust Company and associated companies.

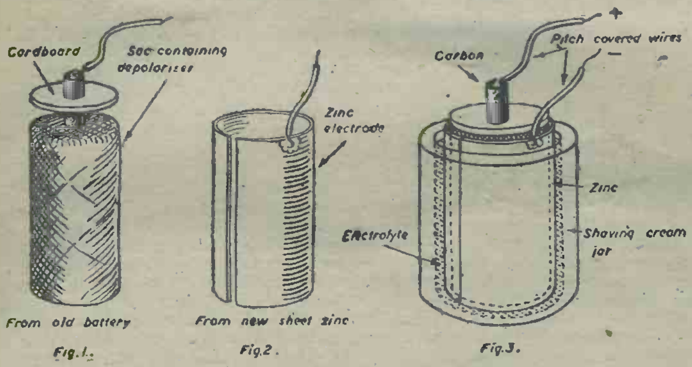
Mr. Bennett will make his headquarters at Donington House, Norfolk Street, Strand, London, W.C.2, the head office of the Philco group of companies. (Please note that Mr. H. S. Bennett is no relation to Mr. Laurence D. Bennett, chairman and managing director of the Philco group of companies.)

Practical Hints

Standby H.T. Batteries

A WET primary H.T. battery can be made from old exhausted dry batteries, at a very small cost. If only two or three cells are made they will be found useful to test the continuity of coils, etc., with a pair of headphones.

To make the battery obtain an exhausted H.T. or pocket-lamp battery, the older the better. Separate the cells from each other, exercising great care to leave a piece of wire connected to the carbon electrode of each cell (Fig. 1). Remove the old zinc remaining around the sac or cloth bag, taking care not to puncture it; do this to the number of cells which are required to be made. Next, get a sheet of zinc and cut it into pieces the height and length of the cells, so that when wound around the sack and carbon it fits nicely. The size varies according to the thickness of the sac. Make an equal



Method of making H.T. batteries from old dry cells.

number of zincs as you have sacs, and obtain an equal number of jars to suit your requirements. Fix a wire connection to the zinc as in Fig. 2. Obtain some sal-ammoniac and drop a little into the jars; put the sac inside the zinc (it should fit tightly) and put the new cell into the jar, pour water into the jar till it reaches ½in. from the top of the zinc, and the cell is then ready for use. To make it into an H.T. battery connect cells in series and paint wires which connect each cell with pitch to prevent corroding.

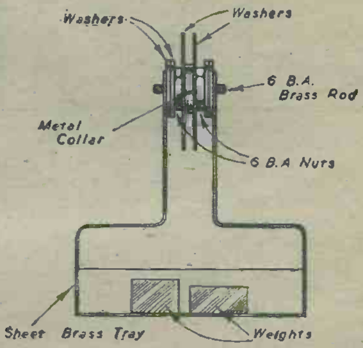
I use such a battery on a three-valve battery set, and get excellent results. I have also got three cells in series for testing coils, etc. The E.M.F. of these cells is about 1.5 volts.—M. O. NOLAN (Blackrock).

Automatic Cut-out for Use When Unwinding Coils

THE accompanying diagrams illustrate a device which I have used with success for unwinding transforemrs. I needed the wire from an intervalve transformer for another job, and to prevent the wire from breaking whilst unwinding, I fitted the attachment as shown.

The motor I am using is a 6-volt windscreen-wiper motor which provides sufficient speed and power without any alteration in the gears.

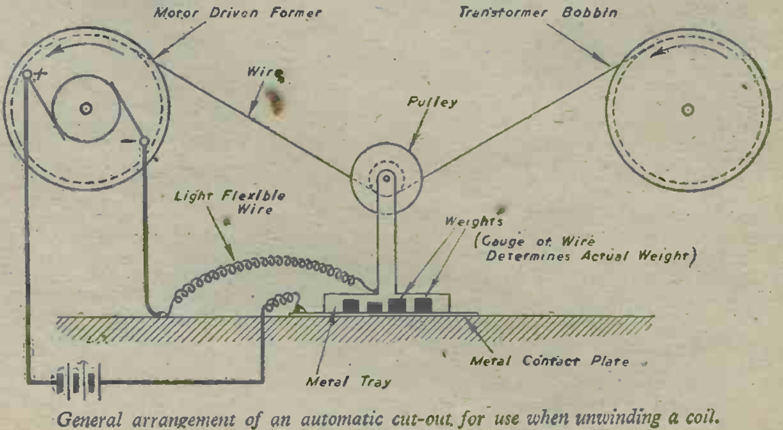
When the wire is caught up on the bobbin by wax, etc., the motor continues to wind in the wire which



End view of the tray carrying weights for the automatic cut-out for use when unwinding a coil.

raises the weight, thus breaking the battery circuit of the motor. The former on to which the wire is wound is worm-driven (the worm-drive being inside the motor housing) and therefore the weight will not unreel the wire when the motor stops. If there is no worm-drive, the motor will keep starting and stopping until the stoppage on the bobbin is cleared.

In practice, I have found that the weight is usually sufficient to clear the wire from the wax or whatever is retaining it. Obviously, this device is hardly necessary for the heavier gauge wires.—J. REECE (London).



General arrangement of an automatic cut-out for use when unwinding a coil.

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."

SPECIAL NOTICE

All hints must be accompanied by the coupon cut from page iii of cover.

ON YOUR WAVELENGTH

By THERMION

ALTHOUGH the Editor informs me that he is dealing with the matter in his leading article, I want briefly to record my views on recent broadcasts. I have expressed myself somewhat forcibly in the past on these broadcasts by novelists and others, and you know my opinions. That by Coward, however, exasperated me. I know that I can switch off my radio if I do not like a particular item, but on this occasion I listened to the end.

Quite apart from the portentous and pompous manner with which Coward delivered his peroration, giving the impression that he was a very important person, I disagreed entirely with his views on subjects upon which he is not qualified to speak, and should not have been permitted to speak by the B.B.C.

I cannot understand why the B.B.C. embarks upon this policy. If you wish to broadcast about international politics or unemployment, or any other subject for that matter, it seems to me that you only have to write a successful novel or a play. This particular broadcast was specially nauseating to me, having read Mr. Coward's own words concerning his joining up in the last war, and his leaving the Army.

There are sufficient numbers of people in the Government talking at us, and advising us, even cajoling us, without novelists and playwrights and those who have just passed out from some school of economics conceitedly telling us what to do, and what is wrong with the world and how to put it right. It really is expecting too much of the listener.

The Brains Trust

THE Brains Trust is another item which irritates me. Instead of continuing, as it was presumably intended to be, as a piece of light entertainment, it has developed into a serious debating society by means of which its members are able to disseminate to an enormous world-wide public wrong views on a wide variety of topics—some of them highly dangerous views having a political bias, and decidedly tendentious. Where questions are asked concerning matters of fact, time and again these pundits have been wrong. If you refer to my notes since this feature started you will find the correct answers to some of the questions wrongly answered by the Brains Trust.

Joad, I see, recommends that we should abolish private motor-cars from the roads in order to prevent accidents. Surely Joad should have said, before answering the question, " It all depends ! " In other words, he should have inquired of the cause of accidents before endeavouring to find a cure. Even philosophers should tackle causes and not effects. Would Joad abolish fish as a diet because a few people die of botulism, or basal metabolism, or ptomaine poisoning ? Would he abolish shaving because people cut their throats with razors, or disinfectants because people sometimes swallow it in order to commit suicide—an action which in certain circumstances Joad thinks justifiable ?

America tried Joad's method by going " dry " in an effort to cure drunkenness. We all know with what result. Joad would apparently like us to go back to parish pump times.

The nonsensical character of the questions asked are typical of the type of listener to whom the Brains Trust appeals. Seldom is a question asked concerning facts. Over 99 per cent. of the questions merely invite expressions of opinions. I understand that many thousands of questions are permitted. Who is responsible for making the selection ? Whoever it is, it is high time that someone else was given a turn. You do not want a trust of erudite people solemnly debating the reason why a cat buries its excreta, as once happened. Nor are the members of the Brains Trust those best qualified to decide how a fly alights on the ceiling. The reasons for that have been dealt with in the aeronautical and scientific press years ago, and as a fact it has been filmed. Not one member of the Brains Trust gave the correct answer. But there it is, some members of the public are stupid enough to believe that members of the Brains Trust are able to answer any questions submitted and thereby lend point to Carlisle's famous phrase—Forty millions—mostly fools, or Barnham's famous dictum, a fool is born every minute.

Purging the Augean Stable

THERE are, I know, many thousands of people who like dilettante drawing-room conversation of a light, but unenlightening, tergiversatory nature. I am one of those who do not. May I hope that in view of the criticism of recent broadcasts the B.B.C. purges the Augean stable and devotes less time to the broadcasting of views which are of no greater value than those of the man in the street.

I know that if some of the broadcasts which I have criticised were stopped the B.B.C. would receive requests for their continuation. I do not suggest that a claque exists, but the B.B.C. should remember that few people take the trouble to write letters of criticism, compared with those who write letters of praise. They are therefore likely to obtain an unbalanced view of the popularity or otherwise of a particular broadcast, and I for one do not believe that they have devised any system which can accurately guide them in that respect.

Our Roll of Merit

Readers on Active Service—Fiftieth List

H. W. S. Reed (Royal Marine, R.N.A.S.).
T. A. Reid (Gnr., 53rd Airlanding Lt. Regt.).
E. W. Matthews (P.O., R.N.).
R. Leach (Sgt., R.A.S.C.).
V. Binsted (Flt./Sgt., R.A.F.).
R. Coyles (Spr., R.E.).
H. Abbott (L.R.M., R.N.).
F. Challinor (A.C.1, R.A.F.).

DEDICATED TO THE B.B.C. POETRY DEPARTMENT

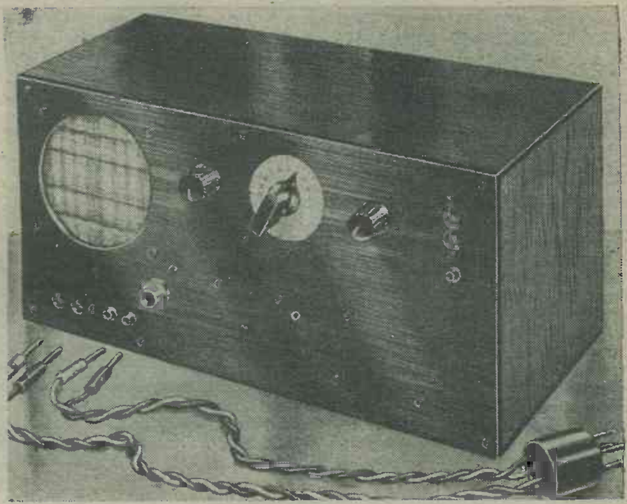
" Ah ! waley waley waley woe."
(Though what this means we do not know)
Thus bards at B.B.C. delight
To mouth such gibberish in the Mike.
In hollow accents, provocative of jeers,
They strive to tap the listeners' tears.
Emotion torn to tatters and to rags,
Verbosely practised till all interest flags.
The Voice rants on, its meaning all unknown,
Until insanity nigh claims us for its own.
Our low-brow brains in shrinking horror quake ;
We cry " Shut up, switch off, for Heaven's sake,"
And most of us, without the slightest doubt,
Just ask ourselves, " What was that all about ? "

Or are we wrong ? Is culture's first demand
A spate of words which none can understand ?
The open sesame to bright undying fame,
For " blue-eye " poets, however halt and lame ?
Whose vague obscurity, as genius is rated.
And ranked with Brains Trust, likewise over-rated
Just cause have we at both of them to scoff,
And exercise our right to switch them off.
Avaunt, ye long-haired poets
With rolling eyes all glistening,
Silence your turgid spate, for few indeed stay listening.

" TORCH."

A 2-valve All-dry Receiver

For Battery Operation



Sketch of finished receiver.

THIS receiver was designed to meet the need for a small inexpensive set for battery operation, having a low current drain and yet giving good loudspeaker reception on the Home and Forces programmes. It was not designed primarily as a portable, although its small size makes it easily transportable from place to place; it will pack into the corner of an average-sized suit-case. The set will operate on a full-size indoor or throw-out aerial quite well, while the addition of an earth gives improved reception, of course. A single dry battery only is required for operation—this supplies 90 volts H.T. and 1.4 volts L.T. Grid bias is automatic. The controls are tuning, reaction and volume, and a 'phone jack is provided for listening to weaker stations on headphones. Alternative aerial inputs are available for different size aerials. The whole cabinet and panel consists of 3-ply wood.

It was decided to design the circuit around valves with 1.4 volt filaments so that they could be operated entirely from dry batteries and avoid the use of a clumsy accumulator. The rather unusual circuit employed is partly the result of the valves which were available when the receiver was designed. The first choice for the detector valve was a 1N5, but this type was not obtainable, and so a circuit was designed around a 1A7. The triode section of a 1H5 did not appear to be very suitable for a detector, having a very high impedance, which would result in reaction being difficult to obtain. The 1A7 is a pentagrid frequency changer, and the oscillator section could be used alone with the signal grid (G4)

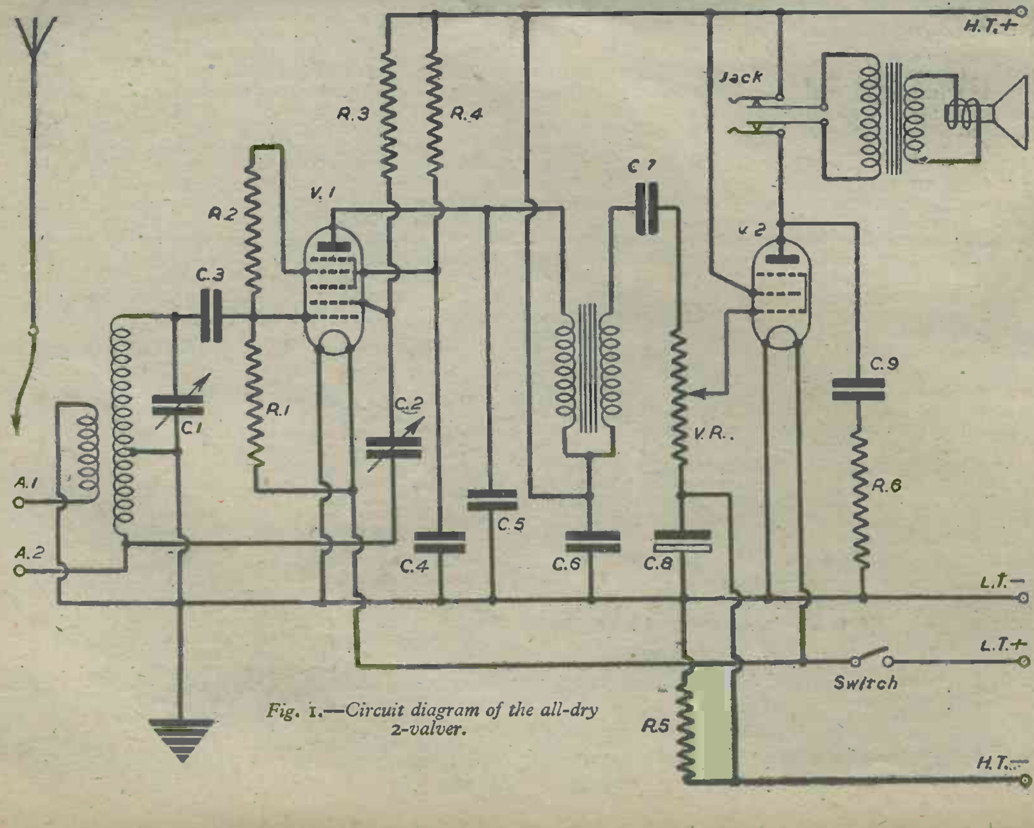


Fig. 1.—Circuit diagram of the all-dry 2-valver.

earthed, the A.F. output being taken from the main anode, but in the circuit described full use of the valve is made and G4 is used. The circuit is shown in Fig. 1.

A Hartley circuit was used for the detector section of the 1A7, employing a tapped coil. This was found to be the most satisfactory circuit for giving good reaction over the whole tuning range. The only critical component in the circuit is R2, connecting G1 to G4 of the 1A7, and it should be of the value specified, 100,000 ohms. It was found that if G1 was connected to G4 directly, the valve would not oscillate and no signals were obtained, while if R2 was very high, e.g., 1 megohm, L.F. oscillation occurred. 100,000 ohms was found to be the best optimum value. If R2 is decreased to 50,000 ohms, the reaction is not very strong, and if increased above about 400,000 ohms, instability and L.F. oscillation set in. The oscillator section of the frequency changer acts as a regenerative detector, while the application of the L.F. component of the signal to G4, the signal grid, via R2, results in the rest of the valve acting as a screen-grid L.F. amplifier. The L.F. signal is taken from the main anode. It is not possible to apply any L.F. voltage from the oscillator anode, G2, to G4 either by transformer or resistance-capacity coupling, as there is sufficient inter-electrode capacity to cause feed-back in such circuits. The resistor R3, of 10,000 ohms, serves the purpose of an H.F. choke.

Another unusual feature of the circuit is in the transformer coupling to the output valve. While only a small parallel-feed transformer is used, direct feed to V1 is employed, with current passing through the primary winding. Normally this would not be advisable,

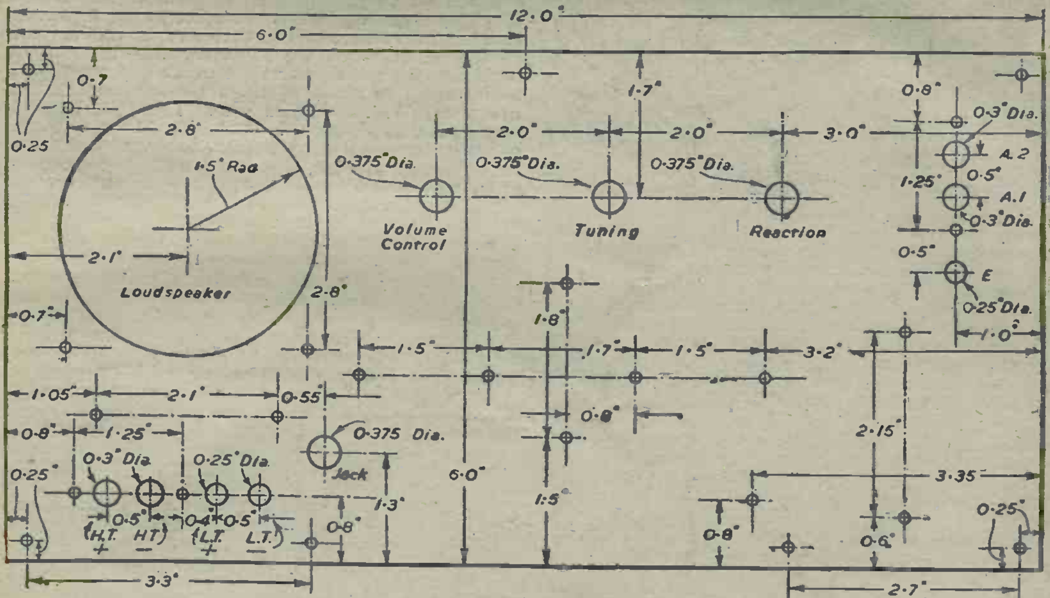


Fig. 2.—Drilling diagram for panel.

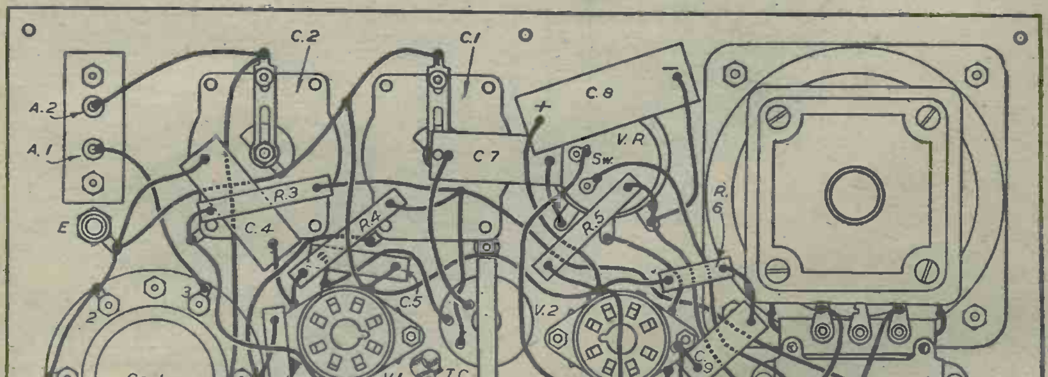


Fig. 3.—Wiring diagram.

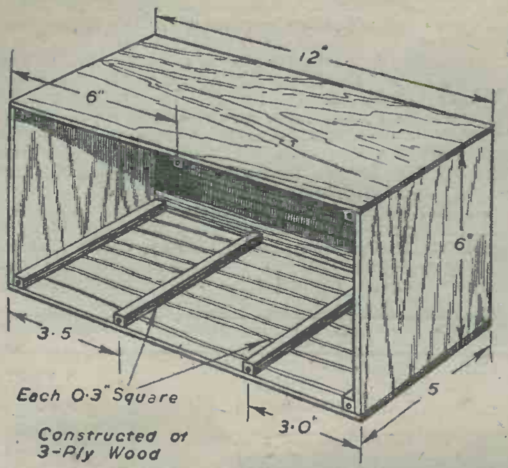


Fig. 4.—The cabinet.

as saturation of the small iron core of the transformer by the direct current would result in distorted reproduction. However, the rated anode current of the 1A7 at 90 volts is only 0.5 mA, and this is quite insufficient to affect the transformer. The component used only had three terminal wires and so it was not possible to separate the two windings—hence a blocking condenser of 0.1 mfd. was inserted at C7. The grid bias is applied through the volume control. The volume control is quite a necessary feature even on such a small receiver, especially when listening with headphones.

Grid bias for the 1C5 is obtained automatically by the resistor R5, of 1,000 ohms, which is by-passed by a high capacity electrolytic condenser C8. The anode circuit of the output valve contains a 'phone-jack which cuts out the speaker when in use.

Constructional Details

The panel and cabinet were made entirely of 3-ply wood, which was quite strong enough for the purpose, although a paxolin panel could be used if preferred. The panel is 12in. × 6in., and the whole assembly is mounted directly on it, no baseboard or chassis being used. A very compact layout is thus obtained and a little care is required in the wiring up due to the close spacing of components. The drilling diagram of the panel and the dimensions of the cabinet are shown in Figs. 2 and 4. In the construction of the cabinet, the corner pieces were glued before being fixed in position with small wood nails. The use of glue as well as nails gives extra strength to the finished article. When the construction of the cabinet and the drilling of the panel were completed, both were given a coat of dark stain. When this was dry, the outside of the panel and cabinet were painted with black enamel (or lacquer could be used).

All the main components were assembled on the panel before wiring was commenced. The assembly of components and the wiring diagram are shown in Fig. 3. Before continuing with the constructional details, a list of components required would be appropriate at this stage. This is given on page 113.

The coil used in the receiver was a commercial product, but a home-made coil could easily be made and would be quite satisfactory. The coil former can be of paxolin or dry cardboard, treated with shellac or varnish. The following data will enable a suitable coil to be constructed: Diameter of former, 1¾in.; grid winding, 80 turns, tapped at 25 turns from earth end; aerial winding, 25 turns, at ¼in. from grid winding. Both windings are close wound with 30 S.W.G. enamelled wire. The ends of the wire are connected to solder-tags fitted round the base of the coil. The numbers of the coil terminals in the wiring diagram, Fig. 3, are: 1. Tapping on grid coil. 2. Top of aerial coil. 3. Bottom of aerial coil. 4. Top of grid coil. 5. Bottom of grid coil.

By fixing a piece of wood across the bottom of the coil, it can be secured to the panel by one or two bolts as required. Fig. 5 gives a general idea of the coil assembly.

As indicated in the list of components, the tuning condenser, of 0.0005 mfd., should be of the mica dielectric type. A bakelite dielectric type can be used if a mica condenser is not available, but imposes more damping on the circuit due to increased dielectric losses. An important point to note is the type of output transformer used with the speaker. The speaker used in the receiver had a speech-coil with an impedance of 15 ohms, but the output transformer which was purchased was designed for normal speakers, which have speech-coils of 3 or 5 ohms impedance. In order to obtain correct matching, therefore, it was necessary to increase the number of turns on the secondary winding. When rewinding the transformer the number of turns should be increased to about 2½ times the original number, using 22 S.W.G. enamelled wire. This should be an easy matter as the secondary winding does not consist of many turns. If the secondary is wound under the large primary winding, it is not possible to remove it, and the extra turns required should be wound over the primary, in the same direction. It is usually possible in such a case to see the number of layers of primary by looking at the edge of the windings, and so calculate approximately the extra wire to be wound on.

Note that while ordinary sockets were used for the H.T. supply, banana-plug sockets were used for the L.T. supply, to avoid wrong connections. The two aerial terminals were normal sockets, while a banana-plug socket was used for the earth connection. The wiring diagram is necessarily rather complicated due to the small size of the receiver, and when wiring up it should be studied carefully in connection with the theoretical diagram. Note especially the valve-holder connections and the direction in which the locator-pin faces. R2 is connected to the top-cap of V1, the 1A7. On the jack, the wires to the output transformer go to the inner contacts, while the outer contacts are connected to H.T.+ and the anode of the 1C5.

Before fixing the speaker, a piece of perforated zinc, large enough to cover the aperture was placed in position and the speaker was bolted down on it. The zinc was given a coat of aluminium paint, which added to the appearance of the receiver.

The valve-holders were supported by long 4 B.A. bolts, which held them about 1in. away from the panel. Small wooden dowels could be used for this purpose also. The 2 mfd. condenser purchase had no fixing feet, and

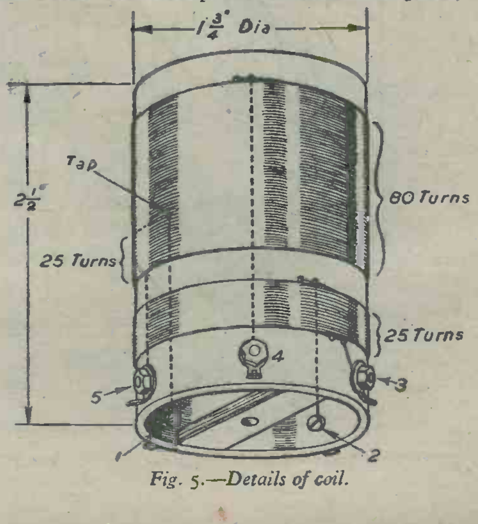


Fig. 5.—Details of coil.

so some were cut from a piece of tin and soldered on in the positions shown in the wiring diagram. When the wiring is completed it should be checked to make sure that no mistakes have been made. Then the valves can be plugged in, and the receiver screwed into the cabinet. The battery leads were made of ordinary lighting flex and were cut to a convenient length. The battery ends of the leads were soldered to an English 4-pin valve base the connections being as shown in Fig. 6.

The valve-base will plug into the 4-pin socket provided on the All-Dry Type Battery. With the connection of aerial and earth the set is ready for use.

Operation

Best results will be obtained with an outdoor aerial of course, but the performance is quite good on an indoor aerial. An earth gives louder reception, but can be dispensed with if it is not possible to obtain a suitable connection. A large outdoor aerial should be connected to A1, while small indoor or throw-out aerials should be connected to A2 which gives closer coupling. The receiver was first used with a 25ft. indoor aerial around a picture rail on the ground floor, and with an earth. Results were very satisfactory. Both the Home and General Forces programmes were received at good loudspeaker strength, together with the various B.B.C. European broadcasts. Using headphones, many French and German stations were received, together with Athlone, Radio Andorra, United Nations Radio, Algiers, etc., all at good strength. The current consumption is 0.15 A. L.T. and 7 mA. H.T., which is quite economical.

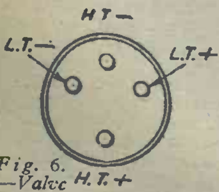


Fig. 6.—Valve base for battery leads.

LIST OF COMPONENTS REQUIRED

3½in. P.M. moving coil speaker.
Small output transformer for speaker (pentode).
Double circuit jack and plug.
2 International Octal valve-holders.
7 sockets (for aerial, earth, battery supply).
Midget parafeed transformer, ratio 4 : 1.
Medium wave coil.
0.0005 mfd. variable mica dielectric condenser.
0.0003 mfd. variable solid dielectric condenser.
Potentiometer, 250,000 ohms, with switch.
Small dial (about 1¾in.) with pointer knob.
2 small knobs.
Wire (20, 22 or 24 S.W.G.) and flex (for battery leads).
Systoflex.
Screws, nuts and bolts (4B.A. and 6B.A.).
Solder tags. Top-cap for valve.
Perforated zinc (for speaker grille).
Red and black plugs (for battery leads, aerial and earth).
4-pin valve base (English).
Fixed Condensers: 2 mfd. Mansbridge type. 0.0002 mfd., 0.0003 mfd., two 0.1 mfd., 0.005 mfd., 25 mfd., 12 v. electrolytic.
Resistors: All ½ watt. 1,000 w., two 10,000 w., 50,000 w., 100,000 w., 5 Mw.
Valves: 1A7GT and 1C5GT.

All components were obtained through the advertisement columns of *Practical Wireless*.

V1 1A7GT	C5 0.0002 mfd.	R2 100 Kw.
V2 1C5GT	C6 2 mfd.	R3 10 Kw.
C1 0.0005 mfd.	C7 0.1 mfd.	R4 50 Kw.
C2 0.0003 mfd.	C8 25 mfd.	R5 1,000 w.
C3 0.0003 mfd.	C9 0.0005 mfd.	R6 10 Kw.
C4 0.1 mfd.	R1 5 Mw	VR 250 Kw.

Factors, Laws, Rules, and Coefficients of Radio and Television

By HEREWARD WAKE

THE tendency of some writers of modern Radionic Text to refer to various factors, laws, rules, or coefficients without definition imposes on their readers the necessity of possessing retentive memories or possessing extensive libraries for reference purposes, and even if one has access to numerous technical books, it may be that one has to wade through a dozen or so in order to find the definition required for checking purposes. Therefore an alphabetical arrangement of such factors, laws, etc., will form an interesting and instructive reference paper for filing.

A

Absorption Factor.—Symbol a. That ratio of luminous flux in lumens absorbed by a body to that incident upon it. A lumen is that luminous flux emitted per unit solid angle by a point source (uniform) of a luminous intensity of one International Candle or 0.98 of the English Standard Candle.

Ampere's Rule.—Refers to the deflection direction of a magnetic pointer that is influenced by a current; an analogy being that if a person is assumed to be swimming with the current and facing the indicator, the north-seeking pole is deflected towards the left hand the south pole being deflected in an opposite direction.

Ampere's Theorem.—That the magnetic field from current flowing in a circuit is equivalent to that due to a simple magnetic shell, the outer edge coinciding with the electrical conductor with such strength that it equals that current strength.

Anode Effect.—That very quick current drop that is caused by film formations of gas on an anode or plate situate in electrolysis.

Archimedes' Principles.—(1). A body in liquid loses part of its weight, the loss to equal the weight of the liquid displaced. (2) The gas pressure on bodies immersed in gases is equally transmitted in every direction.

Asymmetrical Effect.—An inaccuracy of reading in radio direction finding that is due to unequal current distribution in the two halves of the loop. This is said to be the result of either inductive or geometric asymmetry.

Attenuation Factor.—A ratio of initial and received amplitude, it being determinable from e^{ax}, where x=distance and a = the circuit attenuation constant.

Austin's Formula.—That field strength in microvolts per metre at a kilometre's distance (D) from a transmitter having a wavelength (λ), an effective height (h) and an aerial current (i) in order to equal

$$(120\pi\, hi/\lambda D)e^{-0.0015D\sqrt{\lambda}}$$

Avogadro's Law.—Defines that equal volumes of all gases at a similar pressure and temperature have the same number of molecules.

B

Baur's Constant.—Is that voltage necessary to cause a discharge through a determined insulating material 1 millimetre thick. The law of dielectric strength is that breakdown voltage necessary to cause a discharge through a substance proportional to a 2/3 power of its thickness.

Becquerel Effect.—A change in electrode potential observed by illuminating an electrode (surface) in an electrolyte.

Belopolsky Effect.—Those spectrum lines displaced by a small, measurable amount when a light beam is reflected from a system of moving mirrors, the light being analysed with a spectroscope.

Boyle's Law.—Defines that if the pressure is not high the volume of a specified quantity of gas varies inversely as the pressure in a constant temperature.

C

Cell Constant.—The ratio of the average distance between electrodes to the average cross section of a current path traversed.

Charles' Law.—All gases heated at constant pressure will expand by equal fractions of their volume at o.c. for temperatures of equal increment.

Corbino Effect.—If a uniform radial current flows through a circular metal disc in a magnetic field normal to the disc plane a circular current is in evidence, the density being inversely proportional to the radius.

Corkscrew Rule.—A current flowing in the twist direction of a corkscrew creates lines of force in the direction of thrust, letting the insertion direction be regarded as a south pole facing the holder of the corkscrew as the lines are entering the insertion.

Coulomb's Law.—Implies that the mechanical force between two charged bodies is directly proportionate to the charges and inversely so to the squares of the distance separating them.

Coupling Coefficient.—That ratio of the difference to the sum of the squares of the resonant frequencies of two oscillating networks, the coupling factor permitting the constants to determine the energy transfer rate. For inductive coupling it is that ratio of mutual inductance to the geometric average (mean) of respective self inductances.

Curie Constant.—The coefficient of magnetism of a material multiplied by the *absolute* temperature. Ferro-magnetic materials possess a definite temperature of transition at which ferro-magnetic phenomena becomes para-magnetic, the property of ferro-magnetisation disappearing; the temperature being usually lower than the *Curie Point*—the melting point of the material.

D

Democritus' Principles.—(1) From nothing comes nothing. Nothing that exists can be destroyed. All changes are due to the combination and separation of molecules. (2) The only existing things are the atoms and empty space; all else is mere opinion. (3) The atoms are infinite in number and infinitely various in form; the strike together and the lateral motions and whirlings which thus arise are the beginnings of worlds. (4) The varieties of all things depend upon the varieties of their atoms, in number, size, and aggregation.

Dalton's Law.—In gas mixtures each exerts similar pressure as if acting singly. If several gases have similar temperatures in a mixture of them and occupy the same volume, the exerted mixture pressure must equal the sum of the pressures severally exerted by the gases.

Dissociation Effect.—Is that theory which assumes that substances in solution are dissociated into positive and negative ions carrying respective charges in opposite directions.

Doppler Effect.—Is that apparent change in the wavelength of light which is produced by the motion in the line of sight of the light source or in the line of sight of an observer.

E

Edison Effect.—The effect of electronic flow from a heated filament in a vacuum to a metal place or anode which is connected to a positive source of high potential.

Elster and Geitel Effect.—Defines that metal surfaces (polished) lose a negative charge if exposed to ultraviolet light, but retain a positive charge. Metals classified as *electro-positive* are most marked in this respect.

F

Faraday's Laws.—That of induction is that the e.m.f. induced in a circuit is proportional to the rate of change in the lines of force linking it. That of electrolysis is (1) That the quantity of a substance deposited in a defined time is proportional to the current. (2) That different substances and quantities deposited by a single current in a similar time are proportional to the electrochemical equivalents. The Faraday Effect states that when a light beam passes through a strong magnetic field the plane of polarisation is rotated.

Fleming's Rule.—By placing the thumb and two fingers at right angles respectively, the forefinger can represent the direction of magnetic force lines, the second finger, current direction, the thumb, motion direction.

Form Factor.—Applying to alternating current, is that ratio of the effective root-mean-square values to the true mean values.

Frauhoefer Lines.—Are noted when sunlight is seen through a spectroscope, they are seen as a great number of dark lines crossing the spectrum.

Fresnel-Arago Laws.—(1) Two rays of light similarly polarised interfere similarly as ordinary light. (2) If polarised at right angles they do not interfere. (3) If polarised at right-angles from ordinary light and then directed to the same plane they do not interfere. (4) If two rays obtained from plane polarised light are polarised at right angles they interfere when directed into the one plane of polarisation.

Fringing Coefficient.—This "spreading coefficient" refers to that factor by which a pole face area has to be multiplied in order to get the effective air-gap area.

Fusing Factor.—That ratio of a minimum fusing current to the carrying current rate of an electrical fuse.

G

Gauss Theorem.—Refers to that charge given to a particle at a particular point in an electrostatic field.

Guy-Lussac's Law.—States that if the pressure of a gas is constant, its volume varies directly with the absolute temperature.

H

Hall Effect.—If an electric current flows across the lines of flux of a magnetic field, an e.m.f. is observed at right angles to the primary current and to the magnetic field. When a steady current flows in a magnetic field, e.m.f. tendencies develop at right angles to the magnetic force and to the current, proportionately to the product of the current strength, the magnetic force and the sine of the angle between the direction of quantities.

Helmholtz Formula.—Defines the law of current rise in a circuit of inductance having neglible capacitance. Symbols are: i=current, t=seconds, R=resistance, L= inductance, E=voltage, e=the base of the Napierian logarithm. The formula is:

$$i=(E/R)(1-1/e^{R/tL}).$$

Hysteresis Effect.—The tendency of a magnetic body to retain any magnetism from a magnetising force, the effect which tends to lag behind a change in the force electrically producing it.

I

Impedance Factor.—This is that ratio of impedance to resistance in an electrical circuit.

Inverse Power Factor.—That reciprocal of power factor applied as a multiplier for changing kilowatts into kilovolt-amperes, this showing the wattless current proportion.

J

Joule's Law.—As a formula this is I^2Rt joules. It refers to that heat developed by the current (I) which is proportional to the square of I multiplied by R and t, letting R=resistance and t=time. If the formula is seen as $JH=RI^2t$ it equals EIt, letting J=joules equivalent of heat, and H=the number of heat units.

K

Kerr Effect.—Illustrates that an angle of rotation is proportional to a magnetisation intensity and applies to the rotation of polarisation plane of plain polarised light as reflected from the pole of a magnet. The number (a constant) varies for different wavelengths and specific materials, making necessary the multiplication of magnetisation intensity in order to find the angle of rotation forming the effect.

Kirchoff's Laws.—(1) In an electrical circuit, at any junction where circuits branch, the algebraic sum of the currents meeting is zero. (2) The total e.m.f. in a circuit equals the sum of the resistances of its parts multiplied by the current.

Klirr Factor.—Or the Coefficient of Non-linear Distortion, is that ration between root-mean-square values of a fundamental oscillation in wave form to that of the wave harmonics.

L

Lambert's Law.—Of illumination refers to the intensity of which on a surface, from a determined source and distance, is proportional to the cosine of the inclination angle of light on that surface, or that each layer of equal thickness absorbs an equal fraction of the light which traverses it.

Lenz's Law.—That induced currents have such a direction that the reaction forces generated have a tendency to oppose the motion or action producing them.

M

Magnetron Effect.—That loss of strength of electronic emission due to a magnetic field from filament current, limiting output, especially with large thermionic type valves.

Maxwell's Rule.—A circuit is acted upon by an impelling force, forcing it in a direction enclosing the maximum lines of force. Maxwell's *unit tubes* of electric or magnetic induction are such that a *unit pole* delivers 4π unit tubes of force.

Miller Effect.—Implies that the grid input impedance of a valve with a load in the anode circuit is different from its input impedance with a zero anode load. Should the load in the anode be resistance, the input impedance is purely capacitative. If the load impedance has a reactive component, the input impedance will have a resistive component. In pre-detector amplification, with a.v.c. to signal grids, the capacity across the tuned grid circuits tends to vary with the signal strength, evidencing detuning, the effect causing a charge (electrostatic) to be induced by the anode on the grid.

O

Ohm's Law.—If the temperature of an electrical conductor is kept constant, the ratio of the steady potential difference between any two points, minus generated electromotive force, to the resulting steady direct current is constant. Shown in symbols $E/I=R$, where E=p.d., I=current, R=a constant=the resistance of that part of the conductor under consideration. Given any two of these quantities, the third may be found, for if $E/I=R$, $I=E/R$, and $E=I\times R$. Variations of the law relative to multiples and sub-multiples of the units E.I.R. are numerous, examples being: $E=W\div I$, $E=\sqrt{R\times W}$, $E=$milliamps, $\times R\div 1{,}000$, $I=W\div E$, $I=\sqrt{W\times R}$, $I^2=W\div R$. $R=E^2\div W$, $R=1{,}000{,}000\times W\div mA^2$, etc.

P

Page Effect.—The audible evidence when iron is magnetised or demagnetised, heard as a "tick."

Paschen's Law.—Relates to the length of a spark in gas and states that the required *p.d.* is constant if the product of the gas pressure and the maximum spark length is kept constant.

Peltier Effect.—That temperature rise and fall on contact between two dissimilar metals by current from applied *e.m.f.* in either direction respectively, as the metal's *thermo-electric e.m.f.* when heated. The coefficient is that energy emitted or absorbed per sec. when unit current, caused by external *e.m.f.* passes through the junction, this being numerically equal to the *p.d.* at the junction in *electro-magnetic units*. The effect alters or varies for certain temperatures.

Phase Factor.—Expressed as a vector, that quantity by which a maximum *e.m.f.* must be multiplied with an attentuation factor to find the *e.m.f.* on any part of a wave sent along a conductor.

Pinch Effect.—Is that magnitude of the up-and-down action or motion of a *pick-up* stylus tip that is caused by the periodic variation of the included angle between the two modulated groove walls on a record.

Planck's Constant.—Quanta of energy radiated when atomic electrons transfer from one state to another, assuming both to be *energy states* with electro-magnetic radiation. The constant (h) is given the value of $6{\cdot}55\times 10^{-27}$ erg second. h is usually coupled to the symbol (v) to represent the frequency of the radiated energy in *c.p.s.* That is, the frequency of the radiated energy is determinable by the relation W_1-W_2, this equalling hv. W_1 and W_2 equal the values of the internal energy of the atom in initial and final stages. Some text books on radio refer to this constant as the *Quantum Theory*.

Power Factor.—In a circuit of *a.c.* this is that ratio of watts to total volt-amperes, being equal to the cosine of the angle of lag between voltage and current—for sinusoidal wave-form currents.

R

Radiation Factor.—That constant of radiation of an aerial which is divided by the wavelength, being proportional to the square root of the radiated power.

Reflection Factor.—Or the coefficient of reflection is that ration of luminous flux reflected by a surface to that incidental on it, or it is the total reflection factor or ratio.

Ripple Factor.—This is that ratio of the *RMS* value of the ripple of a rectified current filter to the mathematical average value of the total $I\times\sqrt{2}$.

S

Shot Effect.—That small anode current fluctuation in a valve due to irregular emission, caused by the finite charges carried by individual electrons—sometimes termed *Johnson Noise*.

Snow Rule.—The deflection direction of a magnetic needle is such that the current flows from South to North Over the indicator, the north pole being deflected to the West.

Space Factor.—That ratio of the cross-sect. of wires in a winding to the cross-sect., including insulation and space, of the actual total space taken up.

Snell's Law.—If light passes from medium to medium the incident ray, normal to the surface at the incidence point and the reflected ray are in the same plane. The ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant for the same *two media*, this, however, is dependent upon the nature of the media. Therefore, $\sin i/\sin r=u$ or the *refraction index*.

T

Transmission Factor.—Of a gramophone record is that ratio of the needle amplitude to the cutting stylus amplitude. Somewhat high, it is not independent of frequency.

Temperature Coefficient.—The proportional change of resistance in a conductor per one degree of temperature. This is positive for metals and negative for carbon. It is approx. constant for pure metals only.

Thompson Effect.—That reversible thermal effect produced when current flows in a conductor having unequal heat. With copper, heat is absorbed when current flows from a cold portion to a warmer one in it.

Tyndall's Phenomenon.—If a light beam penetrates a dark room containing particles of dust, the light is in evidence from the *scatterings* of it on the particles, the silight being fairly polared.

(*Continued on page* 130.)

Re-using H.T. Batteries

A Topical Article Showing How to Extend the Life of Old Batteries as a Wartime Measure

By B. W. F. MAINPRISE, B.Sc.(Eng.)

IN these days the scarcity of H.T. batteries makes it essential to obtain the fullest life from each, not only to conserve raw materials, but also to enable the receiver to be kept in action until a new battery eventually comes to hand. Most batteries are incapable of working the set when their voltage has fallen below about 60 in the case of the usual 108 volt size, and they are then thrown away. The user seldom realises that even if such a battery shows a voltage of only around 30 this figure can, in a large number of cases, be easily restored to about 80 volts or more.

The drop in voltage is not normally confined equally to all the cells which make up the battery. Usually it is confined to only about a couple out of the 75 employed. In these few defective cells local action has been excessive, often due to the presence of impurities. This results in an extremely high internal resistance, which sometimes amounts almost to an open circuit. It will be found that the zinc cans of these cells will have corroded, with a white paste or powder oozing out. It is the leakage of this substance which impels manufacturers of torch batteries to print on the label a warning to remove the battery when this is run down. In H.T. batteries the removal of these few defective cells is all that is required generally to restore the voltage to a value much nearer that originally supplied.

Locating the Fault

The location of these cells is a very simple matter. Turn the battery upside down and slit along the edge of the protective cardboard cover so that it can be hinged back, exposing the bases of the cells. Now connect a voltmeter across each bank of cells in turn. Most of the banks will probably show a voltage not much below the correct amount given by $1.5 \times$ No. of cells. (For this test a moving iron instrument taking a fair current is just as satisfactory as a moving coil meter.) One bank, however, will show a greatly reduced voltage, and the polarity may even be reversed. This is the faulty bank, so connect the voltmeter across the bases of adjacent cells in it to locate the faulty ones. Note their position, turn the battery right side up and chip away the black sealing compound above them, so that they can be pressed out from the battery. Connect a wire across the gap they have left, and the battery voltage will be found much nearer its original value.

Often the defective cells can be located merely by inspection, without recourse to a voltmeter, for their corroded zincs, with the white paste oozing out, will be readily visible, though the voltmeter test is more conclusive. It is better to remove these cells from the battery and not to leave them in position, with shorted connections, for the paste will penetrate to adjacent cells, and, worse still, to adjacent banks through the cardboard spacers.

Such treatment should by no means be thought to produce only a very temporary reprieve for the battery. It will often enable the set to be kept working for another 100 hours or so of reception, by which time a replacement battery will probably have become available.

While crackles used to be produced in abundance by the batteries of a decade or so ago, they seem much rarer in modern types. One experience of this year, however, may be of interest. The writer had bought a brand new battery, and on connecting it to the set there was a continuous background of crackles, which were completely absent with the old battery. The bottom of the cover was removed, and by testing as already indicated, one cell was found to give no voltage. Removal of the sealing compound immediately above this cell disclosed a rust-coloured bubble between the positive rod and the zinc casing. Apparently a drop of rusty water, possibly from a leaky factory roof, had entered the battery or perhaps had entered via the tapping socket (for the cell was that providing the 60-volt tap), during transport and had short-circuited this one cell. The removal of this from the battery cured the crackles.

The Economy of Decoupling

Another point to remember is that efficient decoupling may prolong the useful life of many a battery. The internal resistance of every battery slowly increases during use, and where decoupling is very insufficient it causes "motor-boating," or a continuous whistle whether the set is tuned to a station or not. In such cases the need for decoupling is obvious so that the battery can still be kept working the set, but there is a less evident state of affairs where oscillation does not take place, but where the phase difference of the feed-back decreases the amplification. Loss of volume is then due to two causes, namely, lack of voltage and out of phase feed-back, and while the first cannot be remedied except by restoring the voltage to the proper figure, the second can easily be avoided by connecting a filter condenser of about 4 or 8 mfd. across the appropriate points in the circuit, which are best found by experiment rather than examination of the circuit diagram. Grid circuits as well as anode circuits may be responsible, and care should be taken to see that while in H.T. circuits the *negative* (container) side of an electrolytic condenser is connected to chassis, in most grid circuits the *positive* side is connected to chassis so that the condenser cannot be mounted in the normal way. The reason is that the grid is more negative than the chassis; hence, the can of the condenser is connected towards the grid end of a biasing resistor.

An example of the saving effected by decoupling is worth noting. The writer found that in one battery portable receiver L.F. instability was produced when the battery voltage had fallen from 108 to about 75 volts, a loud howl being produced, with the programme only faintly audible behind it. Connecting an 8 mfd condenser in the circuit completely cured this, with considerable increase in programme strength—in fact, when the same battery had still further fallen in voltage to less than 40 the set was still usable for listening to news bulletins.

While on the subject of battery life, a few notes on the maintenance of L.T. accumulators may not be amiss. First of all, obtain a hydrometer—beg or borrow it if you have not one of your own—and check the specific gravity of the acid. Time and again people have mentioned to the writer that their accumulators seem able to work the receivers for only a few days at a time, and new ones will have to be obtained. In the majority of these cases a check on the electrolyte has shown this to be scarcely stronger than water. Giving the accumulator a thorough recharging, and then filling with acid of 1.25 sp.gr., as recommended by the makers, has resulted in a vast restoration of the accumulator's ability to work the set for a proper number of hours, and the improvement is not only a temporary one. The rule is quite simple: if liquid is lost by evaporation pure and simple the acid salts remain and only the water component is lost, so that only water must be used for "topping up." But if liquid is lost by spilling, or spraying, or foaming over the vent holes through excessively fast charging, then acid is lost, and the level must be restored by the addition of acid of similar specific gravity to that remaining in the cell, provided this is of correct value, namely, 1.25 for a fully-charged cell.

High Q Resonant Circuits

The Function of Iron-cored Inductances, and the Elimination of A.C. Ripple

THE use of iron-cored inductances in resonant circuits in radio has always been strictly limited for at least three reasons. First, at radio frequencies the self-capacitance of the coil and core is far from negligible, and eddy currents in the core present difficulties even with the finest laminations. Secondly, the high value of the inductance calls for a correspondingly low value of capacity, and this, apart from being more susceptible to unbalance by stray capacities than a large one, would offer difficulties to variable tuning by its small physical size. Thirdly, the resultant L/C ratio, or more particularly the L/R ratio (Q), would give such sharp tuning as to cause serious high-note losses through band-spreading on all but the very highest frequencies, which is just where the iron losses and the self-capacitance of the coil would begin to make themselves apparent.

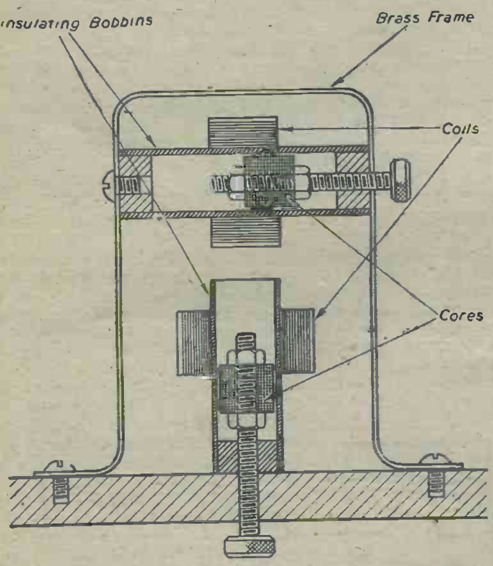


Fig. 1.—Sectional elevation of a typical I.F. transformer.

There is, of course, no need for the iron circuit of an inductance, as opposed to a transformer, to be closed. In practice, in low frequency chokes and swinging chokes, it seldom is. The effect of an air gap is to reduce the effective permeability of the core, thus allowing a greater magnetising current before saturation point is reached, at a cost of a proportionate reduction in the inductance. Alternatively, for the same magnetising current a smaller area of core is required with an air gap than without.

Air Gap

If the length of an air gap is small in comparison with both the length and the area of the core, it may safely be assumed to reduce the effective permeability in the ratio

$$\frac{\text{Total length of core}}{\text{Length of iron plus (length of gap)} \times \text{(permeability of iron)}}$$

With the introduction of band-pass tuning and the superheterodyne receiver intermediate-frequency transformers with a certain amount of iron in the magnetic circuit made their appearance. They can easily be designed to minimise all the disadvantages previously enumerated. Tuned for a band-pass at a predetermined frequency, the high Q and the smallness of the trimming condensers were turned to an advantage. The high frequency effects were minimised by the mechanical design of the transformer (Fig. 1).

The coils were wound in many cases on separate cores, and these were so disposed as to obtain the degree of coupling (mutual inductance) required. In the best, the cores were of electrolytic iron, and were carefully adjusted to the position relative to the coil which gave them the required degree of saturation.

Iron-cored Inductances

Iron-cored inductances in resonant circuits are also found in the smoothing circuits of the H.T. supply in radio work, but it is only in teleprinter and automatic relay work that they are really common.

Some readers may remember the introduction, a few years ago, of remote control for street lighting, etc., by means of a superimposed ripple on a D.C. supply. At various points switches are arranged to be operated by resonant circuits, resonant at different frequencies. When a certain set of lights are required to be lit, an A.C. ripple of the correct frequency is superimposed on the supply at the control point, and the appropriate relay, and no other, is operated. Obviously the number of circuits it is possible to control simply depends on the range of frequency of the ripple and the sensitivity of the resonant circuits.

In the teleprinter the same principle is used to operate at a distance the keys of what amounts to an automatic typewriter. Here again the number of keys it is possible to have depends upon the same two factors.

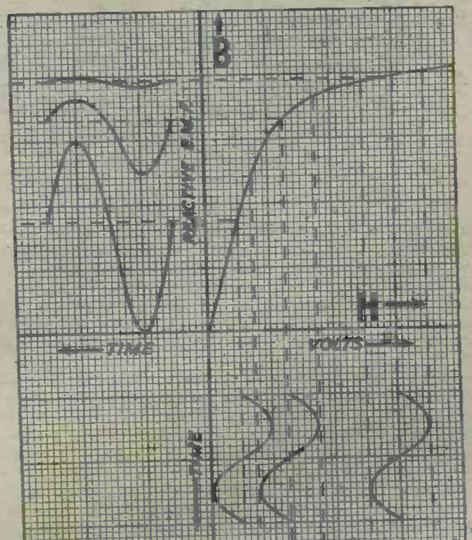


Fig. 2.—Curves indicating the reactance of a choke to A.C. ripple on D.C. supply.

Up to the outbreak of hostilities it was understood that the teleprinter was the only method of communication which it was considered impossible to tap. The reason was that such highly selective circuits were employed that any attempt to tap the line resulted in unbalance which prevented the machine from working. During wartime all such work is shrouded in official secrecy, but it is doubtful whether any means has been devised of overcoming this.

Ripple

In all cases where the coil deals with a superimposed ripple, whether a relay-operating or a smoothing circuit, there is a direct current passing through the coil. Unless this is within definite limits it is likely to alter the value of the inductance in a manner similar to that caused by excessive A.C., as discussed by the writer in "Saturated Cores." Fig. 2 shows how this biasing current, if small, permits the ripple to have full choking effect, but if large, reduces the effect considerably.

For this reason, if the direct current is not certain to be limited to a very small value compared with the ripple (and this is seldom the case) it is necessary for its magnetising effect to be nullified. This is done by passing a demagnetising current through a secondary winding on the same core (Fig. 3). This demagnetising current must be pure D.C., for if there is any irregularity the two windings will act as a transformer and the fluctuations in the secondary will all be faithfully reproduced in the main circuit, probably with serious results. Also, in a smoothing choke the demagnetising current cannot possibly be drawn from the smoothed side, because by a similar transformer action the ripple will be passed on.

Saturated Cores

Finally, it may be interesting to consider the writer's remarks on "Saturated Cores" as applied to a resonant circuit. Fig. 4 is the wiring diagram of a circuit designed to eliminate A.C. ripple from a D.C. constant current supply. As the value of the direct current was known to be fairly constant, the demagnetising winding could be designed with a fair degree of accuracy. This leaves only the maximum value of the A.C. ripple to be considered in designing the core. Given a ripple of constant frequency the resonant circuit could be designed to practically eliminate the A.C. voltage, but if the amplitude of the ripple were increased beyond the value allowed for in design, or if the core were wrongly designed and consequently became oversaturated, or again if the demagnetising coil were not correctly matched to correct the D.C. effect, the results would be as illustrated in Fig. 5.

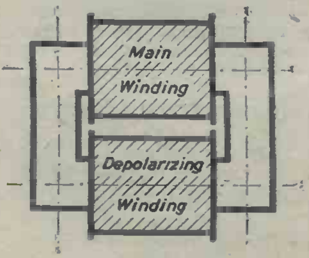


Fig. 3.—Core-type shunt—field choke.

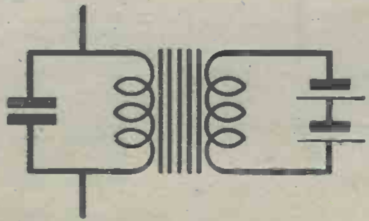


Fig. 4.—Smoothing circuit with depolarised choke.

Assuming a sinusoidal alternating voltage across both parallel paths, the current in the coil becomes either peaky in the first case (Fig. 5a) or irregular (Fig. 5b). In either case the current in the condenser will be nearly enough sinusoidal, and cannot possibly match the current in the coil, and there will be a trickle of current leaking through. As the diagrams show, this is not of the frequency of the applied voltage, but is an impure third or second harmonic.

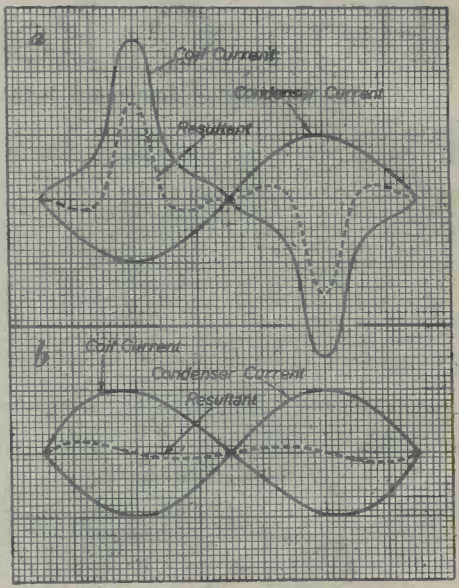


Fig. 5.—Coil/condenser current curves.

As the diagram shows graphically, pure resonance is almost impossible to obtain without sinusoidal wave-forms. It is too often assumed that the reactance of the coils and condensers in resonant circuits have to match according to the formula

$$wL = \frac{1}{wC}$$

This, of course, only applies in the case of sinusoidal waves. The more general formulæ are

(a) for series resonance

$$L\frac{dI}{dt} = \frac{1}{C}\int Idt$$

(b) for parallel resonance

$$\frac{1}{L}\int Edt = C\frac{dE}{dt}$$

In either case, for the wave-forms to correspond, the wave-forms of the integral curve and the differential curve must be identical.

High Efficiency Power Amplifiers

A Practical Study of Class A, B and C Systems

By H. REES

OUTPUT stages in audio-frequency amplifiers generally operate in Class A, the essential features of which are illustrated in Fig. 1.

Grid-bias is adjusted to fix the initial operating point at P, about midway on the straight portion of the valve characteristic. With this bias the grid "signal" e.m.f., Eg, must not be large enough to run into the region of grid-current, i.e., where the sign of the grid potential becomes positive.

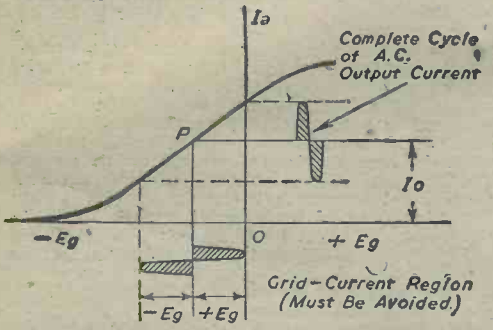


Fig. 1.—Class A operating conditions. Bends in characteristic, and grid-current must be avoided for minimum distortion. Steady D.C. feed, Io, is large and constant, leading to low efficiency.

If these conditions are strictly observed the waveform of the A.C. output, Ia, will be a close replica of the original waveform of Eg. We have *sinusoidal* operation, or *minimum distortion*, which is the outstanding feature of the Class A amplifier. Running into grid-current, or curvature of the characteristic, implies that partial rectification will take place, and in an A.F. stage this is another name for distortion, e.g., the positive and negative half-cycles of Ia will be of unequal amplitudes.

It is fairly easy to design a Class A stage which is well within the usual prescribed limit of 5 per cent. distortion, i.e., 5 per cent. harmonic content. Where "minimum distortion" is the prime consideration, as it must be in an L.F. amplifier, there can be no question of using any alternative to Class A. But the fact that Eg must be restricted to a figure that will avoid grid-current and "bending," means the A.C. output obtainable will be similarly restricted. In practice, it simply amounts to this: we must not apply too large a signal to the grid, because, even though that will force more power into the loudspeaker, the power gain is obtained by putting up with more distortion.

For this reason, a large proportion of the *input power* from the H.T. is not converted into useful *A.C. output*, but simply wasted in heating the anode. At best, the useful output cannot be much more than some 30 per cent. of the input, which means that 70 per cent. of the H.T. power is wasted at the anode. Under the worst conditions, i.e., with no signal at all on the grid during intervals in the programme, etc., the full H.T. input will be dissipated.

Anode Efficiency

Thus another outstanding feature of the Class A stage is its extremely poor *efficiency*. Expressed as a percentage as above, *efficiency* simply means the percentage of the total power supplied that is obtained as useful output, or,

$$\text{Anode Conversion Efficiency} = \frac{\text{A.C. Output (watts)}}{\text{D.C. Input (watts)}} \times 100$$

Now, in small power amplifiers efficiency is not an important consideration. The total H.T. power is, in any case, small, and there is but little danger of overheating the anodes. It is far more important to get an undistorted output into the loudspeaker, and no one worries what proportion this is of the few watts the power valve takes from the mains.

This is, provided we have not to worry about H.T. battery renewals! But at one time a "battery economy"

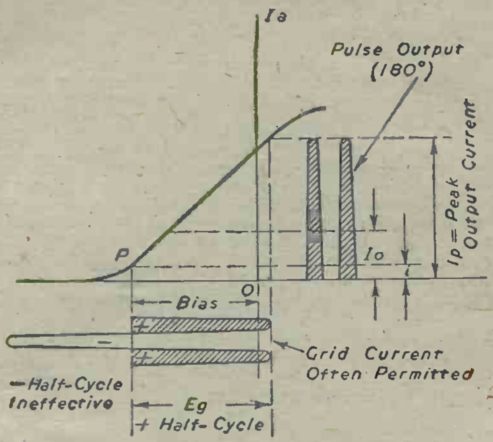


Fig. 2.—Class B operation, showing small standing Ia under "no-signal" conditions. Io mean D.C. input current, which varies with IP and Eg.

circuit was brought out, designed to save the power wasted during low passages and quiescent intervals in the programme: in other words, to improve the efficiency. A considerable improvement was effected—from 30 per cent. or less, to something like 50 per cent. or 60 per cent.—but before we consider high-efficiency

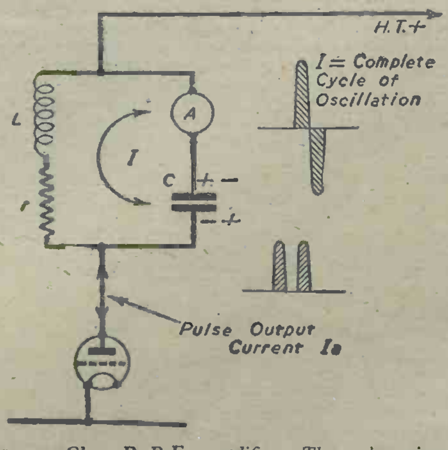


Fig. 3.—Class B R.F. amplifier. The valve gives a "pulse" output current, Ia, but complete cycles of oscillation I occur in the LC circuit. Harmonic components are bypassed by the tuning condenser C.

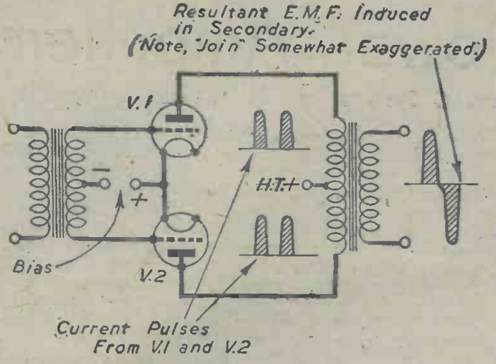


Fig. 4.—Class B audio-frequency push-pull amplifier. Each valve gives a current pulse alternately, as shown, but phase-reversal occurs in the transformer to give an approximation to a full sine-wave of e.m.f.

methods let us note another feature of the Class A amplifier.

The current (and power) taken from the H.T. source is *constant*, and quite independent of the amplitude of the signal. A milliammeter in the anode circuit will continue to show the same mean current Io, Fig. 1, irrespective of any signal on the grid, i.e., provided no rectification and distortion is taking place. Io is determined simply by the H.T. voltage and the grid-bias point. The latter, as seen, must be set high-up at the mid-point of the characteristic, and Io will remain constant at this high value, since it will be the *mean* of the alternating current component Ia—ordinarily, the mean value of a pure A.C. is zero, but here it is the *steady D.C.* component Io.

What we have, then, is a type of amplifier having a *constant input*, but of variable output and efficiency determined by the grid signal amplitude. Moreover, owing to the restricted signal, the greatest possible efficiency cannot exceed some 30 per cent., and it will be considerably less than this for smaller signal amplitudes. It follows that a large percentage of the "constant input" must necessarily be wasted.

When we come to consider large power-amplifying equipment, *efficiency* becomes a prime consideration. The size and cost of valves, rectifying and smoothing equipment, transformers, etc., etc. is directly dependent upon the amount of power that has to be "supplied" in relation to the useful "output" obtained. Even so, it may still be necessary to employ Class A amplifiers for audio-amplification, owing to distortion considerations. But for supplying large amounts of *radio-frequency* power, "distortion" is by no means such a serious question.

This is because no *audible* distortion then arises. Distortion of R.F. waveforms is regarded from the point of view of "harmonics," and these are largely eliminated by the tuned circuits which respond only to the desired "fundamental frequency." Thus, it becomes possible to use high-efficiency amplifying methods that would be out of the question for A.F. purposes, and to get rid of the harmonics caused by distortion.

Class B

Now, instead of operating at a "constant input," it is possible to fix the bias point, as in Fig. 2, to operate at a practically *constant efficiency*, but with a variable power input that will change almost in direct proportion to the signal amplitude.

As explained, this will mean having to tolerate more distortion, but the gain in efficiency will be fairly evident. Instead of the valve taking a large and constant power from the H.T. as in Class A, the power will be very small for small signals, but will *increase automatically when it can best be converted into useful A.C. output*, i.e., at large signal amplitudes. During quiescent intervals the valve takes little or no power from the H.T.

Since the input is now proportional to the output, the *ratio* of the two, the efficiency, tends to remain constant. Power that would be wasted in heating the anode is saved, simply because it is not being taken from the H.T. supply except when the signal amplitude demands it. This is the operating principle of Class B and Class C systems, and we will examine each in somewhat more detail.

Reference to Fig. 2 shows that the bias point is very near *current cut-off*. The valve is actually operating as a half-wave rectifier, cutting-off almost completely the negative half-cycles, since it is only the positive half of successive cycles of Eg that will be instrumental in causing rectified pulses of Ia. These "pulses," in fact, last only 180 deg. of the grid cycle—the *angle of flow* is said to be 180 deg.

From an audio frequency standpoint, this represents pretty appalling distortion. It would be quite hopeless to try to get satisfactory A.F. results with only one valve functioning in this manner, though an R.F. current produced in a tuned circuit would perform complete, nearly sinusoidal, oscillations — the harmonic frequencies would be largely by-passed via the tuning condenser. This is shown in Fig. 3. For R.F. purposes, much larger distortion still could be tolerated.

A fair approximation to a sine-wave A.F. output can also be accomplished by using two Class B stages in push-pull, Fig. 4. A positive half-cycle causes a current pulse of 180 deg. approx., from each valve *alternately*; in the transformer primary and secondary windings, these pulses will induce voltages that will "join" to give a full sine-wave, somewhat as drawn in Fig. 4. Adjustments are rather critical and troublesome to get really satisfactory results, e.g., the valves must not be biased right down to cut-off, and they must be fairly closely matched under A.C. and D.C. conditions. At best, there is more distortion than in a Class A push-pull amplifier, though the gain in efficiency is considerable.

Looking again at Fig. 2, we note that the *mean current* Io is no longer constant as in Class A. A milliammeter in the anode circuit will give a reading that is changing about over wide limits, with the amplitude of signal, which bears out the above statement about the relation of H.T. input to A.C. output. When a current is *rectified*, as in this case, it has a *D.C. mean value of its own*, that varies with the amplitude of the pulses, whereas in the Class B amplifier, the A.C. component changed equally on both sides of Io, leaving the value of the latter unaffected.

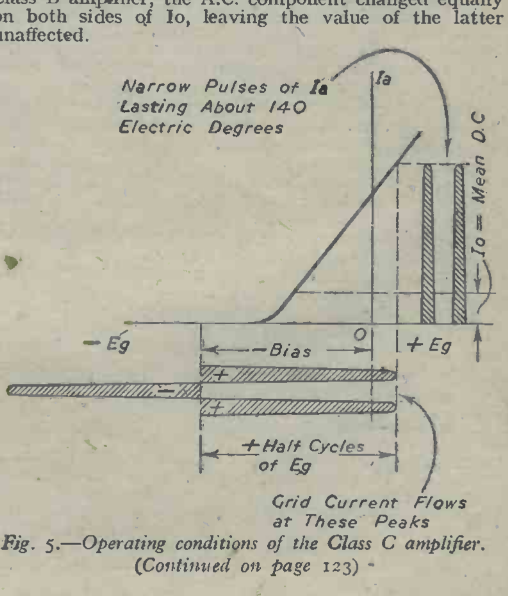


Fig. 5.—Operating conditions of the Class C amplifier.

(Continued on page 123)

The maximum possible theoretical efficiency of a Class B stage is $\pi/4=0.7854$, or $78\frac{1}{2}$ per cent. This can never be realised in practice, though efficiencies around 60 per cent. are quite common. By putting up with more distortion, driving the valve right into grid current, the efficiency figure can be raised to something like 65 per cent., but this will demand *driving-power* from a previous power stage, matched to take the grid loads of the Class B valves.

For R.F. purposes, a single Class B stage can be employed quite satisfactorily, as in Fig. 3, but a still higher efficiency and more satisfactory conditions for modulation are realised by using Class C.

Class C

This is merely an extension of the principles outlined for Class B. The bias is now increased to something like twice the cut-off bias, resulting in output current pulses whose angle of flow is considerably less than 180 deg., as in Fig. 5.

With anode current flowing for an interval less than a half-cycle—usually about 120 deg. to 140 deg., instead of 180 deg. as in Class B—distortion is so great as to make Class C quite out of the question for A.F. work—either in single-ended or push-pull form. But, again, distortion simply represents "harmonics" in R.F. amplifiers which are easily filtered-out by the tuned circuits.

What matters as far as design problems are concerned, is the *fundamental-frequency* current component in the distorted wave. This will be a pure sine-wave whose amplitude will be directly related to the angle of current flow, mentioned above, and the higher harmonic components can be completely ignored.

The arguments applied to explain the higher efficiency of the Class B amplifier are equally true for the Class C. The input power varies with the driving voltage (generally constant in R.F. amplifiers), and greatest power is taken from the H.T. supply at the current output *peak*, when the bulk of this input is converted into R.F. output. Furthermore, the intervals during which the valve is taking no power are longer than 180 deg.

Theoretically, efficiencies approaching 100 per cent. could be attained in a Class C state, with a sufficiently high load impedance, H.T. voltage, and grid driving power. The latter usually determines the final figure to which it is worth pushing-up the efficiency. Beyond a certain point, it will not be economical to improve the efficiency, because what is gained in the amplifier will be offset by the larger power-stages necessary to supply the grid driving-power. Efficiencies around 80 per cent. are quite practicable.

For modulation of an R.F. carrier, a Class C R.F. amplifier is invariably used, since a Class B is not biased sufficiently to take the large voltage swings corresponding to anything approaching 100 per cent. modulation. Grid or anode modulation is possible, though the former is only used in relatively low-power jobs, and is not so generally satisfactory as anode-modulating systems.

In a future article it is hoped to deal with some of the mathematical aspects of the three types of amplifiers. Class C is of considerable practical interest at the present time, because of its use in high-power oscillators for radio-heating equipment.

Half-wave Dipole Aerials

Factors to be Considered in Their Design

IT is a well-known fact that a wave radiated from an aerial is reflected at some period of time by the Heaviside or Appleton layers. For the purpose of convenience let us call this point of reflection "P" in our calculations.

For a horizontal half-wave dipole aerial suspended in free space above a perfect earth, the effect is to have a directly-radiated wave and a reflected wave from the earth's surface which we will call F and Fr respectively. The distance P is so great in respect to the points A and D in the diagram, Fig. 1, that these two waves can be stated to be parallel.

The impression gained at the distant point P is that Fr is radiated from an "image" aerial in the earth, which we will call A1.

For Transmission or Reception

This effect applies to both "radiators" or "receivers," so that a theoretical study may be for either. We will, therefore, suppose the aerial to be a "receiver."

The length of the line A1B indicates the distance that the wave has to travel farther to the aerial A1 than to A, this being the phase lag which is equal to the length A1B and dependent on the angle θ, which is known as the angle of "strike."

The polar diagram for a half-wave aerial in free space is a figure 8 and the maximum reception of radiation takes place at the broad side on position, namely, 90 degrees in this case. This we have already called "F," and in this case is taken as unity. Now for smaller angles than 90 degrees, the radiated or received wave is dependent on a constant "R," a factor giving RF, which is less than unity.

When the aerial is in the proximity of the earth, or a reflector, there are two such factors to be considered: (a) the angle of the wave direct, and the resultant value of RF; (b) the effect of reflected or indirect waves which reach the aerial some time after having been reflected from the earth and according to the phase relationship between F and Fr will modify (increase or decrease) the original figure of 8 diagram.

Thus, for an aerial situated near the earth, correction must be applied for all waves, which arrive at such angles that they can be reflected back to the aerial from the earth. These reflected angles are denoted by θ.

It has been found that on reaching the ground and being reflected back, a 180 degrees phase change takes place in the flux of the wave. Also, the effect of the earth can be simulated by studying an image aerial situated in the ground at an equal distance from the surface as the original aerial.

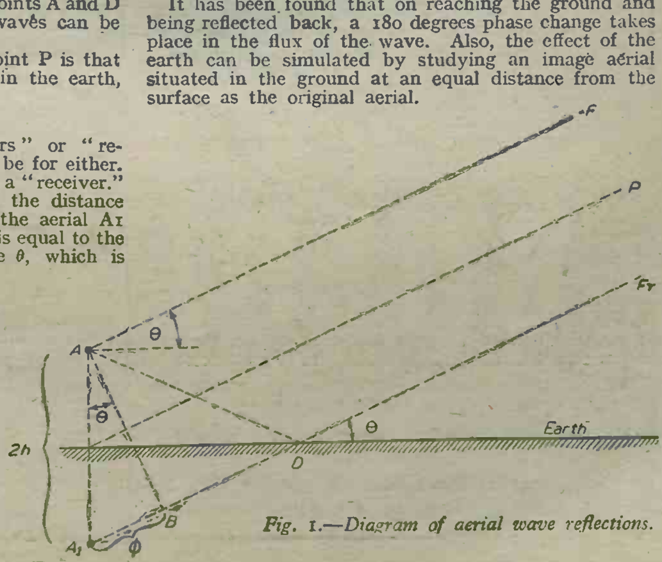
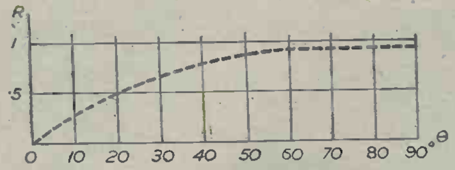
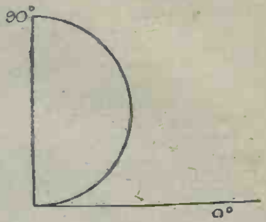


Fig. 1.—Diagram of aerial wave reflections.



Figs. 3 and 4.—Diagrams for ½ wave dipole ¼ wave above earth.



Thus, if F is the maximum induced E.M.F. in a dipole broadside reception position, Fr represents the equivalent E.M.F. in the image aerial. In Fig. 1, A is a half-wave dipole aerial at a height h above the earth and facing broadside to the wave F. A1 is the image aerial below the surface of the earth, and h is the height of the original and image aerials from the surface of the earth. The angle of the wave from the earth's surface or the horizontal is θ.

Phase Displacement

It can be seen that Fr takes longer to reach A1 than F to reach A, therefore Fr must be lagging on F by an angle which will be called Φ for phase displacement. In the diagram Fig. 1 we express h in terms of λ for convenience, therefore, the distance A to A1 becomes $\frac{2h}{\lambda}$ and the phase displacement A1B can be written $\frac{2h}{\lambda}$ sin θ, which is the amount Fr takes longer than F to reach its aerial.

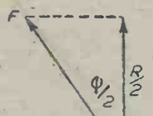
This expression is Φ, therefore, to this we must add 180 degrees phase change due to the ground and Φ then becomes:

(1) Φ equals $\frac{2h}{\lambda}$ sin $\theta + \pi$ (π is used instead of 180 degrees) in radians.

Now as $\frac{h}{\lambda}$ will eventually be expressed as a fraction and as 360 degrees or 2 π radians are equal to λ, converting (1) to radian measure $\Phi = (2\,\lambda \frac{2h}{\lambda} \sin\theta) + \pi$

$$= \frac{4h}{\lambda} \sin\theta + \pi$$

Fig. 2.—Diagrams illustrating calculation for F and R.



This represents the angle by which Fr is lagging on F, and in order to find the resultant in a dipole, vector addition of F and Fr must be made. In Fig. 2 it will be seen that:

$$\cos\frac{\Phi}{2} = \frac{\frac{R}{2}}{F} \quad \therefore \frac{R}{2} = F\cos\frac{\Phi}{2} \quad R = 2\,F\cos\frac{\Phi}{2}$$

Now from (1) $R = 2\,F \cos \dfrac{4\,\pi\,\frac{h}{\lambda} \sin\theta + \pi}{2}$

$$= 2\,F \cos 2\,\pi \frac{h}{\lambda} \sin\theta + \frac{\pi}{2}$$

(Note: $\cos \theta + 90° = -\sin\theta$)

$$\therefore R = -2\,F \sin\left(2\,\pi \frac{h}{\lambda} \sin\theta + \frac{\pi}{2}\right)$$

We can now express h in terms of λ above earth, and for convenience 2F can be taken as unity.

Therefore, our expression becomes:

$\frac{1}{4}\lambda$ above earth $-2\,F\sin(\frac{\pi}{2}\sin\theta)$
$\frac{1}{2}\lambda$ „ „ $-2\,F\sin\pi\sin\theta$)
$\frac{3}{4}\lambda$ „ „ $-2\,F\sin(\frac{3}{2}\sin\theta)$
1λ „ „ $-2\,F\sin(2\,\pi\sin\theta)$
$1\frac{1}{2}\lambda$ „ „ $-2\,F\sin(3\,\pi\sin\theta)$

Now for a figurative result, π can be converted to degrees: $\frac{\pi}{2} = 90°$. $\pi = 180°$. $\frac{3\,\pi}{2} = 270°$, and so on.

The following table is calculated for a $\frac{1}{2}\lambda$ dipole aerial, $\frac{1}{4}\lambda$ above earth:

θ	Sin θ	$\frac{\pi}{2}$ sin θ	R= -2 F sin $\left(\frac{\pi}{2}\sin\theta\right)$
0	0	0	0
10°	0.1736	15.62°	0.31
20°	0.3420	30.8°	0.512
30°	0.5	45°	0.707
40°	0.643	58°	0.85
50°	0.768	70°	0.94
60°	0.876	78°	0.97
70°	0.94	84.5°	0.99
80°	0.982	88.5°	0.995
90°	1.0	90°	1.0

The diagrams Figs. 3 and 4 are for a ½-wave dipole situated a ¼-wave above earth. The other lengths can easily be calculated in the same way and the polar diagrams drawn.

Impressions on the Wax

Review of the Latest Gramophone Records

THIS month appears to be a special one from the point of view of quality and quantity of record releases, and it will be an exceedingly unfortunate gramophone enthusiast who does not find a goodly portion of this month's programme to satisfy his or her taste. The task of attempting to please all record players every month must almost be as difficult as that experienced by the B.B.C. with respect to heterogeneous mass of listeners; therefore, we are doubly fortunate this month, as the list of latest releases offers a delightful range of diverse forms of musical entertainment.

H.M.V.

FOR example, on *H.M.V. DB*6178 that great artist Yehudi Menuhin, has made a superb recording of "Roumanian Folk Dances" (Bartok arr. Szekely). It occupies both sides of the record, and Menuhin shows complete understanding of all that is embodied in the composition by his perfect expression and technique.

On the orchestral side I strongly recommend the N.B.C. Orchestra, conducted by Arturo Toscanini, playing that delightful and popular Overture "Mignon," by Thomas. The recording takes both sides of the record, and I can only say that the overture, the horn solo by Arthur Berry and the performance by the orchestra are all that anyone could desire. I advise you to make a note of the number—*H.M.V. DB*6177.

The next four 12in. H.M.V. records consist of the three movements forming "Concerto No. 2 in G, Op. 44," by Tchaikovsky, played by that noted pianist, Benno Moiseiwitsch, and the Liverpool Philharmonic Orchestra, conducted by George Weldon. The solo violin and 'cello parts are taken by Roy Robertson and Anthony Pini, respectively. The three movements are: 1st, Allegro brillante e molto vivace (4 parts); 2nd, Andante non troppo (2 parts); and finally, 3rd, Allegro con fuoco. About the rendering of this great concerto, I think one word will suffice, and that is magnificent, and that applies to all concerned. Moiseiwitsch, to describe his performance in rather non-musical terms, simply sails through the whole work as though he delighted, and perhaps he does, in intricate passages fraught with numerous technical obstacles. His faultless playing is in close harmony with the splendid performance by the orchestra and the violin and 'cello soloists. Remember, four records, *H.M.V. C*3410–13. Another record calling for special mention, but this time as offering good light or dance entertainment, is *H.M.V. C*3415, on which the New Mayfair Dance Orchestra has recorded a fine "Paul Jones" in two parts, consisting of a very nice selection of popular dance tunes linked together.

For the kiddies, Uncle Mac (Derek McCullough), of B.B.C. fame, has recorded Uncle Mac's bedtime story, "Rumpelstilskin," by Grimm. It is on *H.M.V. BD*1095, and it should prove very popular with the kiddies.

"Hutch" has selected "It Could Happen to You" and "Time Waits For No One" for his two numbers this month, on *H.M.V. BD*1094.

Tommy Dorsey and his Orchestra have recorded two good foxtrots, "Hawaiian War Chant" and "Symphony in Riffs," on *BD*5867, in true Dorsey style.

Columbia

THOSE who have seen the film "Love Story" will remember the "Cornish Rhapsody" which is featured in that production. It is a delightful piece, and I imagine that very many people will welcome the opportunity of hearing it again (and again), especially when it is played by Harriet Cohen (pianoforte) and the London Symphony Orchestra, conducted by the composer Hubert Bath. Columbia have made this possible by the release of *DX*1171, a 12in. record, both sides of which are occupied by the work in question.

The Leslie Heward String Orchestra and The Light Symphony Orchestra make *Columbia DX*1174 a distinctly attractive record in the light music class. It is one of those records which, to my way of thinking, forms, as it were, a good companion who is always good company. The two compositions recorded are "Londonderry Air," that ever popular old Irish tune arranged by Percy Grainger, and "Tuesday Serenade"—Valse Lente, by Stanford Robinson, played by the two orchestras.

I am very pleased to see and hear that Harry Davidson and his Orchestra have recorded some of the old time dance tunes, on *Columbia DX*1172. These records are actually No. 1 of the Old Time Dance Series, which occupies three sides of two 12in. records, the fourth side being another old favourite, "The Druids' Prayer," in waltz time. The title of No. 1 of the series is "The Lancers," and a jolly fine recording it is, and one which is bound to bring back many happy memories to those who in days gone by enjoyed the fun, excitement and exercise of a dance which is a dance in the true sense.

David Lloyd has a most pleasing tenor voice, and the two ballads he has recorded on *Columbia DB*2159, namely, "Tell Me Ye Flowerets" and "Silent Noon," show the quality of his production.

Ronald Gourlay—entertainer at the piano—has two fine recordings on *Columbia FB*3066 in the form of songs for the kiddies. They are "The Birthday of the Little Princess" and (a) "Habits" and (b) "Laughs." Ronald sings them in that delightful free and easy style of his, which should captivate the hearts of all kiddies. In the Princess song he does some of his wonderful whistling, which alone will cause him to have many imitators, both young and old. Carrol Gibbons and the Savoy Hotel Orpheans have two records this month, *Columbia FB*3068 and *FB*3069. The former consists of "I'll Be Around" and "When They Ask About You," both foxtrots, while the latter (3069) is "Shine On Victory Moon," another foxtrot, and "Let Me Love You To-night"—Beguine.

Victor Silvester and his Ballroom Orchestra play a fine waltz, "Give Me The Stars," on *Columbia FB*3071, and he links with it "And Then You Kissed Me," a slow foxtrot.

Parlophone

I CANNOT quite associate Richard Tauber with the two numbers he has selected for his latest Parlophone record, *RO*20534. I suppose they are topical, as one is entitled "White Christmas" and the other "Where the Blue Begins," from the show "Jenny Jones," but they are not a suitable medium for a voice of Tauber's quality. Naturally, he sings them as one would expect him to, and he makes the most of them, but I like him better when he is singing something worthy of his undoubted capabilities. Geraldo and his Orchestra have two good numbers on *Parlophone F*2047; they are "It Could Happen to You" and "Spring Will be a Little Late This Year," both slow foxtrots.

The Victor Feldman Trio, with string bass and guitar accompaniment, have recorded "Sweet Georgia Brown" and "Drummin' Man" on *Parlophone F*2050. For those who like their music "hot" with a generous portion of drums, this record should have an appeal. "Ditties from the Ditty Box" is the title bestowed on *Parlophone F*2046, of several ditties sung by Box and Cox.

Regal

LOU PREAGER and his Orchestra offer "I've Got a Heart Filled With Love"—quickstep—and "Choc'late Soldier From The U.S.A."—slow foxtrot—on *Regal MR*3744. Two good numbers for the dance enthusiast.

George Formby sings one of his numbers from his latest film, "He Snoops to Conquer," on *Regal MR*3745. It is "Unconditional Surrender" and he links with it "Our Fanny's Gone all Yankee."

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).

Shonan

SIR,—In reply to Mr. M. Goldberger's letter asking for particulars of a station by the name of Shonan or Shonon, I have received a station which I believe to be the one in question.

It appears to be known as "Radio Shonan," and operates in the 31 metre band. On the three occasions that I have picked up this station they have been giving news in English, and although I haven't been able to get exact details of times and wavelength I was able to establish that this station is operated by Japan for propaganda purposes.

Should I be lucky enough to get better reception and more details I will let you know.—F. B. BENNETT (Walthamstow).

An Interesting Lay-out

SIR,—I enclose a circuit diagram of my receiver. The panel is bakelite backed with copper foil. The RX is built on a baseboard, also covered with copper foil. The A.V.C. system I described in my last letter, that is, obtained from the grid of the detector valve, acting on the screen grid, was found to be unsatisfactory, so I have omitted it. The power supply consists of H.T. eliminator, which, with further condensers (2 and 4 mfd.) across the output, gives absolutely silent and constant strength background.

I am shortly to overhaul my aerial system, which is a 10ft. vertical copper-rod, 20ft. above ground-level. The proposed change is to carry the lead-in along the side of the house on beehive insulators which I have obtained for the purpose. This should make a really good job. I put the RX on the air about three days ago and I had plenty of time to test it, as I was indisposed and unable to go to work for a couple of days.—R. H BOWDEN (Walton-on-Thames).

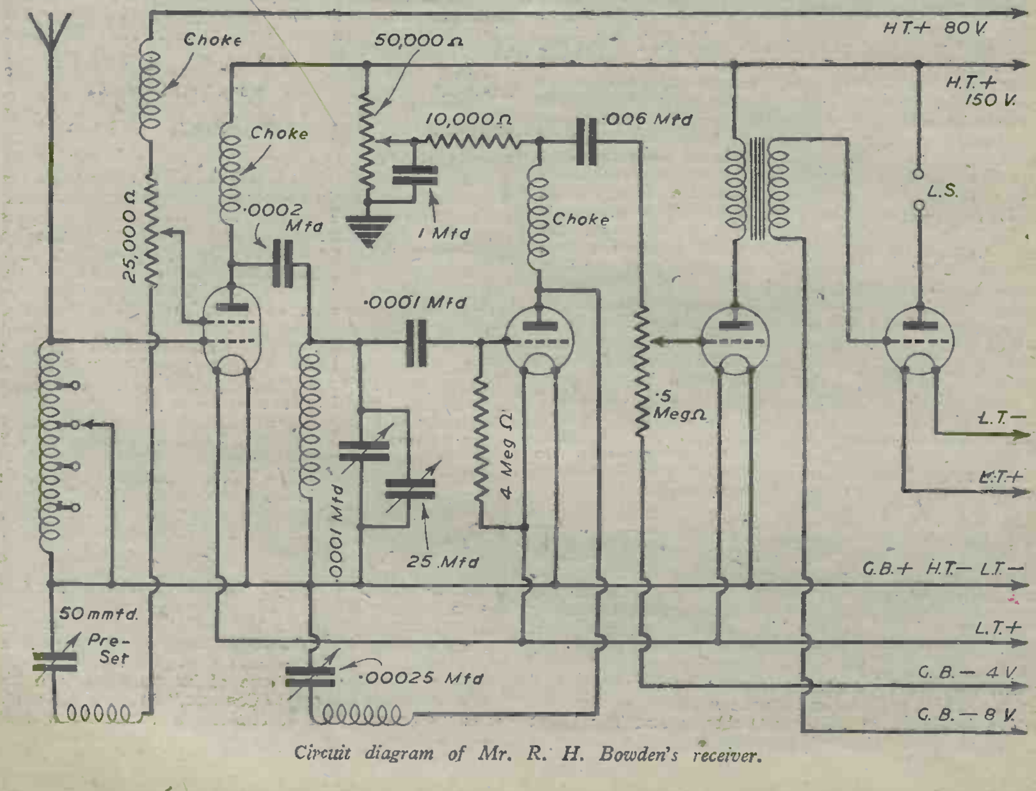
Automatic Speed Control

SIR,—I have read with a good deal of interest the recent correspondence in PRACTICAL WIRELESS regarding Automatic Speed Control. I have tried the circuit submitted by Mr. L. King, and I was not really surprised to obtain a nice high-pitched howl. This was eliminated by a minor adjustment and a signal tuned in, but there was no difference in speed from that of the same signal tuned in on a set not using the A.S.C. device.

Bearing in mind that Mr. King reduces his 10,000 ohm resistance to increase the speed, I also did the same: in fact I tried many values of resistance in this position, from nil up to 5 megohms, all without the slightest effect on the speed of the signal.

Now, let us examine this matter of automatic speed control. It is to be assumed that the device is supposed to "accumulate," say, a number of disconnected words, and then to deliver, suddenly and without warning, a complete sentence. How, then, are we to account for the fact that some words will necessarily be retained longer than others, or indeed, that when delivered they will be in the correct order?

(*Continued on page* 128)



Circuit diagram of Mr. R. H. Bowden's receiver.

(I say that the words will be "accumulated" by the device, for no receiver can receive as yet untransmitted signals.) Admitted that it is possible to introduce a period of delay between reception and reproduction of a signal, this delay is equal for all portions of the signal i.e. "quiet" periods as well as "speech" periods, and it is pointed out that during these "quiet" periods of the news broadcasts there is a definite microphone hiss.

But what is the point of all this desire to speed-up the news which is broadcast at dictation speed? After all, the news is given in this way for a very definite purpose, and every paragraph is, in any case, repeated at normal speed: any other programme speeded by A.S.C. would in all probability become quite unintelligible.—E. PARSONS (Luton).

[*A.S.C. is just a leg-pull.*—ED.]

Wind Chargers—and Coil Construction

SIR,—I wonder if any of your readers could give me any information on wind-generators and mechanical coil winders.

May I compliment you on your excellent journal. I should like the Editor's views on automatic speech control.—A. J. COLLETT (Wolverhampton).

[*Our own book, "Wireless Coils, Chokes and Transformers," 6s. 6d. by post, contains details of several coil winders. Our companion journal "Practical Mechanics" recently published a series of articles on wind-generators. Automatic speech control is just a joke.*—ED.]

Design for Amplifier

SIR,—In the November issue of PRACTICAL WIRELESS, Mr. H. Rees' article on the Cathode Follower may be misleading in his phrase "the stage will show no amplification."

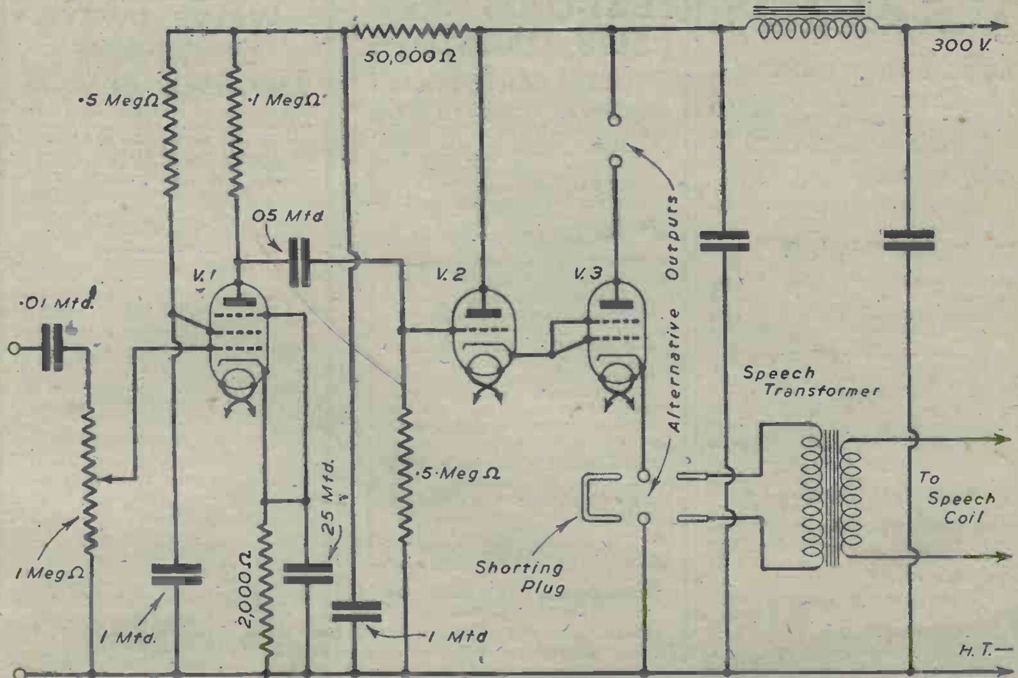
In a recent amplifier design I used the Cathode Follower as the penultimate stage and *very high* gain was obtained. Circuit, herewith, shows a 6J7GT voltage amplifier resistance-capacity coupled to a triode, 6J5 or 6P5GT. This valve has its cathode *directly* connected to the *grid* of the output valve. As the grid is positively biased by the same amount as the penultimate valve cathode, the output valve must be arranged to run under these conditions.

As Mr. Rees states, the Cathode Follower may be classed as a generator with a high input impedance but with a very low output impedance. Thus, as a penultimate valve between a 6J7 and an output valve whose input is of low impedance due to grid current, the Cathode Follower is ideal. Owing to this excellent matching, and direct coupling, high gain is obtained.

The American 6B5 and 6N6G valves are directly coupled twin triodes and are suitable, but greater gain may be had with separate valves. The 6AC5GT is specially designed for the job, for at +13 volts grid bias (this is the 6P5 cathode bias), 250 volts anode, 32 m.a. anode current flows; the power output being 3.7 watts in a 7,000 ohm load. Beam tetrodes, 6V6G or KT63 may be used if the control and screen grids are tied together at the socket. As an alternative, the output may be taken from the output valves' cathode circuit. The quality is then exceedingly good owing to the high damping factor, but at a great sacrifice of volume. Increasing audio gain in the earlier stages made no improvement as oscillation, due to feed back, was evident. I welcome criticism on this work by Mr. Rees or any reader who may be interested.—H. J. B. TELFORD (Edinburgh).

Some Early Experiments

SIR,—Reading Herbert S. G. Bray's letter in "Open to Discussion" has caused me to look back over the past to the very early days of cat's whiskers. His experiences have been almost identical with my own except that I started earlier, in telegraphy, in the days of iron pyrates, and drifted on into telephony with progress which was slower in those days. With an experimental licence, my first attempt to get on the air was with a tuning coil the length of my attic den, suspended on elastic, and tuned by pulleys to compress or expand the coil, and an air condenser of three plates about 11in. square made variable by closing the outer



Design for amplifier by H. J. B. Telford.

pair towards the fixed centre one. With the coming of the valve, my first grid condenser was two pennies and a grid leak of indian inked blotting-paper, the valve connections being soldered to the circuit wirings. When transformers made reception loud enough for the family to distinguish the sound from my phones, I made up various "loudspeakers" from earphones in jelly-moulds to large editions made from 8in. magnets and biscuit tins, as horn and vibrating disc. Unlike Herbert Bray I have kept in close touch with the modern circuits, valves, and components and as far as my pocket allows still experiment, but only on the receiviug side these days. A set that has broken down has more interest to me than one that is perfect. From a DX fan I have changed over to get the best reception from our own stations with as near as possible a faithful reproduction of the singer or band. Through all these years I have never owned a commercial receiver.

Looking back over my old copies of PRACTICAL WIRELESS I must congratulate the Editor for its advance with the times, and also the present size, which I find quite adaptable to my pocket and also stows away much neater.—W. A. G. NEALE (Gillingham).

The Cathode Ray Oscilloscope

SIR,—Your article under the above title in your issue dated October, 1944, needs some further comments:

The circuit explanations start in column 2 (page 461) and in paragraph 2 the author states "R7 and R8 are used as the spot positioning controls," but R7 or R8 in the C.R.T. are not shown.

Next, in paragraph 4, we have, "R3 acts as the variable input control to the amplifier." This is not so, R3 being 2 resistors, fixed 5 megohms each, inserted to provide a circuit between an X plate and final anode, and a Y plate and final anode. They certainly will not vary the input to anything.

Then in paragraph 1 (page 462) we have, "To obtain a linear waveform a charging valve is used to charge the gas triode." Surely we charge the time base condenser? Again, in this paragraph we come to, "The screen of the charging valve has its voltage controlled by R4." This is wrong. R4 is a 75 K. resistor forming a part of the potential divider for the C.R.T. supplies. Once more in the same paragraph we find, "The setting of R5 controls the grid bias of the triode, and hence the amplitude of the sweep." Wrong again! R5 is a pair of 30 K resistors in series at the top of the C.R.T. potential divider, inserted to permit voltages positive or negative in respect of the final anode to be picked by the shift controls.

You are well aware that the screen of the charging valve has its voltage controlled by R21, and that the setting of R20 controls the grid bias of the triode and hence the amplitude of the sweep, but this does not help the reader.

Another detail is the C.R.T. supply mains transformer. Why specify a winding 6.3 volt, 4-5 *amp.*? Such a transformer is quite hard enough to find without this winding.

Lastly, I feel it should be pointed out that owing to the tube's susceptibility to stray fields, it will "pick-up" patterns or waveforms from the power transformer, unless the latter is mounted behind the tube or at a suitable angle (which usually makes for an untidy lay-out.) Beginners should also be advised that where a potential divider is used in this way for the time base, both the frequency and amplitude controls will have some effects on the function of the other, otherwise the beginners look for non-existent faults.

Technically, of course, your article is quite sound in all respects, although the design of an oscilloscope using 4-volt valves (making the power transformer easy to come by) would have been more practical, and more easily completed.—C. F. TAYLOR (Herts).

[*The author replies: In column 2 on page 461 it states that R7 and R8 are used for spot positioning controls. On examination of Fig. 2 it will be seen that two potentiometers have no number against them. These are R7 and R8.*

Also in paragraph 4 for R3 read R18, and for R4 read R21, and for R5 read R20.

Readers seem to have had trouble in finding satisfactory mains transformers for the oscilloscope. Radio Instrument Co. make transformers which will supply the necessary voltages.

Type A, 350-0-350, and two 4-volt windings. (One can be used for the U17 and one for the GT1C and the tube).

Type B, 350-0-350, and a 5-volt and 6.3-volt winding. (This can be used as the amplifier transformer; the 6.3-volt winding being used for the two 6J7 valves and the 6X5 valve.)

Some readers have wanted to know where to place the various components. For their aid I have drawn some sketches which I hope will be of use.

Fig. 1 in the article shows the oscilloscope from the front. All the controls are mounted on a steel panel. Fig. 2 shows a view from the top.

Difficulty may be found in obtaining a potentiometer suitable for R21 (300 ohms). For this control a half megohm may be used with a 300 ohm resistance across it. All the values, R13, 20, 14, 21 and 15 are very critical and should definitely be used.

The connection between the horizontal and vertical input should be connected to earth.]

Wanted—A S.W. Circuit

SIR,—To-day various journals arrived in the form of comforts, among which I was delighted to see PRACTICAL WIRELESS. This took me back to better times, when I was a keen enthusiast and an early reader, period Vol. 1, No. 1. I must say it is as fascinating as ever, in spite of your journal's reduced size. In a get-together with some of the boys, the keen amateur type, they have kindled in me an old flame. Inspired by this, I make the following inquiries. Can you suggest a suitable circuit that would give short-wave enthusiasts an ether contact with the outside world, a quarter of which they have already seen. Power availability is a six-volt accumulator stepped up by a rotary converter, giving an output of at least 110 volts D.C. In view of the drain on the accumulator I have in mind a two-valve short-wave set, some 12 to 200 metres with automatic grid bias, fixed coils.

Portability calls for not too large a chassis, and sensitivity, without too long an aerial. With a good pair of 'phones we shall probably try to bring in the impossible.

Our needs in this direction are great, but our comforts are small. I shall be grateful of any help you can give me, and may I add that a reliable vendor's name, who can despatch the necessary components, would be useful. No cabinet is required, no 'phones.—R. J. G. STEVENS (C.M.F.).

Radio "Jakarta" and "Shonan"

SIR,—Noticing John J. Riordan's request for information regarding Radio Jakarta, it broadcasts on 16.6 metres at 15.00 hrs. G.M.T. a half-hour programme in English to India daily, and is situated at Batavia on the Island of Java. Regarding M. Goldberger's request, Radio Shonan operates on 31.42 metres 9,540 k/cs and is situated in Free India; programmes in English at 14.45 and 17.30 hrs. G.M.T. It sometimes announces itself as the Voice of Azad Hin and The Voice of Free India. I hope this will be of some use to them. Could any reader give me any information regarding the following stations: J.C.J.C., giving a special transmission on 41.55 metres on October 21st, 1944, at 12.00 hrs. G.M.T., their regular schedule being at 06.30 to 23.00 hrs. Cairo time, M. or N.P.Q.3, 19 metre band, 12.30 and 14.00 hrs. G.M.T. Calling B.B.C. in London and B.B.C. Italy.

I have compiled a good log, using F. J. Rayer's 2-valver, March, 1943, issue. I added an untuned H.F. stage and it was a great success. I received W.J.Q. press wireless, New York, calling M.C.D. Paris in Voice at 21.15 hrs. G.M.T., 31 metre band, 10,010 k/cs.—F. J. LONGMAN, (Mansfield).

Receiver for Motor-cycle

SIR,—I am contemplating the building of a small receiver to insert into the well of my motor-cycle tank, which is limited to a space of approximately 11 cubic inches. I intend to supply power from the 6-volt accumulator, via vibrator.

I have spent many enjoyable hours wading through my issues of PRACTICAL WIRELESS (I have every copy you have published) and find that I am unable to decide as to best circuit suited for speaker reproduction.

It occurred to me, however, that you may have readers who have successfully experimented along these lines, and believe me I should indeed be grateful for any advice or help that could be offiered.

Before closing, I should like to tender a vote of thanks to you, Sir, and to the staff of PRACTICAL WIRELESS for your excellent triumph over circumstances that must have caused no little inconvenience and worry.

May I at this juncture raise my hat to "Thermion" who to me occupies a position only equalled by the Prime Minister himself; he has stuck by his principles since his first article.—HENRY G. WHEELER (Plumstead).

An 0-v-1 for S.W.

SIR,—I would like to write to you about my s.w. set. It is of the 0-v-1 type, for A.C. mains. It uses four-pin coils, AC2HL detector, and AC2 Pen output. The circuit is of my own design and it works out very well. Among stations I have logged are WCRC (25.3 m.), WCBN (26.9 m.), WOOC (19.7 m.), WOOW (25.3 m.), also WGEO, WBOS (19 m. band), WNRA, WNRI and WNRX. Recently at 2.30 p.m. I heard a station which sounded like Radio City, Moscow, 18-19 m. band. Could any reader give me any information about same?—J. H. BRUNT (Biggleswade).

The Universal Two

SIR,—Having read W. James's (Enniskillen) letter in the November issue, I should like to mention that I have built the Universal Two described in the April issue. I managed to get the components easily enough from PRACTICAL WIRELESS advertisers, though I contented myself with two 16 mfd. smoothing condensers which have proved ample. My first attempt using two gang variable condensers proved a big success, but in a later modification I damaged the secondary of the aerial transformer and it took me until quite recently to find the fault, which was intermittent. Luckily I had a spare H.F. transformer which works quite well as a replacement, and I receive all M.W. stations at normal strength. I also use a 15ft. throw-out aerial. I have been interested in radio for about 18 months, and I have read quite a lot about it since then, including Scott Taggart's "Manual of Modern Radio," published by P.W. in 1933. My latest is "The Admiralty Handbook of Wireless Telegraphy," Vol II, price 6s. and worth every penny of it to amateurs interested in design. I have taken P.W. since January, 1944. The above set is the first I have built, but when parts get cheaper I hope to build others. I am well satisfied with your magazine, which forms a happy bond between readers. May I back up the other fellows who would like to hear more about crystal sets?—H. WILSON (Didcot).

Stations Identified

SIR,—I have identified a few more stations with my DX Economy 3. They are as follows:

WCBN 16.86 m., WRUS 19 mb., WNRI 23 mb., WRCA 25.2, 16 mb., WLWL 19 and 16 mb., WNRA 16 mb., WNRX 20 mb., WRUL 25 mb., WLWR 23 mb., Radio Dakar 26 mb., WQV New York calling FCA. I heard replies from FCA, and would be grateful if anyone could give me its location, and also that of an Italian transmitter in the 35 mb. (approx.)?—J. M. EALEY (Swindon).

SIR,—Here are the details of a transmission I heard recently, they might be of some interest to the readers of PRACTICAL WIRELESS:

News in English from Melbourne, Australia, VLG 31.32 metres at 3.35 p.m. B.S.T., and closing down at 3.45 p.m., also VLC6 31.2 metres, both stations at loudspeaker strength on a simple home-made 1V2.—A. COULTHARD (Carlisle).

Testing Ground Motor Speed

SIR,—I would like to make a few remarks about an article on gramophone motor speed testing in the April, 1944, issue.

The turntable is required to do 78 revs./min. This is 78/60 rev./sec., if the light comes on 50 times a sec., then for every flash the table will do 78/60×50 rev. This is 13/500 of a turn: one hole per flash will therefore be 500/13 holes per turn. This works out at 38.461 holes. The best way out of the difficulty is to double = 76.922 holes and 77 will be near enough for most purposes.

To check my working I made a disc like a sunflower with alternate black and white petals, 77 sectors, leaving two white ones at the end. As expected, when tried out—on an induction type motor—the marks appeared to be stationary for a whole turn and then jumped half a mark.

As a matter of interest, 78 holes would give speed as follows (light in every other hole): $\frac{50}{39}$ turns-sec. $=\frac{50 \times 60}{39}$ turns/min. = 76.923 revs./min.—STEWART BINSTEAD, B.Sc. (Huddersfield).

Esperanto

SIR,—As a reader of PRACTICAL WIRELESS from the first number and as an Esperantist with a practical experience in that language for international purposes for over 40 years, I should like to endorse your correspondent's remarks.

Before the war there were quite a number of Continental stations giving an Esperanto transmission, and it is to be hoped that not only will they resume this service but extend it.—A. E. LEE (Colwell).

FACTORS, LAWS, RULES, AND CO-EFFICIENTS OF RADIO AND TELEVISION

(*Continued from page 115*)

U

Unit Charge.—That electrostatic charge causing a mechanical repelling force of one *dyne* on an equal charge *of similar sign* at a point 1 centimetre from it in a vacuum, both charges to be concentrated.

V

Volta Effect.—When two metals are placed in contact with each other in air, one possesses feeble positive charges and the other feeble negative charges.

W

Wow Factor.—(1) The maximum instantaneous variation from the average speed of a *recording turntable* shall not exceed plus or minus 0.1 per cent. of the average speed. (2) The maximum instantaneous deviation from the average speed of a *reproducing turntable* shall not exceed plus or minus 0.3 per cent. of the average or mean speed.

Y

Young's Modulus.—That force necessary to stretch a substance of unit to an elastic limit to double its length, it being constant for any one material. As a formula, $M=LF/ea$, where L=length of substance, a=area, F=force applied, e=total of elongation produced by F.

Z

Zeeman Effect.—That distortion of the *spectrum lines* in the light emitted by a flame when that flame is subjected to strong magnetic fields.

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SEE PAGE 83 JANUARY ISSUE

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(Continued top of third column)
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YAXLEY TYPE W/C SWITCHES. 2in. spindles, 4-way, 3-bank, with shielded osc. section, 6/3; 5-way, 6-bank, with 3 screened sections, 7/3; 3-way, 3-bank, without shields, 4/6.
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P.M. SPEAKERS. Goodman's 6in., with Pen. Output transformer, 34/6. 8in., less trans., 30/-.
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