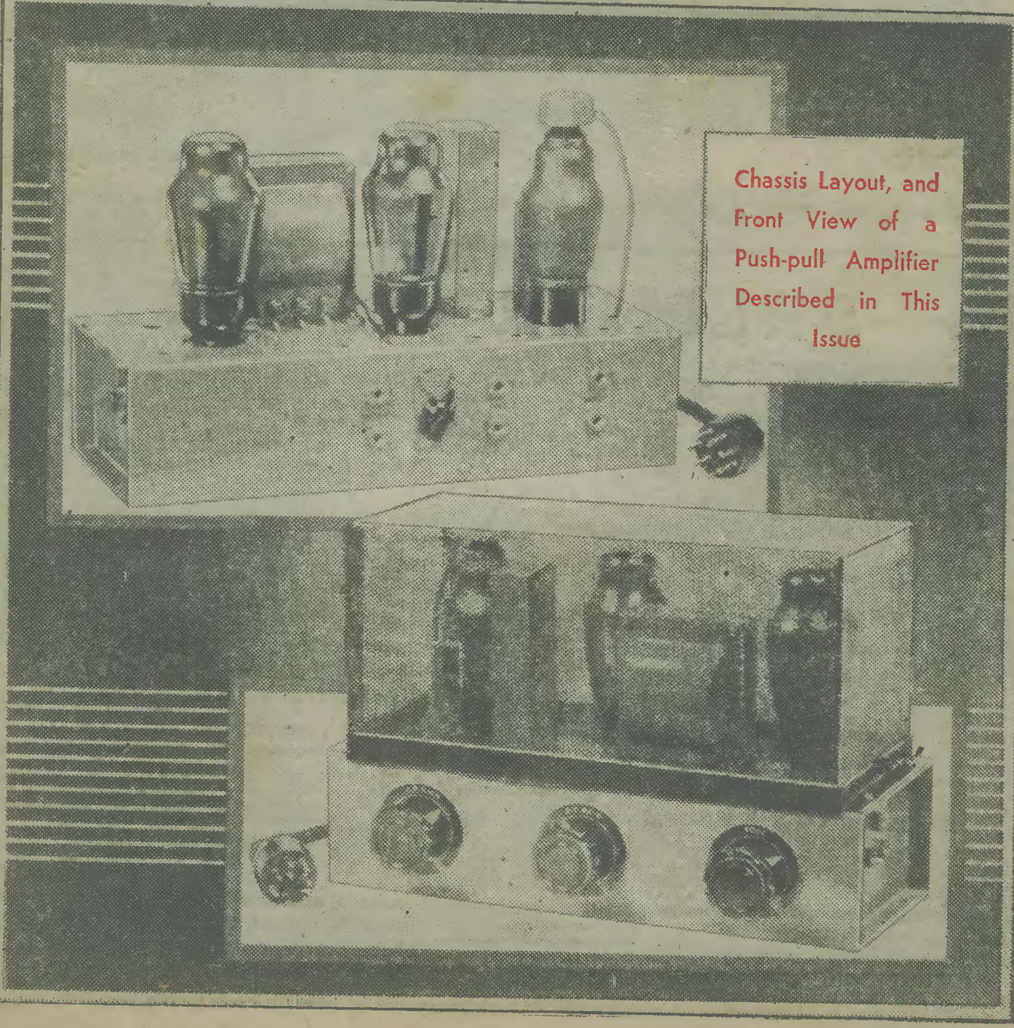
DIRECT DISC RECORDING

Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

Vol. 20 No. 460 NEW SERIES OCTOBER, 1944



Chassis Layout, and Front View of a Push-pull Amplifier Described in This Issue

Practical Wireless
and PRACTICAL TELEVISION
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Government Surplus Stocks

THOSE manufacturers who apprehended that Government surplus wireless equipment would be unloaded on the public after the war at low prices may be reassured by the Government White Paper entitled "Government Surplus Stores—Plans for Disposal." This Paper indicates the general line on which the Government propose to proceed in disposing of Government stores whilst reserving the right to develop and modify their policy in the light of experience and changing circumstances, or in accordance with any international agreement which may be made. Distribution and price are both to be controlled, and stocks will be gradually released to avoid any adverse effect on production which would be caused by flooding the market with surplus goods.

Distribution will be carried out through manufacturers, and dealers who normally handle similar goods, and profiteering will not be possible, as the prices will be fixed at a reasonable level. This system of disposing of stocks will also apply to other Government surpluses. The President of the Board of Trade indicated as long ago as November, 1943, the general lines of Government policy in the following words:

"As I have already stated in the House, there must be after the war an orderly disposal of surplus goods, which, on the one hand, will not allow profiteering at the expense of the consumer, and, on the other hand, will pay due regard to the interests of producers and distributors.

"The Government have decided that disposal shall be carried out, in each particular case, through the agency of the department mainly concerned with the supply of the goods during the war. Before working out the plans for disposal, the Board of Trade, together with other responsible departments, will consult with representatives of the producers and distributors concerned."

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ROUND THE WORLD OF WIRELESS

New Swedish Transmitters

IT is reported that two new short-wave transmitters are to be erected in Sweden to increase the radio efficiency of that country. Each transmitter is to have a power of 100 kW, one being designed for home use, and the other for directional transmissions to Swedish nationals abroad. The old short-wave transmitters at Motala each have a power of only 12 kW.

War Correspondent in S.E. Asia

B.B.C. War Correspondent John Nixon flew to India in February to cover Chindit operations. He flew with General Wingate to watch the first Chindits crossing into enemy-occupied Burma, and subsequently flew into our airstrips 200 miles behind the Japanese lines. He grew a beard, wore the official Chindit outfit of green jungle shirt, green battle-dress trousers and bush hat (with razor blade in pugaree in case of snake bite and fishing hook and lines in case he had to make his way back on foot without rations).

Nixon has had wide experience as a war correspondent and has covered operations from Norway to Burma, serving with the Navy, Army and R.A.F. On three occasions he has been watching the battle from the ship's bridge when it has been hit; in the *Prince of Wales*, in the *Bismarck* action; during an action in the Mediterranean against the Italian fleet; and in the *Zulu*, when she was landing Royal Marines off Tobruk.

Fleet Air Arm personnel during their training course learn to signal by means of the Aldis Morse lamp to keep in touch with aircraft flying in the vicinity of the 'drome, and here is the signaller and reader "talking" to one of the Trainer aircraft.

New Radio Telephone Service

THE new radio telephone service which is now in operation between the United States and Trinidad, the most southerly island of the West Indies, is handled through short-wave telephone facilities at Maimi, Florida.

P.O. Appointment

THE Postmaster-General has appointed Mr. G. R. Parsons to be his Principal Private Secretary and to be Secretary of the Post Office Board and of the Post Office Advisory Council.

"Music While You Work"

FROM Sunday, September 3rd, the afternoon programme of "Music While You Work" will be broadcast an hour and a half later, from 4.30 to 5 p.m. This change in timing will only affect Sundays, and the weekdays afternoon sessions will still be heard from 3.0 to 3.30 p.m.

In making this alteration in the Sunday broadcasts, the B.B.C. has taken notice of many suggestions from factory listeners that the afternoon programme would be of greater benefit if placed nearer the end of the day shift. It is now possible to make this change for Sunday workers. At present other programme commitments prevent its being extended to weekdays.

"Carroll Levis Hour"

"CARROLL LEVIS Hour," starring Vic Oliver, began on July 18th and was originally scheduled to run for four weeks only. It has proved successful and will now continue till October 3rd. Besides Vic Oliver, assisted by Betty Paul, the programme includes a weekly selection of the Levis Discoveries, Radio Deceivers, Just the Job and other features, guest stars, and Stanley Black and the Dance Orchestra.

When Levis was with the troops overseas he asked them to tell him what kind of shows they wanted to hear. They told him, the "Carroll Levis Hour" is the result.

What the Forces Want to Hear

THE B.B.C., seeking the guidance of service listeners, is sending its General Overseas Service Director, Norman Collins, on a tour of the Mediterranean and other theatres of war. His journey is made possible by the co-operation of the Welfare Departments of the three Services.

He will visit officers in charge of British forces stations which rebroadcast the G.F.P. for some six of their ten daily hours of transmitting time and will also see some of the Forces correspondents who send regular listening reports to the B.B.C. Above all, he wants to meet as many men as possible, both officers and other ranks, who will give him their personal views of the type of entertainment now provided for them by the G.F.P. and suggestions for improving the service.

The object of his visit is to ensure that the G.F.P. provides men and women serving overseas with the kind of entertainment they want at times at which they are able to hear it. The B.B.C. feels that the G.F.P. is a service that can fill a definite need; Collins intends to do all that is in his power to see that this need is adequately fulfilled.

R.A.F. Signals Unit News Service

MEMBERS of a R.A.F. Mobile Signals Unit operating on a Mustang airfield in Normandy are producing "hot news" of such topicality that they are beating the B.B.C. When they started producing bulletins to meet the constant demands of pilots and ground crews for up-to-date news on the war situation, they confined their activities to the dictation-speed broadcasts of the

B.B.C., but one or two "lucky strikes" by dial-roving wireless operators off duty have made them more ambitious, and they now garner news from Stockholm, Algiers, Mexico City, and any other available source. Often producing twelve or more news-flashes a day, they frequently tap morse broadcasts emanating from the Reuters News Agency, and have even intercepted the despatches from B.B.C. reporters in France to their headquarters in London, with the result that commentaries broadcast on the six o'clock news have appeared on the camp bulletin board two hours earlier. The "editor-in-chief" is a former theatrical producer, now a cypher sergeant. His wife is a member of the B.B.C. Overseas Staff. An American-built set provides most of the "gen."

Broadcasts to Schools, 1944/45

THE McNair Report on the Training of Teachers, speaking of the contribution which broadcasting and the cinema can make to education, says: "Teachers cannot afford to be ignorant of the influences which shape the opinions and habits of men and women at large, among which broadcasting and the cinema are two of the most powerful. Children are continuously affected by both, and for this reason alone it is essential that the teacher's training should cause him to think critically and constructively of the relationship of broadcasting and of the cinema to education. We should expect such studies to be part of an enlightened course in education or social studies, and to result in the schools doing something to influence children's taste. But there is another and perhaps even more important reason why a teacher's training should take account of these things. Both radio and films are becoming more widely valued as instruments of education in all types of schools. In 1942 some 12,000 schools listened to programmes of broadcast lessons. . . ."

Two Aspects of School Broadcasting

SCHOOL Broadcasting, then, has two aspects. It has elements common to broadcasting in general; and elements of a more directly educational character, series which can be integrated with the teacher's own courses of instruction, supplementing his work and bringing him the help of a wide range of experts.

Details of Broadcasts to Schools for the Autumn Term, 1944, to the Summer Term, 1945, have recently been issued by the Central Council for School Broadcasting in their annual programme, which in its length and in the information that it gives is nearer to pre-war editions than others issued during the war years. The purpose of School Broadcasting is unaffected by the war—its aim is still to supplement the work of the teacher. Since, however, in war-time many schools find it difficult to follow a series regularly week by week, in most subjects each broadcast, though one of a series, is self-contained and does not assume knowledge of what has gone before.

There are to be 28 series of broadcasts for schools in Great Britain, with two series designed specially for Scottish schools and three for Welsh-speaking schools.

Many of the series follow old and well-tried paths, but there are several new approaches and new subjects which deserve mention. "Britain and Her Neighbours," the subject of the Senior History talks, will include stories of great events and great personalities from the 15th century to the present day and will show Britain as part of the stream of Western civilisation, both in Europe itself and overseas. "The Changing World," another history series, takes for its subject for the Autumn Term "Growing Food"—as the note for the teacher says, "the oldest industry in the world and still the most important." The broadcasts will show some of the main stages in the story of man's food from the mediæval village to the mechanised farm and the age of scientific agriculture.

News of the G.F.P.

THE Army overseas now has its own radio network of low-powered mobile stations which pick up the B.B.C.'s shortwave programmes and re-transmit them on medium wave for the local forces audience. On New Year's Day, 1944, the first of the British Forces Stations was opened in Algiers. Then in mid-April a station was opened at Campobasso, chiefly to serve Eighth Army listeners, and by May 1st a third station was operating in Bari. The branch of Army Welfare which is responsible for broadcasting follows close on the heels of the fighting men: within a fortnight of the occupation of Rome a British Forces Station was installed there. All these British Forces Stations carry a mixed bill of original shows, transcriptions (special recordings) and rebroadcasts from B.B.C. programmes. A report of the first six months of the Algiers Station shows that during May the station broadcast 103 "live" studio performances, as well as 158 hours of entertainment taken direct from the General Forces Programme.

The Algiers Station—"British Forces Station No. 1"—is run by Lieut.-Col. G. Pedrick-Harvey, better known to listeners over here as Gale Pedrick, author of "The Fingers of Private Spiegel" and many other radio shows.

B.B.C. Symphony Orchestra Tour

ON August 28th the B.B.C. Symphony Orchestra went on tour again to play to Service men and women in their camps in England and Wales. This tour has been arranged in co-operation with ENSA and is the fourth occasion in just over a year on which the B.B.C. and ENSA have collaborated to give the best music to the Forces and, in some instances, to war workers as well.

The Fifth Army mobile wireless station, which is in communication with the United Kingdom day and night. This station sends and receives several thousand messages every twenty-four hours.

NEW SERIES

Direct Disc Recording

An Historical, Theoretical and Practical Exposition of Recording Methods

By R. W. LOWDEN

WE are all familiar with the gramophone record and the talking film, but few of us realise the very great extent to which sound recording is being used in industry, educational, general training and medical purposes and, of course, in all branches of the Services.

It is not the purpose of this series of articles to detail all these applications of recording, but it is interesting to note the great increase and enormous possibilities of the art as applied by the B.B.C. in its entertainment and news services which use well over 4,000 discs every week.

The first mention of recording was in 1857 when Leon Scott, a Frenchman, made the first known recordings in the form of wavy lines on a piece of smoked paper. Not until 1877, however, were practical recordings made and reproduced by Edison on a cylinder covered with tinfoil. Some years later the wax cylinder—familiar to the old gramophone enthusiasts—took the place of the tinfoil and the gramophone was born as a means of education and entertainment.

From that time onwards improvements came from all quarters and the flat disc we know to-day came into being. In 1926-27 electrical methods, as distinct from the acoustic methods used up to that time, for recording and reproducing, were introduced, and with the many improvements in equipment and technique it is possible to-day to reproduce speech and music with a faithfulness which leaves little to be desired.

Of the various methods of recording available to the home and semi-professional enthusiast such as disc, film, wire, and the several methods of each, it is probable that disc has become the most popular and widely used, partly due to the fact that it is within the means and capabilities of most amateurs and requires less complicated apparatus to get reasonable results and, furthermore, those results are immediately apparent without resort to any outside assistance.

The author therefore proposes to deal with the disc method first and to split the subject into reasonably self-contained sections dealing with the disc, how it is cut and the various types; cutting heads and stylii; traverse mechanisms; motors; amplifiers and tone controls; use of the complete equipment, with practical hints based on the author's 15 years of practical experience.

What is Sound?

As we are dealing with sound and shall constantly be referring to the various terms and symbols used in its measurement and definition, it would be as well to spend a few minutes clarifying our ideas as to what sound is. Sound is a disturbance set up in a medium in which the particles of the medium oscillate about their average position. We all know that we hear sound, although all sounds are not audible to the human ear, and most of us know that sound is vibrational energy and is conveyed from one place to another by means of a wave motion and that when sound waves fall on the normal human ear they give rise to a sensation of hearing.

Any type of wave motion has four properties:

(1) Velocity, which is the speed with which energy is conveyed from one point to another by means of the wave motion.

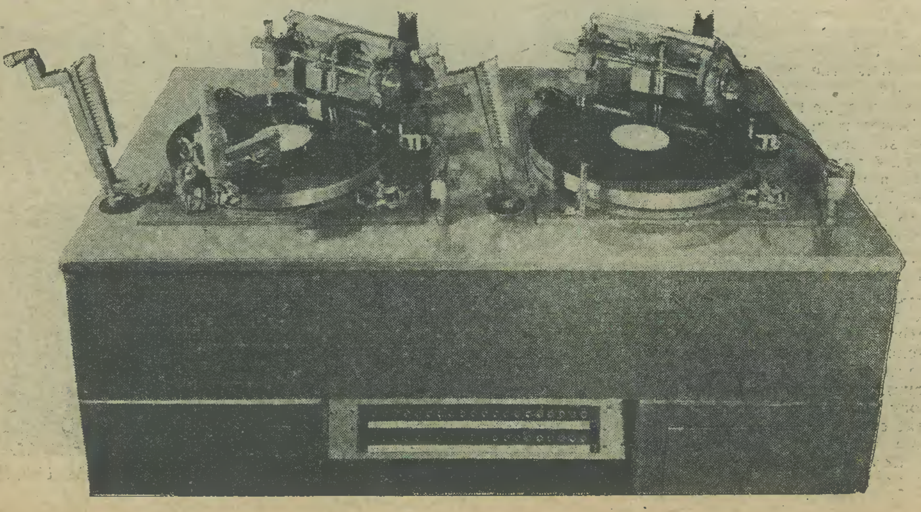
(2) Frequency, which is the number of waves passing a fixed point in a given interval of time, usually taken as one second.

(3) Wavelength, which is the distance between one wave crest and the next.

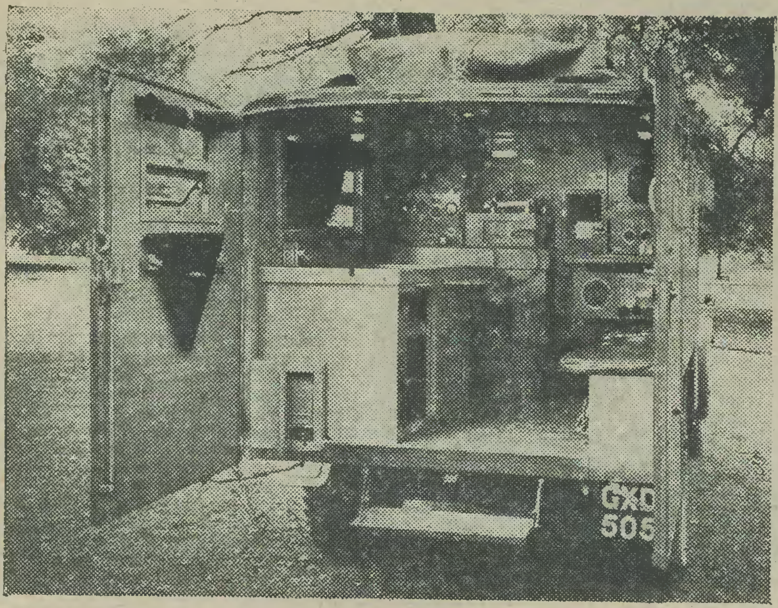
(4) Amplitude, the maximum displacement of a moving particle of the medium from its mean position, or very roughly the amount of medium in vibration. The reader is referred to Fig. 1 for a graphical representation.

Let us imagine ourselves to be standing on a bridge over a large pool of water. If we drop a stone into the centre we see waves spreading outwards due to the disturbance. If we take a larger stone and lower it into the water slowly the waves produced will be barely visible, but on the other hand if we drop it in the waves will be considerably larger. The difference in the two types of waves we have produced is that of amplitude, a greater amount of water having been set in motion.

Now let us raise and lower our stone slowly, noting the distance between the tops of the waves, which will be large. Then let us raise and lower much more rapidly and we see that the distance between tops is much



Modern type of dual recording machine. The traverse mechanism is driven from the centre spindle and swings clear for loading.



A B.B.C. recording truck, as used by B.B.C. war correspondents. Interior view, showing single channel recording apparatus. Short-wave receiver can be seen on the right and three channel mixer and loudspeaker above.

smaller. The difference we have seen is that of frequency or the number of times in a given period that the water has been disturbed.

The author makes no apologies for introducing at this stage some simple mathematics, as the real recording enthusiast will want, at a later date in this series, to work out the wavelengths and velocities of waves in order to determine how much can be recorded at various speeds and positions of the disc.

Frequency is given in terms of cycles per second and one cycle of a wave is one complete set of varying conditions; the part above the mean line XY in Fig. 1 being termed positive half cycles and those below the negative half cycles.

The time between successive waves is known as the Period and the number of waves per second the Frequency (f). The relationship between the two may be shown as

$$\text{Period} = \frac{1}{f} \text{ seconds.}$$

If we take Frequency (f) and wavelength (λ) the product will give us the speed at which the wave is traveling, or its velocity:

$$f \times \lambda = V \text{ (velocity) or}$$
$$f = \frac{V}{\lambda} \text{ or } \lambda = \frac{V}{f}$$

Before going on to discuss the various types of disc recording a few facts and figures appertaining to the audible scale which the human ear can deal with would not be out of place. Sound waves of given frequencies produce a sensation described as "pitch." To raise the pitch of any given note one octave we must double the frequency. As an example, let us take the pitch of middle C on the piano, which for scientific purposes is taken to be 256 cycles per second (although British standard concert pitch is 261 c.p.s.). Raising this one octave to the next higher C would give us a frequency of 512 c.p.s., and in the same way lowering it one octave would give us 128 c.p.s.

Let us now apply the formula given a little earlier in this article to work out the wavelength of middle C. Sound travels in air with a velocity of 1,130ft. per second (about 770 miles an hour) so that substituting 1.130 for V and 256 for f we have $y = \frac{1.130}{265}$ or 4.4ft. per second. We shall find the use of this formula in a later article dealing with the frequency response obtainable at various distances from the outer edge of the disc.

The human ear is a very sensitive instrument and is capable of detecting sounds as low as 16 c.p.s and up to 20,000 c.p.s. and even higher, depending upon the age and state of health of the person concerned. The useful frequency range of a full orchestra extends from 30 c.p.s. to 15,000 c.p.s., but if restricted to a band of 80 to 8,500 c.p.s. more than satisfies all but the keenest musician so accommodating is the human ear. Indeed, the average gramophone record is restricted even more than that, especially in the lower region,

Artist recording in the H.M.V. personal recording studio. Note the moving-coil microphone.

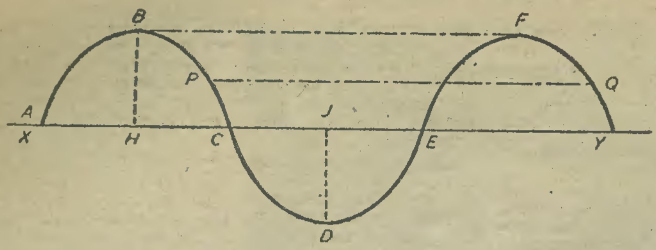


Fig. 1.—Amplitude H.B. is positive or JD negative. Wavelength BF or PQ. One complete cycle ABCDE.

whilst in the upper range is rarely above 6,500 c.p.s., with a sharp falling off above that.

Types of Disc Recording

The three main types of disc recording are shellac pressings, i.e., the usual gramophone record; the electrical transcription used in the broadcasting studios; and the instantaneous or direct recording used in private studios, the home, and to a great extent in broadcasting, film studios, etc., where immediate playback is required without any processing.

All these are produced by causing a "wax" or other type of blank disc to rotate at a fixed speed of usually 78 r.p.m. or 33⅓ on a turntable. A spiral groove is cut in the blank by means of a cutter or stylus, which is made to traverse the blank from outside to inside, or vice versa. At the same time the cutting stylus is made to vibrate according to the frequency and amplitude variations of the sound being recorded.

The commercial gramophone record sold to the public begins life as a solid block of "wax" (really a metallic soap) one to two inches thick and several inches larger in diameter than the finished record is to be. This wax is made to rotate on a heavy turntable which is driven by a gravity motor and is engraved with a sapphire stylus. The master record thus produced is then subjected to a process of sputtering with gold or silver, which causes it to become metallised. This metallised disc is then put into an electrolytic bath, where it forms one electrode, and a layer of copper is deposited on it to a thickness of approximately 0.05in., some 10-14 hours being required to complete this process. It is of interest to note that marks on the original wax as fine as 0.00002in. can be faithfully reproduced by this process.

This "master" is a negative and if backed with a solid metal plate and treated with a thin layer of nickel may be used to stamp up to some 50 records before being ruined. If, however, large quantities are required, as in the gramophone industry, this "master" is put into an electrolytic bath and a coat of nickel deposited on it to a thickness of about 0.03in. The nickel plate is then stripped from the copper and is a positive, or "mother," and must be treated very carefully indeed as it is used for the production of the stampers from which the shellac pressings are produced.

The "mother" is now put through the same process as the "master" and what is known as the stamper is produced. A "mother" may be used for the production of any number of stampers by the same process and is stored carefully as it is the only exact copy of the original wax recording.

The stampers are used in the hydraulic presses used for pressing out the records which we buy in the shop. These are usually referred to as shellac pressings, and the various firms producing them have their own, usually secret, formulæ for producing the "biscuit" or type of dough used in the pressing. A typical example may consist of slate dust 55 per cent., orange lac 22 per cent., shellac 15 per cent., rosin 5 per cent., lamp black 2 per cent., cotton flock 1 per cent. It would be as well to state here that, contrary to general belief, no abrasive material is added to the biscuit for the purpose of grinding down the reproducing needle point. The finished record is slightly abrasive in itself because it has to have a certain degree of hardness otherwise its life would be too short for practical purposes.

The electrical transcription, a term which the author believes has been imported from the U.S.A., is made in the same way as the shellac pressing, but instead of the final pressings being produced in the shellac form they are stamped out in a substance known as vinylite, which is a vinyl acetate plastic and is remarkable for its very low surface noise, making it very suitable for the recorded programmes used in broadcasting. The pressings so made have not quite the length of life of the shellac type, but they are capable of very high quality when used with the light type of reproducer as in the broadcasting studios, and are very much in favour in this country and the U.S.A. for almost all classes of recording work where a number of copies are required as against the single original of the direct record and the large number of copies obtainable by the usual process and which are rather noisy and limited in frequency response.

The direct or instantaneous method consists of recording directly on to a lacquer coated metal or glass disc which is played back without processing in any way. This type of recording is capable of as high a degree of quality as the transcription type and both are capable of a higher degree of fidelity and volume range than the normal shellac pressings. Modern technique allows of a flat response up to the region of 8,000 c.p.s on good class equipment available to the home user, and up to at least 12,000 c.p.s. for the better class of equipment used in the studios.

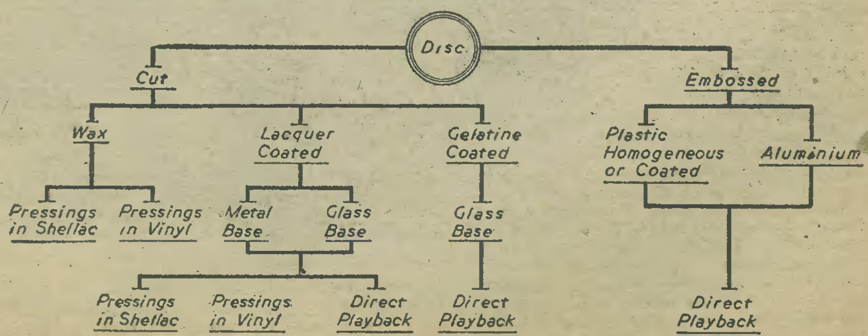


Fig. 2.—Types of disc recording and relationship between cut and embossed records.

Fig. 3.—The different groove shapes, for (A) shellac pressing cu with sapphire, and (B) direct record cut with steel cutter.

It is quite safe to say that the home enthusiast, using good equipment and the best quality blanks, can, given the right experience, produce records better in quality and amplitude range than the records he can buy in the shop. It is only fair to say, at this stage, that such results are not being obtained by many amateurs to-day, simply because they have rushed into buying equipment and putting it into use without first getting a thorough knowledge of the subject. Anybody with a camera can take photographs, but it takes more than just enthusiasm to produce one that can be put alongside the professional. In the same way anyone can make a record on his own equipment, but to obtain results on a par with those of the experienced recording engineer needs patience, at least a good grounding in the basic requirements of the art and lots of experiènce. The would-be recording enthusiast must aim higher than to be just another "home recorder" with a five pound equipment and a radio set.

The groove cut in the wax for commercial shellac pressing differs in some cases from that cut in the direct recordings. That of the shellac pressing is slightly rounded at the base, while that of the direct recording is a definite V-shape. Several years ago this was almost always the case, due to the fact that in the case of the wax recording it was possible to use a sapphire stylus with a definite tip radius, while with the direct record, due to the much harder material, it was not possible to cut a groove unless a sharp V-shaped tip was used. The present-day tendency is to adopt the rounded stylus for both the wax recording and the direct recordings, due chiefly to the greatly improved direct blanks now obtainable and the fact that most up-to-date recording engineers now use sapphires for cutting direct records, although, of course, excellent results are to be obtained with the V-shaped steel cutter, which has certain advantages so far as the home experimenter is concerned. It is a fact that better and more consistent results can be obtained by the use of a sapphire cutter with a rounded tip, and no better example of the results to be obtained can be given than the recordings of the B.B.C., both studio and many outside recordings, the majority of which are done with this type of cutter. Fig. 3 shows cross sections of both types of groove.

Vertical and Lateral Methods

The groove cut in a disc may be either from side to side—lateral recording—where the depth of the groove should always be the same; or up and down—vertical recording—where the groove should be of a constant pitch all the time. The former is the type used by the gramophone companies and most direct recording studios and home recordists, whilst the latter is perhaps more commonly known as "hill and dale" recording, and is used on the office dictaphone, most American transcriptions for broadcasting, and was, of course, the original method used by Edison on the early phonographs.

No two experts agree as to which is the best method and as we are concerned with the more usual and most used method—the lateral type—we shall in passing only mention several of the advantages to be gained by the vertical method, without discussing in greater detail the relative merits and demerits of either system. As the vertical system uses an up and down motion with no side motion, it is possible to cut more grooves to the inch without the fear of one groove breaking into the next, consequently greater playing time can be obtained. It is also possible to record without restriction the low frequency end of the spectrum and to obtain a greater signal to noise ratio than with the lateral system.

On the other hand some form of tracking mechanism is required to reproduce the vertical system, and it is a fact that quite serious harmonic distortion can be caused in the reproduction of vertical recordings due to the difference in the contours of the tracks traversed by the sharp-faced cutter and the round-pointed playback stylus. In general it is perhaps a significant fact that the most universally used method is the lateral cut. Fig. 4 shows cross sections of the tracks made in each system.

Embossed Recording

Any mention of direct recording methods would not be complete without drawing attention to the embossed type which has recently come very much in favour, especially in America, where there are at least a dozen firms making embossed type recording equipment.

This method uses a round-pointed sapphire stylus which is heavily weighted and embosses or burnishes the track into a plastic material, such as ethyl-cellulose, or in nylon and similar materials. The track is a lateral one, as in the cut method, but it is much more shallow and requires a tracking mechanism for playback. On the other hand, more grooves per inch can be cut, and as no swarf or shavings are removed, it lends itself very favourably for the long-playing type of equipments, especially when used with a constant groove speed drive, as is usually the case.

Using a 16in. disc it is possible to record for one hour, and there are at least four types of equipment using disc. There are just as many using various lengths of film strip of varying widths on which are embossed up to 115 tracks, giving a playing time of from one to five and even more hours without a break.

The frequency response is restricted to a range of some 200 to 4 or 5 thousand c.p.s. due to the slow cutting speed, heavy weight of the recording head, etc., and at best can only be termed high intelligibility. For monitoring, recording conferences, speeches and the like this is, of course, quite satisfactory, but no embossing equipment has yet been produced capable of high quality recording as we know it to-day. This may be due to the fact that most equipments have been produced with the sole idea of long playing in view, but it is doubtful if the speed of the recording material under the embossing tool can be increased sufficiently to give the necessary response at the higher end of the scale before serious wear shows up in the tool itself.

In our next article we shall go very thoroughly into the types of disc for direct cutting, their composition, frequency response, how they are best cut, and their general treatment for recording.

(To be continued)

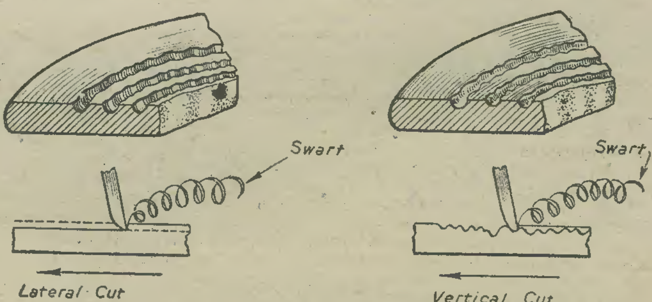


Fig. 4 (Left).—Lateral cut, constant movement; and (Right) Vertical cut constant pitch lateral contour, but cut up and down, giving variable depth.

Modern Broadcast Transmitters

Details of the Circuits Used for Modern High-fidelity Transmission

By S. O. MAWS

THERE are comparatively few who have much knowledge about the circuits used in modern high-fidelity broadcast transmitters. It is chiefly for the benefit of "receiver-minded" folk that the present article has been written. It does not claim to be a full-length treatise on the subject of broadcast transmitter design, about which whole books might well be written: instead, it is a very brief outline of the subject, showing, in a very general way, the type of circuit used in up-to-date equipment.

One section that a transmitter has in common with a receiver is an audio-frequency amplifier, but a difference between these amplifiers is that in a receiver the amplifier is rarely called upon to deliver an output of more than 10 watts of A.F. power, whereas, the amplifier of a transmitter will need to supply, say, 50 kilowatts of A.F. power in order to modulate fully a transmitter rated at 100 kilowatts output power. Such a great power as this is not achieved, as one might expect, by using a large number of small valves in a parallel-push-pull arrangement, but is quite frequently delivered by only two valves, working a push-pull and under class B conditions. The valves are very large, of course; they stand 4ft. high, have a high tension supply of 12,000 volts, and have a filament consuming 200 amps. at 30 volts. The anode current fluctuates in a Class B system, but it probably averages 2 amps. The bombardment of the anode of such valves by the electrons from the filament normally would produce sufficient heat to bring it to incandescence, and water-cooling of the electrode is necessary to prevent this. And the provision of water-cooling introduces a fresh problem, that of getting rid of the 12,000-volt charge which the water acquires because of its contact with the anode. This is done by providing the water with an extremely long (i.e., high resistance) path to earth from the anode cooling jacket. By this means the drain on the H.T supply via the water path can be reduced to a few milliamps.

The Audio-frequency Amplifier

Readers who remember the days, some years ago now, when class B outputs were popular in battery receivers, may be somewhat surprised in view of the poor quality frequently delivered by this arrangement, to find that this type of output stage is used in high-fidelity transmitters. It is used here, of course, primarily because it is a very economical system. Class A operation, which gives the best fidelity, gives only about 20 per cent. efficiency, but in a well-designed class B output stage it is possible to double this figure. The distortion, with which we were familiar in these old battery sets, is completely eliminated by very accurate adjustment of the operating conditions, by the use of very good transformers, and frequently by the use of negative feedback. Feedback is sometimes achieved by rectifying some of the modulated R.F. from the transmitter output and feeding it back to an early stage in the A.F. amplifier. One of the causes of class B distortion is lack of uniformity in the characteristics of the valves used. It is, in fact, extremely difficult to ensure precise equality in the characteristics of any two nominally identical valves, and so precautions are taken in the design of transmitters to avoid the distortion which non-equality in the characteristics would produce. The two halves of the Class B output stage are given independent grid bias supplies, so that the anode currents of the two valves can always be made precisely equal. The magnitude of the audio-frequency input to each valve is also controllable by means of potential dividers, so that differences in amplification factor can also be allowed for. Both of these points are illustrated in Fig. 1, which shows the circuit diagram of a typical Class B transmitter output stage. In this diagram the circuit of the driver stage is also included. This usually takes the form of two triodes, again in push-pull, but operating generally under Class A conditions. It is interesting to notice that the same two precautions are taken with the driver stage to ensure precise equality in the outputs of the two valves. The A.F. amplifier of most transmitters consists of pairs of valves operating in push-pull throughout, the valves becoming larger as one moves towards the output of the chain. All stages use Class A working, except the last, usually.

Radio-frequency Amplification

Another surprise awaits the reader when he examines the circuit diagram of a broadcast transmitter. This is the discovery that in most transmitters all the radio-frequency amplification is carried out by neutralised (or neutrodyned) triodes. Such R.F. amplifiers became obsolete in receiver design prior to 1930, yet they are still used in transmitters. This does not indicate stagnation in transmitter design—far from it. There is a very good reason which can be advanced for this apparent anomaly. It is that there is little point in using valves more complex in structure than triodes, for the efficiency obtained from these neutralised triode R.F. amplifiers is surprisingly high. A triode amplifying unmodulated R.F. (as the early R.F. stages in transmitters do) and operating under class C conditions can fairly easily be made 90 per cent. efficient. Neither tetrodes nor pentodes could improve on this figure. Neutralisation, which was such a nuisance in those pre-1930 receivers, is not troublesome in transmitters. Its snag with receivers was that every time the tuning knob was moved then a corresponding adjustment of the neutralising condenser became necessary. Transmitters, however, operate for long periods at a fixed carrier frequency: thus there is no need for constant re-setting of the neutralising condenser and the employment of this system becomes a practical possibility. It is not surprising in view of the large powers involved to find that the R.F. valves are used in push-pull, and a typical circuit for the carrier (i.e., the unmodulated R.F.) section of a transmitter is given in Fig. 2. In this C1 and C2 are two neutralising condensers and all the others indicated are for tuning purposes. Notice that these tuning condensers are always used in pairs. This method is useful in that it permits the moving vane of all condensers used for tuning to be earthed. The grid bias supply, usually derived from D.C. generators, is such as to bias the triodes well beyond the point of cut-off of anode current, so that anode flows only for a small fraction of each positive peak of the input signal. This is class C operation, of course, and accounts for the very high efficiency of these amplifiers.

The Mixer Stage

We have now discussed the principal sections of a transmitter except for the apparatus producing the carrier signal and the mixer stage, where the audio-frequency signal is superimposed on the radio-frequency carrier. This part can be compared with the frequency-changer in a superhet receiver, for the same sort of thing goes on in both, namely, that sum and difference terms are produced from the two input signals applied to the stage. In a transmitter the mixing usually takes place in the anode circuit of the final R.F. amplifier, this being known as "high level" modulation. Some types of transmitter employ amplifiers of modulated R.F. following the modulating stage, this alternative

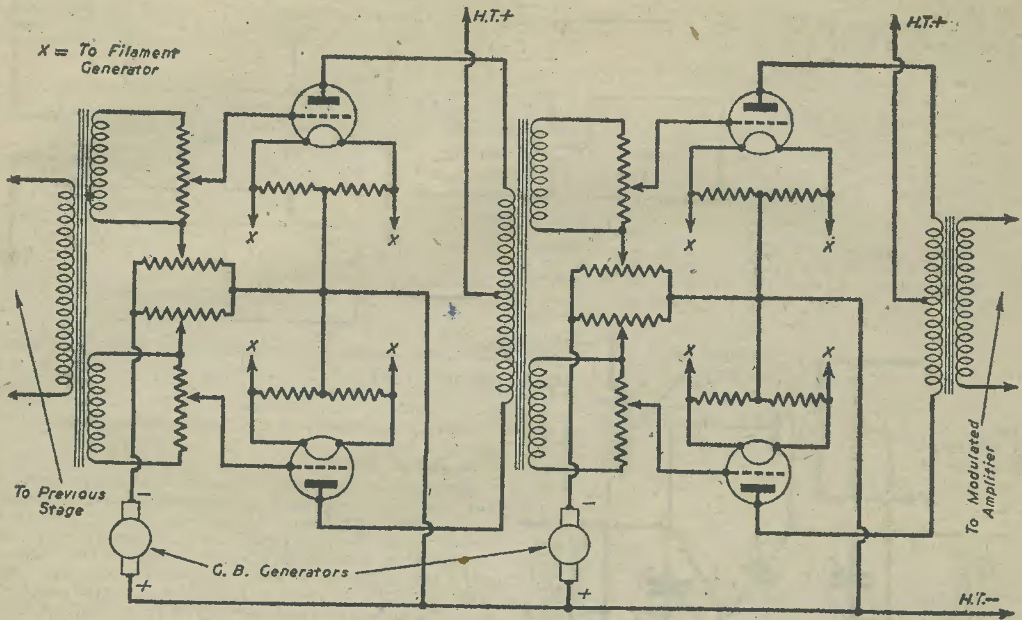


Fig. 1.—Circuit for control of magnitude of audio-frequency input to each valve by means of potential dividers, permitting differences of amplification factors. The two halves of the class B output stage are given independent grid bias supplies.

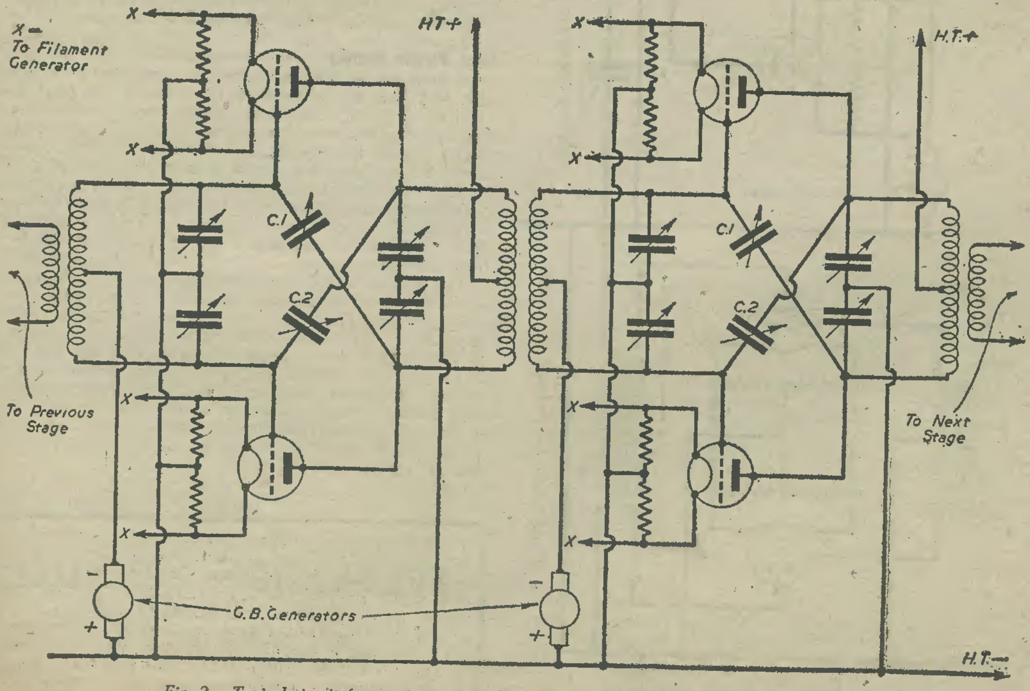


Fig. 2.—Typical circuit for carrier section of transmitter. R.F. valves are used in push-pull.

system, which now seems to be losing favour compared with the alternative already discussed, is known as the "low level" modulation. Mixing is achieved by allowing the amplified A.F. signal to control the H.T. supply to the R.F. amplifier. A simplified circuit diagram of this, the Heising modulation circuit, is given in Fig. 3. In this the anode voltage of the R.F. amplifier is supplied from two sources: one is the H.T. supply system of the transmitter (about which a little information will be given later) and the other is the voltage drop developed across L, the modulation choke, as a consequence of the A.F. power delivered to it from the A.F. amplifier. The isolating condenser C has the purpose of preventing a short-circuit of the H.T. supply through L and the secondary of the output transformer.

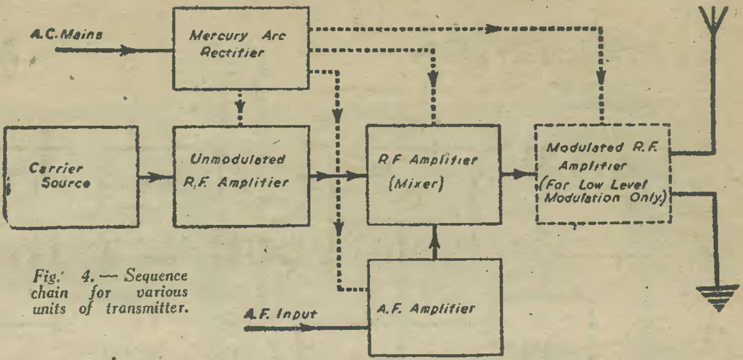


Fig. 4.—Sequence chain for various units of transmitter.

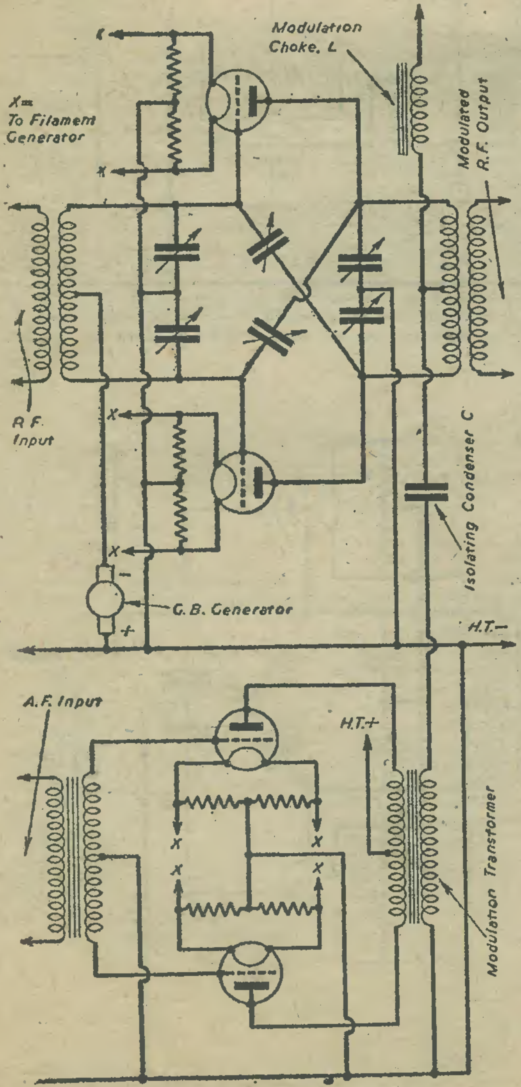


Fig. 3.—The Heising modulation circuit, employing R.F. amplifiers following the modulation.

The Carrier Source

Most of the carrier frequencies used by transmitters are much too high to be generated by alternators and are accordingly produced by valve oscillators, precautions being taken to keep the output waveform pure (the presence of harmonics is clearly undesirable) and to keep the frequency constant within very narrow limits. The necessary frequency stability is achieved either by using an oscillator controlled by a quartz crystal which is mounted in an oven maintained automatically at a constant temperature, or else by using a specially designed tuned circuit contained within a thermostatically controlled oven. The carrier source need not give an output at the wanted frequency; it can generate a multiple or a factor of it and the needed carrier frequency can be obtained from this by stages of frequency multiplication or division.

The Power Supply

A transmitter has, of course, a power pack to supply the H.T. for the anodes of the valves, but this is all it does supply. The L.T. (which, in a receiver, also comes from the mains transformer) is, in a transmitter, derived from D.C. generators driven by electric motors, each large valve having a generator to itself. The H.T. supply may be taken from three-phase A.C. mains. To minimise the amount of smoothing necessary following rectification, the nature of the A.C. input is usually converted into six-phase, and is then rectified by mercury-arc rectifiers.

The way in which the various sections of a transmitter so far discussed fit together is indicated in Fig. 4.

So efficient are most of the stages in a modern transmitter that the overall efficiency, i.e., the fraction of the total input power, including all L.T., G.B. and H.T. supplies, which is turned into useful radiated energy, may be as great as 40 per cent. This is considerably better than can usually be achieved in a receiver. A typical receiver consumes about 60 watts from the mains and delivers an output of, say, 4 watts which is less than 7 per cent. efficiency.

COMPETITION **MANY PRIZES**

Your Post-war Receiver

WANTED—YOUR SPECIFICATION

IN order that manufacturers may be accurately guided in the design of the post-war wireless receivers, and produce designs which will satisfy popular requirements, we invite readers to let us have their suggestions.

Below will be found listed the main features of a wireless receiver. Copy that list, striking out the features which you think are undesirable or not required, and post so that we receive it not later than September 18th. Prizes will be awarded to those readers whose list most nearly coincides with the specifications decided by the popular vote.

The end of the war is in sight, and we shall publish the specification decided by this competition for the guidance of manufacturers.

Envelopes containing entries should have the word "Specification" marked in the top left-hand corner, and should not contain any other correspondence.

You may if you so desire add any items not covered in the list, or make suggestions for improvements not at present incorporated in wireless receivers.

The following prizes will be awarded:

First prize: £5 5s. 0d.

Second prize: £2 2s. 0d.

Six third prizes of a W.B. loudspeaker.

50 consolation prizes of books to be selected from our technical list.

TYPE ..
- Portable.
- Transportable.
- Table Model—Upright.
  —Horizontal.
- Console.
- Radiogram.

POWER ..
- Battery.
- AC/DC.
- AC.

WAVEBAND
- Medium.
- Medium and Short.
- Medium Short & Television sound.

TUNING ..
- Press Button.
- Press Button and Manual.
- Manual only.

DIAL MARKING ..
- Wavelength.
- Station Names.
- Both.

LOUDSPEAKER ..
- Permanent Magnet.
- Electro magnet.
- Dual Speakers.
- High Fidelity Speakers.

REFINEMENTS ..
- Tone Control.
- Tuning Indicator.
- Switching to enable either the internal speaker or extension speaker or both to be used.
- Gramophone attachments.

SPECIAL TYPES ..
- Speaker mounted separate from set.
- Set designed for quality reproduction and having only mediocre selectivity.

Sound Amplifying Equipment—2

Completing the Metalwork of the Case for Housing the Two-valve A.C. Operated Pre-amplifier

HAVING completed the chassis and front panel, which were described in detail in the previous issue, work can now be commenced on the main case. This involves slightly more work and patience than the chassis, but with reasonable care it is not a difficult task, and the finished article will well repay the time and care taken. The case, which for convenience in making and servicing, consists of three sides and top, is cut out in one piece according to the dimensions and shape shown in Fig. 4. Before marking out, it is advisable to check width and depth against the finished chassis, as slight variations are likely to be experienced owing to bending and to the thickness of the sheet metal used.

When the sheet has been cut to the desired shape, the folded front edges form the first bending operation, and, owing to their narrowness and the importance of getting the finished folds perfectly flat and flush with each other, this demands more care than the rest of the work. The three front cut edges have to be folded back on themselves to a depth of only 1/8in., and then turned or bent at right-angles to the remainder of the piece. A vice is really essential for this work, as it is very necessary to avoid the formation of crinkles or the risk of distorting the metal, otherwise the finished edges will not present a uniformly flat surface to the lid. Note that the folded edge which comes at the front of the top piece, does not extend along the whole length of the case. This is shown in Fig. 4, where it will be seen that the 1/8in. plus 1/8in. strip is cut away at each end by 1/8in. This is to clear the folded edges of the sides, when the case is formed. The rest of the bending is perfectly straightforward, and it is a matter of choice—according to equipment available—whether the sides are bent in before the top or vice versa. Whichever procedure is adopted, it is certainly best to bend up the narrow strips on the sides of the top piece, otherwise, it will be difficult to give them a good sharp bend once the main piece is bent into position. These strips come *outside* the sides, thus forming a strong joint between top and sides—when soldered—and, at the same time, adding rigidity to the top plate. As with all the bending, every endeavour should be made to secure clean sharp bends, and these can only be obtained by holding the metal firmly between two hard surfaces and applying good pressure in short, quick periods rather than a single stroke of doubtful force.

Regarding the drilling. Assuming that the chassis makes a good fit in the case, i.e., the folded edges of the sides of the latter clipping round the front edges of the former, the five holes shown on Fig. 4 can be marked off and drilled. While this method is quite satisfactory on paper, it may not be so perfect in practice, therefore, some may care to follow the same procedure as the writer of this article used, namely, to fit the chassis into the case, making sure that bottom edges are flush, etc., and scribe the holes on the inside of the side pieces by running the scriber round each hole. It is not a difficult matter to pick up their centres and locate them with a centre punch, the points being taken through to the outside of the case by drilling a 1/16in. hole at each punch mark. The final drilling can then be done from the outside of the case, any slight variations in lining up with the holes in the chassis being corrected by means

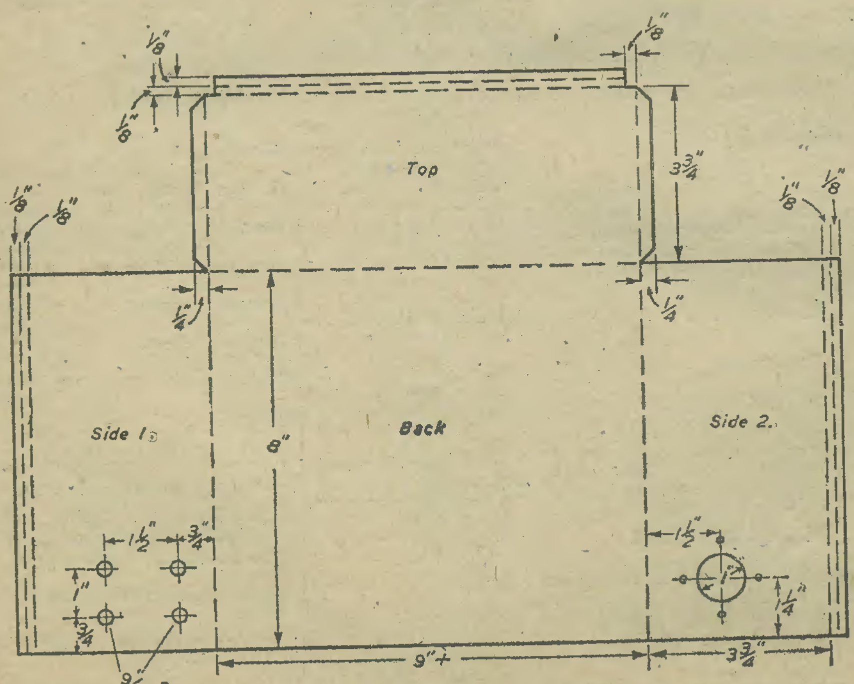


Fig. 4.—Developed plan of the metal box.

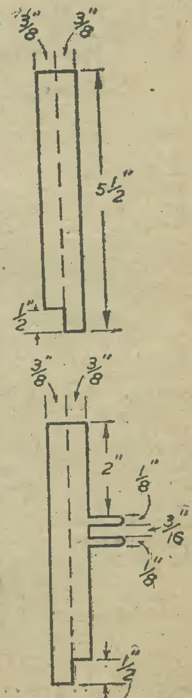


Fig. 5.—Grille fixing pieces.

of a round and half-round file. Should the chassis not be drilled by the time this is read, it would be better to drill the case and chassis together, thus assuring perfect alignment with the minimum of trouble.

Bottom Plate

To simplify servicing of the amplifier, should the need arise, it was decided to make the bottom of the case removable, as this would allow easy inspection and testing of all components without having to go to the trouble of removing the case or any connections.

The pattern of the bottom plate is shown in Fig. 6 and owing to its simple formation there is little to say about it other than a few words about the two projecting ⅝in. by ¾in. strips, which are on its front edge. The lid or door of the case is secured to the latter by two hinges of the slide-off type, and the two strips are needed to form the female part of the hinges. Using a piece of, say, 3/32in. diameter rod or a suitable nail, roll the projecting pieces round it to form a tube as shown by the side view, Fig. 6, taking care to see that each one is parallel with the front edge of the plate and dead in line with each other. The bottom surfaces of the tubes must be flush with underside of the bottom plate, otherwise the case will be tilted backwards when in use. When the above and the bending is finished, fit the bottom to the case, *with the chassis in position*, and through the centre of the turned up edges at the sides and back, drill clearance holes for 4BA round-head bolts right through the case and chassis. Strip down the assembly, and solder over the holes—on the inside of the chassis and back of case—full 4BA nuts, so that short bolts can be screwed through the turned up edges of the bottom plate, the case, and the chassis, thus bolting together this part of the assembly.

Smooth off corners and any doubtful edges, so that the hands can pass over the metal work without coming in contact with any burrs or rough parts.

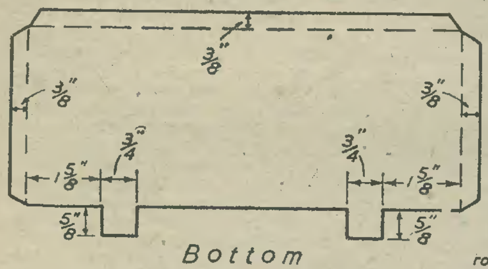


Fig. 6.—Pattern for bottom plate.

Showing Strip rolled to form Hinge

The Lid

The shape and dimensions of the metal required for the formation of the lid are shown in Fig. 7, and the constructor is advised to select for this a piece of metal free from any signs of warp or distortion. Bend up the three edges as indicated by the broken lines in Fig. 7, but it is advisable to check fitting when one side and top edges have been bent, as this will allow any variations in this instance to be corrected, by adjusting the remaining bending line, and, should the lid be a shade on the tall side, by cutting off the desired amount from its bottom edge. Although this suggestion is made, it does *not follow* that errors will be experienced if the diagrams are followed, but it will help to ensure a perfect fitting, a very desirable feature for the lid. When the lid is in position its bottom edge should be well down on the hinge strips, while the hinge tubes or rolls should have their horizontal centre lines approximately 3/32in. above the bottom edge. This will be obvious when the next operation is carried out. Take two pieces of stiff wire or suitable rod 1-3/16in. in length and of a diameter which will ensure a nice smooth fit in the hinge tubes. Place the lid in position—remembering that its bottom edge must be well down on the inner face of the hinge strips, and after putting a slight kink in each wire, ¾in. from one end, slide the wires into the hinge tubes so that approximately 7/16in. is projecting and making contact along the lid. Both pieces of wire must project in the same direction. When satisfied that the kink is sufficient to allow the projecting ends of the wires to rest squarely on the lid and, at the same time be truly located in the tubes, anchor them to the lid with solder. Don't make a finished job of the soldering until the hinge movement has been tested, to make quite sure that the alignment of the wires and tubes is sufficiently accurate to allow the lid to open and close smoothly, and to be removed from the case by opening it fully and sliding it to one side. The object of making the lid removable will be apparent when the unit is put into use, and constructors are advised not to use hinges of the ordinary type.

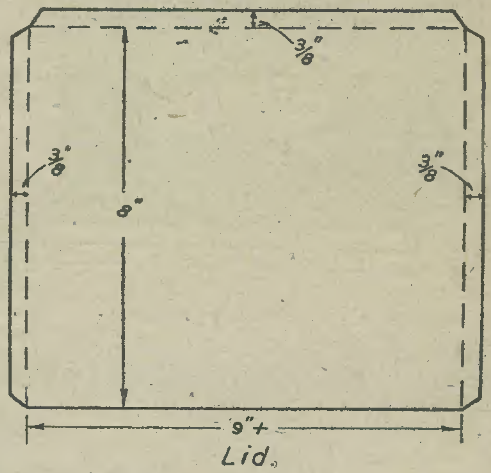


Fig. 7.—Dimensions for the lid.

Microphone Container

To the inside of the lid, in the centre of the area *above the top edge of the chassis*, i.e., approximately 5½in. above the bottom edge of the lid, solder a round tin having a diameter in the region of 2⅜in. and a depth of ½in. If nothing better is available, a No. 2 size boot polish tin will be quite satisfactory when well cleaned. Don't solder round the edge of the tin; a much neater job can be made by depositing a reasonable amount of solder on the bottom of the tin, and, after tinning the required area on the lid, place the tin over it and apply a well heated soldering iron to the inside of the tin until the solder runs, and then leave to cool. This fixing can be simplified if the lid is placed over a very low gas flame, so that both parts assist in melting the solder.

A circular hole, say, 1⅞in. in diameter can then be cut in the lid of the *tin*, and the opening covered by a piece of perforated zinc soldered to the inside. An alternative to this, and the method used by the writer, is to drill a series of 3/16in. diameter holes in concentric circles, as shown in the illustrations, and then produce a slight domed effect by lightly beating the inside of the lid with a round-headed hammer, while slightly tilting the lid in step with the path of the hammer.

Fasteners

Assemble the case, chassis, bottom plate and lid, and then solder to the outside of the top plate, the spring-clip portions of two small attaché case fasteners, which can be secured from most ironmongers for a few pence. The centres of the fasteners are located 1in. in from the sides, but their distance back from the front edge will be governed by their size. If the *complete* fasteners are held in position, i.e., the clip portion on the top plate, and the other part on the overlapping edge of the lid, the correct position will readily be determined. If the lid shows any signs of opening, fasten it truly in position by string or wire round the case.

The Handle

As the writer was unable to secure an attaché case carrying handle, of the type which falls flat on the case when not in use, one had to be made from a strip 6½in. by ¾in. by 3/16in. cut from an old leather strap. The piece was cut with a slight taper to within ½in. of each end, actually the width was reduced to ½in. at that point,

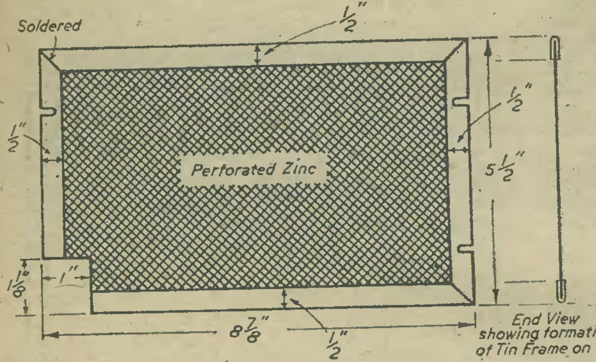


Fig. 8.—The grille.

and the ends finished off to arrow head shape. Two small bridges were made from some spare tin, their dimensions being ¼in. high, ⅜in. wide by 9/16in. in length, with ¼in. feet turned outwards at right-angles to the vertical sides. To provide smooth edges, it is best to cut the tin sufficiently wide to provide, say, an ⅛in. fold over along the longest edges, the fold over, of course, being on the inside of the bridge when the latter is formed. Short 6BA bolts—round-head—are used to fasten the bridges to the top plate, and to secure balance when carrying, the handle should be located 2in. in from the *back* of the case, but centrally as regards the width.

Don't be tempted to solder the bridges in position. While a neat fixing could be obtained in that manner, some little trouble is likely to be experienced when painting the case, especially if hard gloss paint is used, as it would be very awkward trying to paint underneath the handle, etc.

The Grille

To protect the valves and "mike" battery from damage, a metal grille is fitted to the interior of the case. Small mesh perforated zinc is used for the actual covering, the edges being finished off and strengthened by encasing them in ½in. wide channels made by folding over suitable lengths of 1in. wide tin strip. The construction and dimensions are shown by Fig. 8. When the folded strips have been cut to the right lengths, their ends should be mitred to form the three corners as shown in the diagram. When the zinc is surrounded by the channelling, the latter can be finished off by pinching the fold over—along its whole length—in a vice. The mitred corners are then soldered, but there is no need to solder the zinc to the framework.

At a point 3in. from the bottom edge of the grille and 3/16in. in from the *inner* edge of the left-hand member of the grille framework, cut a hole through the zinc, having a diameter of approximately ⅜in.

In the same frame member, drill a 4BA clearance hole, 1in. down from the top edge and a ¼in. from the side. Repeat this procedure on the right-hand side member, through which must also be drilled another hole of the same size, only 1½in. from the bottom edge. With a pair of tinsnips, cut through the framework, from the outside edges, to the holes, thus producing "U" shaped openings.

Fixing the Grille

Cut two pieces of tin to the dimensions and shape shown in Fig. 5, and before bending them at right-angles along the broken lines, mark off points to coincide with the "U" shaped holes in the grille. At these points drill 4BA clearance holes, and dead behind them solder 4BA full nuts. Note: The holes must be drilled on the sides which are 5in. in length, as it is the 5½in. sides which, when the material is bent, make contact with the inside of the sides of the case. The ½in. cutaway is to clear the top of the panel, and therefore, represents the bottom end of the angle strips. The one with the projecting tongues, cut to form a terminal tag to make contact with the "mike" battery, is located on the left of the case, when looking at the panel. When completed, both angle strips can be soldered in position so that their front surfaces are flush with the front of the panel and parallel with the front edges of the case. Use ¼in. or ⅜in. round-head 4BA bolts for fixing grille to the strips.

(To be continued)

INDUSTRIAL ELECTRONICS

According to the report of the British Institution of Radio Engineers to industry generally, radio engineering has been synonymous with entertainment, and, prior to 1939, the application of electronic principles in the industrial field was, save for the most elementary purposes, confined almost entirely to the radio and light electrical engineering industries. That this was so, was not because the equipments in use were unreliable or demanded the constant attention of skilled engineers, but because industry generally had not appreciated or had not even been made aware of the versatility of this new branch of engineering.

War has done much to alter this state of affairs. The vital part that electronics has played, in all phases of war production, has led to a far wider knowledge and appreciation of its industrial scope. The intensive research and development that continues unremittingly is opening entirely new fields of application until now there is hardly a single branch of industry that cannot benefit in one way or another by an intelligent application of electronics.

A large number of applications of electronic devices has been made during wartime in the field of electrical machines and industrial process control. Such devices include voltage regulators, speed and process controllers, motor controllers and welding timers, as well as equipment for the detection and control of radiant energy, the control of heat in resistance welding and the control of temperature in resistive and inductive heating. These devices can be set to operate within precise limits and give indication aurally, visually or mechanically when certain limits are exceeded; the limits can be established in terms of colour, shade or density, time or speed, rotation or vibration, temperature or humidity, physical size or shape, continuity or interruption of flow, silence or noise, compression or expansion or even changes in the chemical or metallurgical composition of a body.

ON YOUR WAVELENGTH

By THERMION

From Three Swing Fans

I HAVE received the following letter signed "Three Swing Fans," and in brackets "Three of the few hundreds still left":

"We should like to express our complete agreement with what Thermion and Basil Henriques have said in the August issue, about the effect of swing and jazz on modern youth. We also agree with Thermion that it should be cut out of radio entertainment. After all the B.B.C. is supposed to cater for the public taste, and if they cut out swing, jazz, and crooning the B.B.C. would receive many more ten shillings at the end of the year."

These readers did not send their address, nor sign their letter, so I was unable to reply by post.

Post-war Car Radio

ACCORDING to Sir Miles Thomas, one of the heads of the Nuffield Organisation, every motorist will have radio as he rides in the post-war cars.

After the cars of the first stage of peacetime—those which should have been produced for 1940—have had their day, he said, there would come models incorporating many of the lessons learnt during the war. He visualised much better springing, sleeker bodies, greater silence, wider use of plastics; nor would the post-war car have so angular a body that it creates noises as it moves through the air.

It would be very many years indeed before we could hope to see an all-plastic automobile body. New techniques demanded a material with the strength of sheet steel. Moreover, could a plastic panel be repaired without a very special plant, as it would have to be if the local garage was to re-condition a bent mud-wing or a stove-in body panel?

The demand after the war should not for long be short of supply if the industry were to fulfil the Labour Minister's pledge to find jobs for the men it gave up on the outbreak of war.

"Believe me," he said, "we shall need no urging to take our men back. It will be a great day when we can see them at their old places at the benches and machines and earning the good money that they used to draw."

The Clubs Are Returning

IF any further indication were needed that the war is in its last months, it is provided by the letters I receive from radio men in the Services. Some of the letters ask me if I happen to know the addresses of the secretaries of clubs to which these readers formerly belonged. The most complete list of wireless clubs appears in the "'Practical Wireless' Encyclopædia," a copy of which is possessed by most readers. This list, however, is only as up to date as the last edition of the book, and no doubt many clubs have gone out of existence since, due to the members being called to the Services.

But Service men are looking forward to an early return to civilian life, and want to rejoin their clubs. I am sorry that I am unable to help because I have heard from very few club secretaries since the war. I do hope that any of them who read this page will write to me and let me know their plans.

Queries

I OBSERVE that although our query service has been temporarily suspended readers are still addressing queries to this office. Will they please note that owing to staff shortage we are unable to deal with them? We are confining our energies under very difficult circumstances to the production of this journal, and we have no time to modify circuits or answer technical queries involving a considerable amount of time. We shall continue, however, to deal with normal corrrespondence relating to the journal itself.

Jungle Fighters' Radio Station

SOMEWHERE in the jungles of New Guinea, near Milne Bay, is a small studio in a native-built grass hut. A cheery Australian voice emanates from here; travels along two miles of precarious land-line through dense jungle growth, and is transmitted, to be picked up by receivers in warships, tankers, Douglas air-transports, patrol aircraft, hospital wards and outlying units. And no doubt the Japs, now threatened with the new landing in Northern Dutch New Guinea, hear it too.

Thousands of Australian and American servicemen are the listening public of R.A.A.F. Radio. The voice says: "This is R.A.A.F. Radio—The Voice of the Islands."

Started and built in face of almost insurmountable difficulties by a small group of R.A.A.F. men, the station provides music of all kinds, light entertainments, news and sport. R.A.A.F. Radio's fan mail is enormous. The Australian airmen who planned it and run it are honorary, and their work is done in spare time, but all of them, in New Guinea, had previously been in wireless work before they enlisted.

Our Roll of Merit

Readers on Active Service—Forty-sixth List

W. R. Clucas (W/O., R.A.F.).
A. Mulvaney (Cpl., R.A.F.).
N. A. Carter (Pte., R.E.M.E.).
J. C. Thomas (Sgt., R.A.F.).
J. H. Nib (Marine).

SHAKESPEARE UP-TO-DATE

"A Croonette by any other name could sound no worse." [Parliamentary Secretary to Ministry of Information recently said: "I do not think that a certain amount of crooning by females—what shall I call them, singers?—is likely to affect, one way or the other, the morale of the British Army."]

What? Does he know no sobriquet—
No nickname he can use?
We here present him several
Which frequently we use.

"Sob-Sisters" might have pride of place,
With "Yowlers" close behind.
Cat-Concert Prima Donnas
Jumps to the tortured mind.

Or Adenoidal Artistes,
With fog-horn voices rough,
And vocal chords most vilely strained
Each time they do their stuff.

And now, dear secretary,
Will this cause you surprise?
We think, perhaps, they're just engaged
Because they are "Blue Eyes."

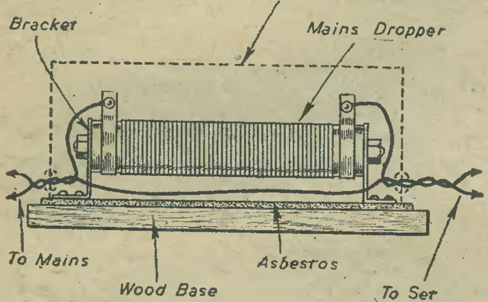
But their "Voices," or what pass for them,
Great numbers find depressing;
And if depression helps morale,
Well, sir, you've got us guessing!

"TORCH."

Practical Hints

Line-cord Substitute

WHEN asked to fix a line-cord on to an American midget recently I devised the following idea for overcoming line-cord cost. The set was a 4-valve + rect. T.R.F. receiver, and the valves took .15 amp. heater current. It was designed for 110 v. A.C./D.C., and the owner wished to have it converted for 250 A.C./D.C. working. The required resistance worked out to approximately 900 ohms which meant that about 15 ft. of line cord had to be used, the cost of which was more than the owner was prepared to pay. I therefore took the following odds and ends: 1 switch mounting block 3in. x 6in., 1 piece asbestos 3in. x 6in., 1-900 ohms wire-wound mains dropper, flex, plugs, 2 brackets and screws, and a square foot of perforated zinc.



Method of using a mains dropper as a line-cord resistance.

The asbestos was mounted on top of the block and the resistance mounted on it. Then the flex and plugs were connected and a cover was made from the zinc, as indicated.—R. V. JENKIN (Launceston).

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."

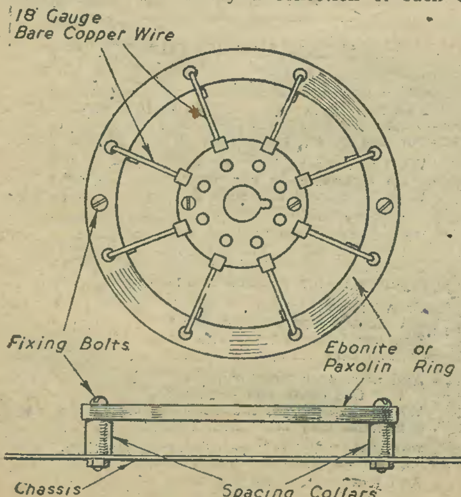
SPECIAL NOTICE

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

Connector for Small Components

EXPERIMENTERS often wish to try the effect of different resistances, condensers, etc., in a new receiver. There is usually a collection of such components around each valve-holder, and the tags to the holder are often difficult to get at with a soldering iron.

The accompanying illustration shows a method of extending the valve-holder connections, making it very easy to solder and re-solder experimental connections without touching the actual joints to the valve-holder itself. An ebonite or paxolin ring is mounted on the underside of the chassis and lengths of 18 gauge wire taken from the valve-holder tags to holes in the ring. The wire should be well cleaned prior to fixing, and components can then be attached anywhere along its length.—K. CHANDLER (Templecombe).

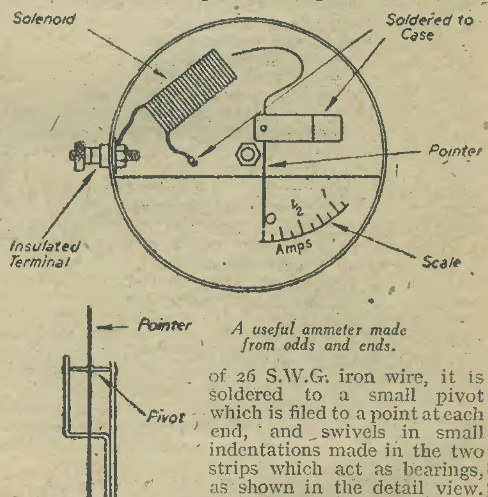


A connector ring for small components.

An Easily-made Ammeter

I MADE this meter several months ago for a small charging board, and it has worked satisfactorily.

The case of the meter is a circular tin about 1in. deep. The sketch shows the tin with lid removed to make clear the location of the parts. The pointer is a length of 26 S.W.G. iron wire, it is soldered to a small pivot which is filed to a point at each end, and swivels in small indentations made in the two strips which act as bearings, as shown in the detail view. The end of the iron wire is curved so that it can pass into the core of the solenoid. The solenoid was made by winding 20 turns of 18 S.W.G. insulated connecting wire round a pencil. The pencil was then removed as the wire is stout enough to support itself. Fix the solenoid by soldering one end of the winding to the case, and the other to an insulated terminal.



A useful ammeter made from odds and ends.

The lid of the tin has a hole cut in it, over which a piece of glass is fixed. A terminal through the centre of the back of the tin secures the meter to the charging board, and, with the lid in position, the whole is enclosed. The pointer end of the iron wire is slightly heavier than the other, and consequently points downwards.

It was found that snipping small pieces off the pointer end of the iron wire increased the deflection for a given current; a full-scale reading of approximately 1 amp. was thus arrived at. For calibration, the meter was connected in series with a ready calibrated ammeter, a 2-volt accumulator and rheostat. By adjustment of the rheostat various currents were passed through the meter, and the deflection for various currents marked in as indicated by the calibrated meter.—F. G. RAYER (Longdon).

"MANUAL OF METALS & ALLOYS" AND "RADIO MANUAL"

BERNARDS (PUBLISHERS) LIMITED, of 77, The Grampians, Western Gate, London, W.6, beg to inform the Trade and the Public that their "Manual of Metals and Alloys" and their "Radio Manual" have been withdrawn from circulation and express their regret to Mr. F. J. Camm, the Author, and Messrs. George Newnes Ltd., the publishers, that these two publications, which are infringements of Mr. Camm's works, "Dictionary of Metals and Alloys," "Newnes' Engineer's Pocket Book," "Practical Wireless Service Manual," and "Radio Engineer's Vest Pocket Book" should have been issued. The entire matter has been settled by payment by Messrs. Bernards of an agreed sum for damages and costs.

The Telechrome

CATHODE RAY COLOUR AND STEREOSCOPIC TELEVISION

Stereoscopic and Colour Television Pictures Shown Directly on the Cathode Ray Tube for the First Time

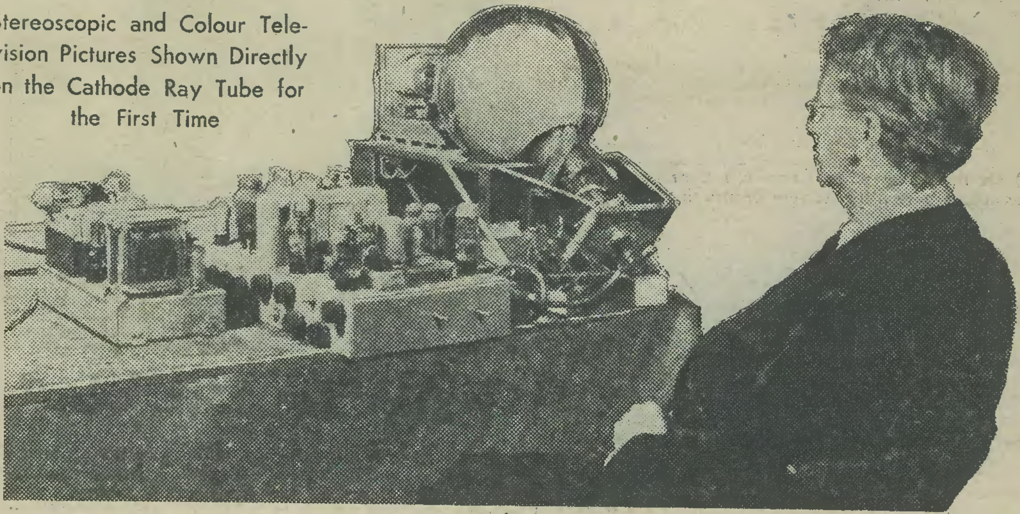
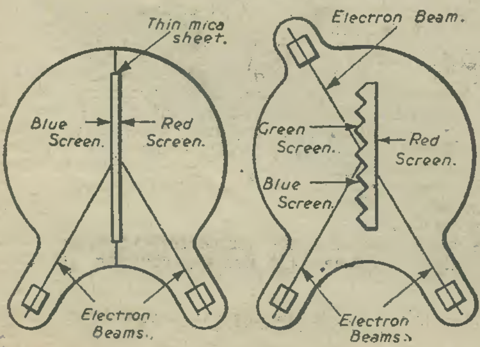


Fig. 1.—Photograph showing Mr. J. L. Baird looking in on the "Telechrome," his latest invention. The "Telechrome" is a cathode ray tube which shows television in colour and also in stereoscopic depth.

THE Telechrome, Mr. Baird's latest invention, eliminates the revolving discs and lenses previously necessary for colour and stereoscopic television. The colour and stereoscopic pictures now appear directly upon the screen of the cathode ray tube, so that *colour and stereo television can now be received on apparatus as silent and efficient as the pre-war black and white receivers.*

The Telechrome differs from the black and white cathode ray tube in having two cathode ray beams and a transparent double-sided screen. The front of the screen being coloured blue-green and the back red, one cathode ray beam produces a blue-green picture on the front surface, the other a red picture on the back surface, the two blending to give a picture in natural colour.

For stereoscopic viewing coloured glasses are used, the left and right eye pictures corresponding to the left and right eye images (a principle well known in the cinema). Stereo television without the use of glasses has been demonstrated by Mr. Baird, but this is still at too early a stage to be practically applied.



Figs. 2 and 3.—Diagrams of the new tubes for colour and stereoscopic television.

Britain is well ahead in the field of colour and stereoscopic television. Both are British inventions and were shown for the first time by Baird in 1928.

Stereoscopic television is unique to this country and has never been demonstrated abroad, while the only colour demonstrations staged in U.S.A. employ Baird's original revolving disc system.

Television in colour has previously been accomplished by three methods. In the first demonstration of colour television revolving discs were used by Mr. Baird to accomplish the scanning and also supply the colour component. In his second method the scanning was done by the cathode ray tube and the colour supplied by a revolving colour disc. In his third method images produced side by side on the face of a cathode ray tube were coloured by stationary colour filters and superimposed by projection upon a viewing screen.

Of these methods the first two come within the category of mechanical systems.

The third, which requires no moving parts, might be best described as an electro-optical system, as the colour is added to the image by optical means. This system has the very considerable disadvantage that the fluorescent screen cannot be viewed directly, the coloured image being obtained by projection, which involves a substantial loss of light.

The present system is entirely electronic, the coloured image appearing directly upon the fluorescent screen—two cathode ray beams being required for a two-colour system and three for a three-colour system. These cathode ray beams are modulated by the incoming signals corresponding to the primary colour picture and impinge upon superimposed screens coated with fluorescent powders of the appropriate colours. For example, in a two-colour system the two cathode ray beams scan the opposite sides of a thin plate of transparent mica, one side of which has been coated with orange-red fluorescent powder and the other with blue-green fluorescent powder. Thus the screen has formed upon its front face an image containing the orange-red colour components and on its back face an image containing the blue-green components; these images are superimposed and thus give a picture in natural colour. (See Fig. 2.)

Where three colours are to be used the back screen is ridged and a third cathode ray beam added, the front face of the screen giving the red component, one side of the back ridges giving the green components and the other sides of the ridges the blue component. (See Fig. 3.)

A two-sided tube has been developed and will be shown receiving a picture from a 600-line triple interlaced moving spot transmitter using a cathode ray tube in combination with a revolving disc with orange-red and blue-green filters. The receiving cathode ray tube is shown in the diagram (Fig. 2) and in the photograph (Fig. 4). The screen is a 10in. diameter disc of thin mica coated on one side with blue-green fluorescent powder and on the other with orange-red fluorescent powder. (The colour may alternatively be provided for the back screen by using a white powder and colouring the mica itself.)

The tube shown in Fig. 2 may be viewed from both back and front, but if used in this way one set of viewers see a mirror image, also coloured mica must not be used, and a filter has to be inserted between the back viewers and the tube to keep the colour values correct and compensate for the light lost in the mica and fluorescent powder when the direction of viewing is reversed.

The tube shown in the photograph (Fig. 1) can only be viewed from the front, but having one cathode ray beam perpendicular to the screen simplifies the set-up of the apparatus. The tubes give a very bright picture, due to the absence of colour filters and the fact that special powders are used giving only the desired colours which are seen additively.

The tubes give excellent stereoscopic television images when used with a stereoscopic transmitter. (The blue-green and orange-red images forming a stereoscopic pair and being viewed through colour glasses.)

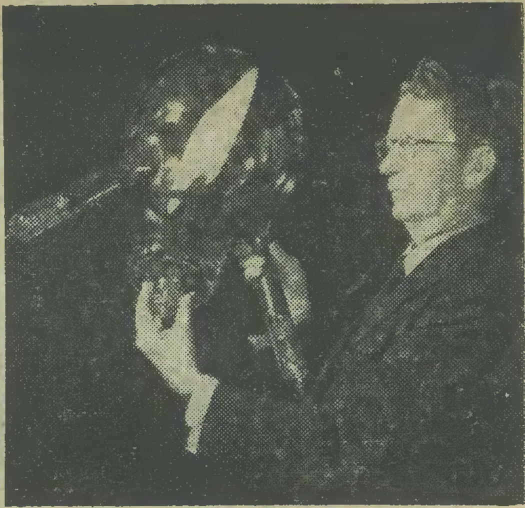


Fig. 4.—Photograph showing Mr. Baird holding the "Telechrome," his latest invention. The "Telechrome" is a cathode ray tube which shows television in colour and also in stereoscopic depth.

New Form of Scanning

In the present form of scanning all the lines in successive frames are of the same colour, the colour changing with each successive frame.

In the new form of scanning now being developed successive lines are of different colour and the number of lines is made a non-multiple of the number of colours, so that every line of the complete colour picture has successfully shown each of the primary colours.

The object of this is to reduce colour flicker. Where frame by frame colour alteration is used flicker becomes prominent in any large area of a single colour; for example, if the picture is showing a large blue area, this blue appears in the blue frame only. While the red and green frames are appearing it is not shown, so that the frequency of the repetition is reduced and flicker accentuated. With line by line colour alteration each colour appears in every frame.

This form of scanning does not lend itself to the revolving disc system.

NOTES AND NOTICES

"One-valve Midget Receiver"

THE valve base connections of the Midget one-valve receiver described and illustrated on page 7 of our September issue are as follow:

1. Not connected (used as H.T. negative).
2. F+.
3. Pentode Anode.
4. Pentode Screen (used as H.T. positive).
5. Pentode Grid.
6. Triode Anode.
7. F—.
8. Diode (not used; shorted to earth).

The numbers given above correspond to the numbers on the diagram inset in the circuit diagram. Condenser C4 was omitted from the list of components is .0002 mfd.

Wireless Section of I.E.E.

ON the recommendation of the Wireless Section Committee, the Council have decided to change the name of the section to "Radio Section" and to modify Rule No. 1, which deals with the scope of the section, to read as follows: "The section shall include within its scope all matters relating to the study, design, manufacture or operation of apparatus for communication by wave radiation, for high-frequency and electronic engineering, or for the electrical recording or electrical reproduction of sound."

"A General Purpose Test Bridge"

THE value of R1 in the circuit given on p. 358 of our issue dated August, 1944, is 500. This was omitted from the list of components, but given in the text.

Radio Examination Papers—34

THE potentiometer in Fig. 2, page 423 of our September issue should, of course, be connected across the filament.

B.S.R.A. Activities

SINCE the last report of the work of the British Sound Recording Association (March, 1943 issue), the inquiry bureau and collection of information services on sound recording/reproduction by all known systems have been maintained. Interest in this subject by the "man-in-the-street" as well as by technicians in other fields concerned with new applications continues to grow, as is shown by the latest list of over 150 names of potential members, whose applications will be dealt with as soon as the association is able to resume its full normal programme. A leaflet, covering B.S.R.A. objects and future plans, is in preparation, and anyone desiring a copy in due course, as well as his name and address added to the mailing list, should forward this request to the Hon. Technical Secretary, Mr. D. W. Aldous, "Strathdee," Studley Road, Torquay, enclosing a stamped, addressed envelope.

The Cathode Ray Oscilloscope

Details of a Satisfactory Circuit

By J. K. MONEY

THE object of this article is not how to make use of the Cathode Ray Oscilloscope, as there are many good books* which can be obtained on this subject. It is written purely from the practical side and is meant for the person who would like to build an oscilloscope but has either been unable to find a really satisfactory circuit or who has always considered the oscilloscope to be rather too complex an instrument for him to build.

This oscilloscope contains all the necessary sections for any use which normally could be wanted for everyday life. It can be made considerably cheaper than any complete oscilloscope on the market at present even with the very high Purchase Tax that is now on all wireless parts.

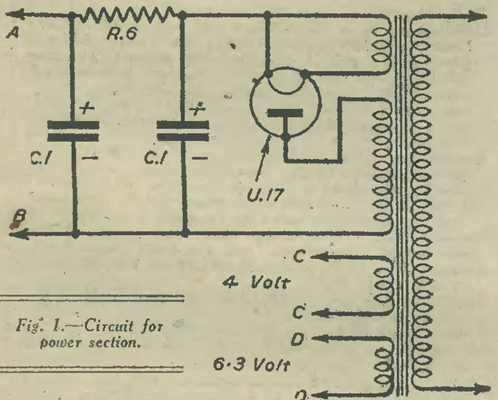


Fig. 1.—Circuit for power section.

The Cathode Ray Tube

This need only be a small tube requiring a comparatively low anode voltage. A very satisfactory tube is made by Mullard—the ECR30. This has a screen 2½in. in diameter, which gives a green pattern when struck by the electron beam. It is of the medium persistence type, which is most satisfactory for oscilloscope work. There are quite a number of these on the market but if this make cannot be obtained, Osram make a very similar tube, the 4081. The approximate length of these tubes is 8in., i.e., from the front of the screen to the end of the pins.

The Power Unit

A transformer suitable for the whole unit (except the amplifier—see later) would need consist of the usual primary windings suitable for the A.C. mains supply with the secondary windings as follows:

- High Tension.—A 350-0-350 or just a 700 volts (the total current taken is about 20 mA., so that a low current winding is all that is needed).
- Low Tension.—One 4-volt winding at 3 amps. for the rectifier; one 4-volt winding at about 2-3 amps. one 6.3 volt winding at about 4-5 amps.

N.B.—These need not be centre-tapped.

Good electrolytics are essential. As very high voltage ones are very nearly unobtainable nowadays, the most satisfactory are the usual 500-volt ones—8 mfd., two of which are connected in series, making a 4 mfd. condenser at 1,000 volts. As the current used is so small a 10,000 ohm resistance will do all the sufficient smoothing together with the electrolytics.

Newnes Television Manual, By F. J. Camm, 6/-, or 6/6 by post.

Fig. 1 shows the circuit for the power section. It is important to notice that it is the positive side of the high tension that is connected to the chassis. This is done because the deflector plates of the tube must be connected to the second anode of the tube, and they are at earth potential since they must be available for connection to external circuits.

Fig. 2 shows the connections to the tube and the resistance network that goes with it. R.1 varies the grid bias and so this behaves as the intensity control. The first anode is connected to the second variable resistance R2, which controls the focusing of the beam. R7 and R8 are used as the spot positioning controls, one for the vertical and one for the horizontal positioning. When the tube is switched on the intensity control should be turned well back for at least half a minute to allow the tube to warm up. This is essential or else the tube may be badly damaged. After the half-minute increase the intensity control slowly, and a fuzzy spot will probably appear. Keeping the intensity low, move the focusing control until a sharp spot is obtained. Great care should be taken to see that the intensity is low during this time or else the screen may be burnt.

Fig. 3 shows the amplifier and time base circuit. As it is necessary to connect the negative side of the H.T. to earth a separate power supply is provided. This consists of a transformer with a 250-0-250 secondary. A 6X5 is used as a rectifier for the output with low current rating choke and two 8 mfd. electrolytics for smoothing the supply.

The 6J7 is a satisfactory valve for amplifying the large range of frequencies which are necessary. R3 [illegible]

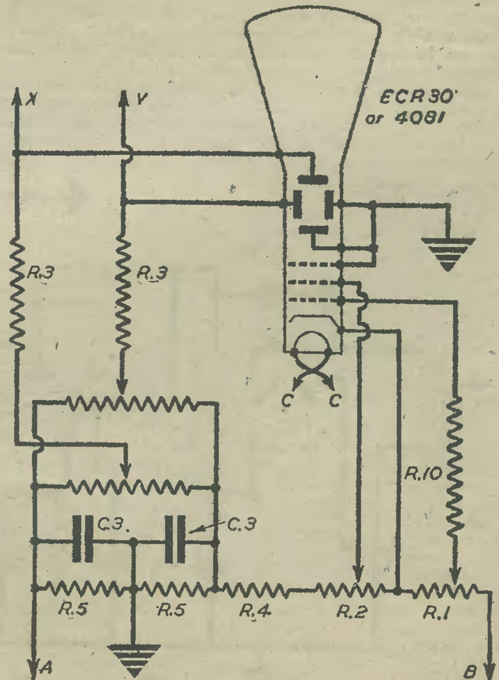


Fig. 2.—Connections to the tube, and resistance network.

as the variable input control for the amplifier. The output is fed directly to the vertical plates of the tube.

To obtain a linear waveform a charging valve is used to charge the gas triode. The 6J7 will do this job well; it is operated with zero grid bias, and it has its anode connected to the cathode of the triode. The GT1C is the most suitable gas discharge triode and can still be obtained. The screen of the charging valve has its voltage controlled by R4. This is the main frequency control, whilst the rough setting is obtained by the setting of switch S3. The setting of R5 controls the grid bias of the triode, and hence the amplitude of the sweep. Synchronisation is obtained by applying a small portion of the input into the grid of the triode, and this can be varied by means of R18. Slight distortion may be introduced if this control is turned up too far.

Construction

Here are a few points which will be of use in the construction of the oscilloscope.

1. Mount the transformers as far behind the tube as possible but in the same line as the tube. The beam tends to be deflected if the transformers are below the tube.

2. If it is possible to build the chassis inside a metal cabinet this should be done as it will stop stray magnetic fields which may be near the oscilloscope when it is in operation.

3. Make sure that the contacts on the condenser selector switch are very clean.

4. It is good practice to provide an interlock switch which automatically disconnects the high voltage supply when the cabinet is opened for servicing.

5. Be sure that all insulation is sound as the high voltages used may result in arcing.

6. Mount as many components below the chassis as is possible. This leads to neatness and hence the construction of a sound oscilloscope.

7. Connect all metal parts—i.e., transformers, panels, etc.—to earth. (Remember to connect the amplifier chassis, if a separate one is used, to the earth of the tube chassis.)

8. Be sure that all electrolytics are the correct way round and that they are internally broken down. Severe damage to the rectifier will result if this point is not realised.

Little has been said about the placing of the various components as it will be much better for the constructor to choose the positions for himself. As neat a job should be made as possible of the wiring and when possible wires should be bound together (i.e., those leading to the condenser switch).

Remember that your tube will show what is fed into it and it is *not* the fault of the tube if a bad pattern is observed on the screen.

Finally, the building of an oscilloscope not only provides a very useful instrument for radio engineering but also will teach the constructor a very great deal more about radio construction and its applications.

LIST OF PARTS

TUBE SECTION

One mains transformer, 350-0-350 volts 60 mA., 4 volts 2-3 amps., 4 volts 3 amps., 6.3 volts 4-5 amps.

Condensers: Four 8 mfd. electrolytics at 500 volts; or two 4 mfd. electrolytics at 1,000 volts (C1); two .1 mfd. 600 volt paper (C3).

Resistances: Two 5 meg. ½ watt (R3); one 10,000 ohms 2 watts (R6); one 75,000 ohms 1 watt (R4); two 30,000 ohms 1 watt (R5); one 300,000 ohms ½ watt (R10).

Potentiometers: Two 50,000 ohms (R1, R2); two 1 meg. (R7, R8).

Valves: One ECR30 or 4081; one U17 Osram.

AMPLIFIER AND TIME BASE SECTION

One mains transformer 250-0-250 volt.

Condensers: Two Electrolytics 500 volt 8 mfd. (C2); three .1 mfd. 600 volt paper (C3); two .25 mfd. 600 volt paper (C4); one .5 mfd. 600 volt paper (C5); one .0001 mfd. 400 volt paper (C6); one .001 mfd. 400 volt paper (C7); one .005 mfd. 400 volt paper (C8); one .025 mfd. 400 volt paper (C9); one .01 mfd. 400 volt paper (C10); one 5 mfd. 25 volt electrolytic (C11).

Resistances: One 100,000 ohms 1 watt (R11); one 300 ohms 1 watt (R12); one 8,000 ohms 1 watt (R13); two 25,000 ohms 1 watt (R14); one 50,000 ohms 1 watt (R19); one 800 ohms 1 watt (R15); one 1,000 ohms 1 watt (R16); one 150,000 ohms 1 watt (R17).

Potentiometers: Two 5 meg. (R9); two ½ meg. (R18); one 50,000 ohms (R20); one 300 ohms (R21).

Chokes: One H.F. choke—25 mH. (L1); one 30 Henry 15 mA. choke (L2).

Switches: Two spdt QMB (S1); one spst QMB (S2); one single-pole 6-way (S3).

Valves: One 6X5; two 6J7; one GT1C.

Miscellaneous: Valve bases, screws, wire sleeving, chassis, knobs, etc.

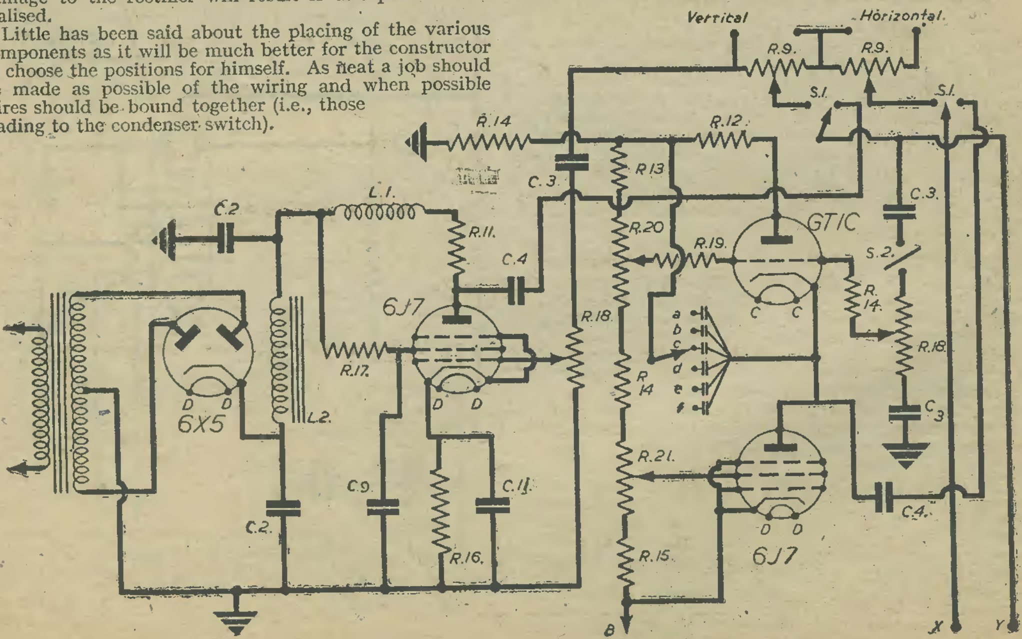


Fig. 3.—A satisfactory oscilloscope circuit; a=c5, b=c4, c=c3, d=c8, e=c7, f=c6.

More About Micro-waves

Some Further Notes on the Generation of Micro-oscillations

By S. A. KNIGHT

IN the previous article the general theory of micro-wave technique from the magnetron point of view was discussed, together with the main difficulties to be overcome in all aspects of the subject. In the present discussion it is proposed to enlarge upon certain points of theoretical and practical natures which, for reasons of clarity, were only lightly mentioned before.

These points are chiefly: (i) the true nature of the effect of the finite transit-time upon the generation of oscillations; (ii) the function of the Backhausen-Kurz positive-grid oscillator; and (iii) the detection of micro-waves by magnetron and Backhausen oscillators. External circuit connections and typical tests will also be discussed at the end of the article. It is hoped that these latter will prove of use and interest to readers interested in the subject.

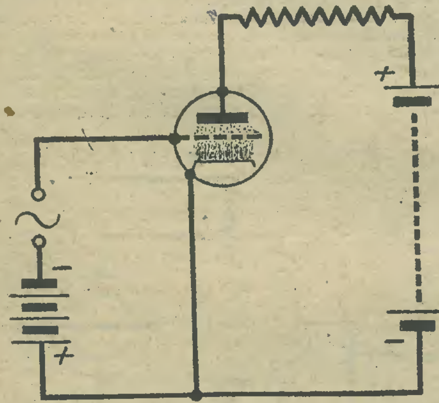


Fig. 1.—Transit-time causes the electrons to be unequally distributed on either side of the grid; hence, a current flows into the grid in spite of its negative bias.

Transit-time

In ordinary oscillator technique it is generally assumed that the time taken for an electron to travel from the cathode to the anode of a valve under the influence of the anode voltage, i.e., the transit-time, is negligible compared with the length of time occupied by one cycle of the oscillatory current concerned. Changes in electrode voltages have, for all practical purposes, an instantaneous effect upon the valve current and no complications are apparent. At extremely high frequencies, however, the transit-time becomes of the same order of magnitude as the periodic time of the oscillations and because of this normal valve characteristics are modified in a number of important respects. The usual valve constants, amplification factor, A.C. resistance and mutual conductance change considerably, becoming vector quantities whose phase and magnitude are dependent upon the frequency being handled. There is a lag between anode current for a given change of grid potential, hence the mutual conductance lags in phase and its absolute magnitude is also slightly modified. The amplification factor falls in value as the frequency increases, as does also the A.C. resistance.

A very great cause of difficulty with ordinary valves in ultra-high frequency work is the extremely low grid input resistance which is encountered, this damping effect being inversely proportional to the square of the frequency. While input capacitance bears part of the responsibility for this, the transit-time effect carries the rest, since it causes power to be taken by the grid even when this electrode is maintained at a negative potential and attracts no electrons.

Exactly how does this effect come about? There is an interchange, says the answer, of energy between the normal signal applied to the grid and the electron stream on its way to the anode, this interchange being of such a nature that part of the signal power is wastefully absorbed. This behaviour gives rise to the same effect as that encountered when a fairly low resistance is connected across the grid-cathode pins of the valve, i.e., its input resistance is effectively reduced.

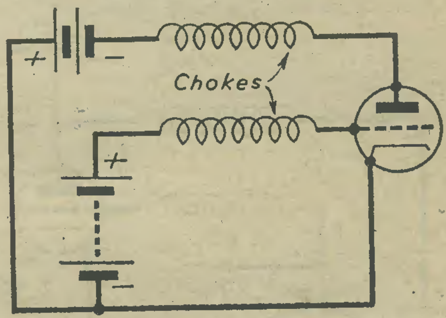


Fig. 2.—Simple form of Backhausen oscillator.

Consider Fig. 1 where a simple triode is shown connected to a supply of high tension, its grid being negatively biased back. A small alternating voltage is superimposed upon this steady grid potential, its frequency being considered as extremely high.

Now, as this alternating voltage rises towards its maximum value a greater number of electrons are attracted across the interelectrode space, but due to the finite transit-time delay the density of them (as shown by the dots) is much greater on the cathode side of the grid than on the anode side. As a result of this unbalanced density on either side of the grid, this electrode draws current because of the electro-static charge induced upon it by the excess of approaching over receding electrons. Later on, when the superimposed grid voltage is falling towards its minimum value the reverse occurs. The number of electrons flowing to the plate is decreasing, but the electron density is now much greater on the anode side of the grid than upon the cathode side, again due to their delay in transit. Thus the grid again draws current as the result of the electrostatic charges induced upon it by the excess of receding over approaching electrons. The magnitude of this grid current is, as would seem obvious, proportional to the alternating grid voltage, its frequency, the transit-time and the number of electrons involved.

The grid current is not, as at first might be supposed, in quadrature with the grid voltage. At the crest of a particular cycle of grid voltage the number of electrons on the cathode side of the grid is still greater by far than the number on the anode side, therefore current is still flowing into the grid at this instant. Thus the grid current has a component representing loss, i.e., there is a phase displacement between the signal voltage

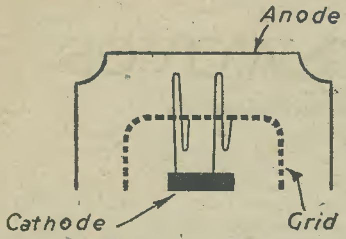


Fig. 3.—How electrons oscillate about the grid in a Backhausen oscillator before being trapped by it.

maximum and the grid current minimum. This angle of loss is normally small and is proportional to the product of the frequency and transit-time.

Grid loss becomes serious at frequencies in excess of about 100 megacycles, and ordinary amplification becomes impossible, the damping on the previous stage often reducing it to less than unity. Specially designed valves of the "acorn" variety can be made to operate at frequencies in excess of the above figure, but other factors such as power dissipation limits their usefulness.

The table below shows approximate values of grid input resistance for a typical modern R.F. pentode type valve at various total valve currents.

This oscillation about the grid may go on for quite a time before any particular electron is captured by the grid and removed from the scene of operation. The frequency at which this electronic oscillation occurs is mainly determined by the dimensions of the valve and the electrode potentials. Fig. 3 shows the way the electrons oscillate about the positive grid before they are captured by it.

For this oscillator to be put to any practical account it is necessary for it to develop power from the effects of the electronic vibrations, that is, a form of oscillatory co-ordination between the electrons is necessary. The circuit of Fig. 2 actually provides for such co-ordination, as the following explanation will show.

Suppose that an alternating voltage is superimposed upon the grid potential of such a frequency that its periodic time is approximately equal to the electron transit-time of the valve. This means that the alternation passes through one complete cycle while an electron is normally passing from the cathode to the anode. An electrode which leaves the cathode as this superimposed voltage is carrying the grid to a positive potential equal to the sum of the steady voltage upon it and the peak value of the alternation, will reach the grid plane at a much greater velocity than it would have done under the influence of the steady grid voltage alone. This extra velocity is derived from the energy which the electron has absorbed from the superimposed oscillation, and which consequently has a damping effect upon this oscillation. As the electron moves into the grid-anode

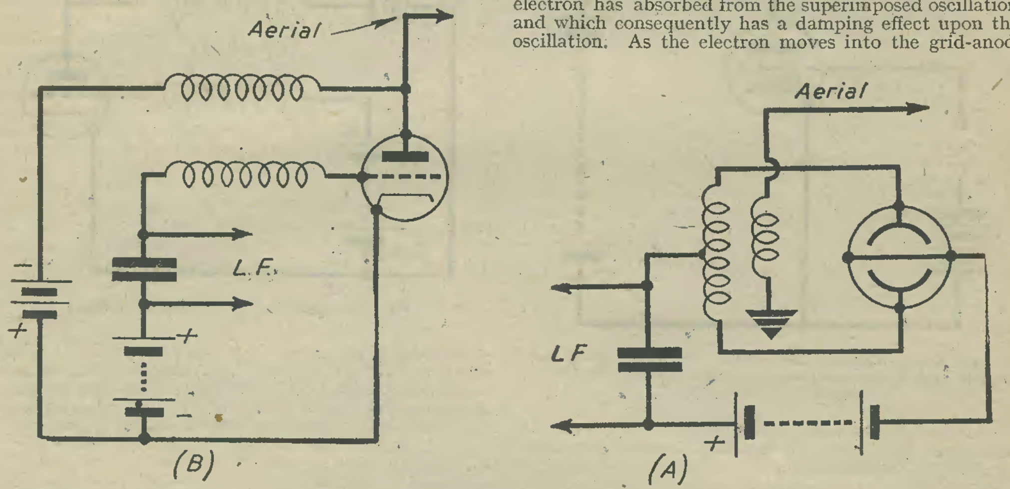


Fig. 4.—Magnetron and Backhausen detectors respectively.

Backhausen-Kurz Oscillators

An attempt to produce ultra-high frequencies with more or less conventional valves led to the development of the Backhausen-Kurz positive-grid oscillator. A simplified arrangement of such an oscillator is shown in Fig. 2, where it will be seen that a triode is being operated with its anode slightly negative and its grid highly positive. Choke coils are included in the leads from the batteries to the valve electrodes, and the system functions in the following manner:

Electrons are emitted in the usual way from the cathode, and at once begin to move towards the positive grid. Their velocity on reaching the grid plane is very great, and the majority of them pass between the grid wires and move into the grid-anode space. Once in this region their velocity rapidly falls to zero, since they now come under the repelling influence of the negative anode before them and the attracting influence of the positive grid behind them. They are thus brought to rest, and are then pulled back towards the grid with increasing velocity, the majority of them again passing between the grid mesh and entering the grid-cathode space. Here they slow down on approaching the cathode, and eventually move again towards the positive grid.

space it is braked both by the grid and the anode potentials, but due to the reversal of the grid superimposed voltage at this stage this braking effect is less than it would have been had the grid been merely carrying a steady positive potential. The electron therefore abstracts further energy from the superimposed oscillation, finally reaching the anode because of this gain of energy in spite of the anode's negative potential. This particular electron is not of much use in maintaining the grid oscillation; rather does it tend to damp it out, and so represents a loss of power.

	Input Resistance	
Frequency	Anode Current 3mA	Anode Current 10mA
50 mc/s	23,000 ohms	10,000 ohms
100 mc/s	6,000 ohms	2,500 ohms
250 mc/s	1,200 ohms	700 ohms
500 mc/s	200 ohms	100 ohms

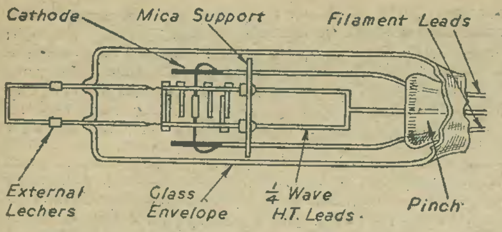


Fig. 5.—Sectional view of typical magnetron.

However, it quickly reaches the anode, and so does not interfere with proceedings to any great extent.

Now an electron which leaves the cathode as the grid superimposed voltage is running towards its minimum value has a different story to tell. This electron is acted upon by a force consisting of the difference between the steady grid potential and the peak of the grid oscillation; therefore, by the time it reaches the grid plane it is travelling slower than if it had moved through the same distance under the influence of the steady grid potential alone. Also, as this electron passes the grid the reversal of the grid superimposed voltage causes it to be acted upon by a much greater retarding force than it would have experienced from the steady grid potential alone. Thus, this electron does not reach the anode, but comes to rest and reverses its direction while still a little distance from it.

As the electron begins its return journey the grid oscillation again reverses its polarity, this time again moving negative. The electron thus has its acceleration once more retarded, this retardation being experienced until the grid plane is reached. Here the superimposed voltage again reverses and the electron's acceleration is still further decreased as it moves towards the cathode. This state of affairs continues until the electron is finally captured by the grid.

The important thing about this second electron as compared with the first is that at all times on its journey from cathode to anode and back to cathode again it is working against the influence of the grid superimposed voltage and consequently delivers energy to this voltage. In fact, this useful electron gives up twice as much energy in one complete trip as the wasteful electron abstracted in its single journey to the anode.

The anode potential supply actually supplies this energy which the electron delivers to the grid oscillation. It is equal to the difference between the kinetic energy (energy of motion) that the electron possesses on striking the grid after making several of its see-saw oscillation and the kinetic energy that it would have had if it had moved directly across from the cathode to the grid without oscillatory motion at all.

The two cases just described are, of course, the extreme instances of electrons which leave the cathode when the grid superimposed voltage is either a maximum or a minimum. Electrons leaving the cathode between these limits are acted upon in an intermediate manner, but, broadly speaking, it will be appreciated that those electrons which are wasteful and extract energy from the grid circuit are quickly removed from operations whilst those which are useful and supply the grid oscillations with energy are permitted to remain and perform a series of energy-delivering journeys. Properly set up, this transfer of energy from the anode supply to the grid circuit can be made to maintain the grid oscillations.

Certain complications modify the picture of the Backhausen oscillator as it is set out above, but the general theory is not far removed from this explanation. In practice, cathode space-charge, grid attraction and the tendency of the electrons to shift their phase with respect to the grid oscillatory voltage introduces certain difficulties.

The latter effect which is brought about by the fact that as the electron gives up more and more of its energy so does the distance that it swings on either side of the grid become progressively less, may be overcome by arranging the grid electrode so that it will on the average trap the oscillating electron at that stage where its period of usefulness is over and its phase shift is just causing it to abstract power instead of deliver it.

This, as will be remembered from the previous article, is similar to the magnetic field tilt given to a magnetron oscillator so that the spiralling electrons will strike the anode just as their period of usefulness is ending.

The frequency of the oscillations generated by the Backhausen oscillator depends upon the electrode spacing and the grid potential and to a certain extent upon the external circuit and the anode supply. It can be shown that the highest frequencies will be generated when the grid voltage is high and the electrode spacing is small. These factors, of course, reduce the efficiency and power output of the system and very careful design and set-up is required in order that anything useful is generated at all.

Micro-wave Detection

Electronic oscillators, either of the Backhausen variety just discussed or of the magnetron variety covered fully in the previous article, may be used as detectors when dealing with ultra-high frequencies and as such are usually very sensitive. Fig. 4 (a) shows a typical magnetron set-up for such a purpose, while Fig. 4 (b) shows an equivalent Backhausen arrangement. Energy from the incoming signal is, in both cases, superimposed upon the oscillations produced by the systems, and this energy modifies the amplitude of the oscillations such that the direct current flowing to the anodes provides an equivalent effect to rectification. The incoming frequency and the oscillation frequency should, for best results, be approximately the same. This is not, however, a critical condition and detection will occur for widely varying frequencies.

It is assumed in the above that the external circuit is connected to the valve electrodes, but this is not always the case, particularly in magnetron technique. It is possible to choose the electrode dimensions in such a way that the system in itself provides the resonant circuit and no external connections (apart from the power supplies and couplings) are necessary. Electrode supports may be considered as lecher or transmission bars and will behave as quarter-wave resonators. Fig. 5 shows a typical modern magnetron where a system of this nature is partially employed.

Experiments

The writer has experimented with the conditions required for the generation of oscillations in magnetron valves and records the following results which were obtained from simple, typical experiments.

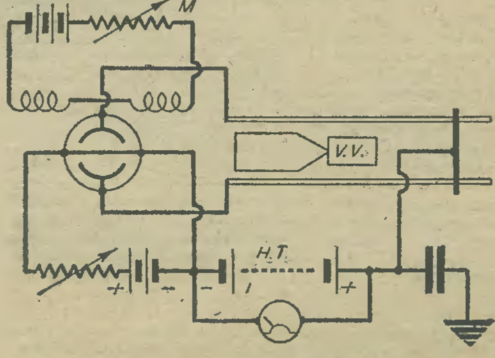


Fig. 6.—A magnetron set up in the electronic mode for experiment to be carried out on oscillating conditions.

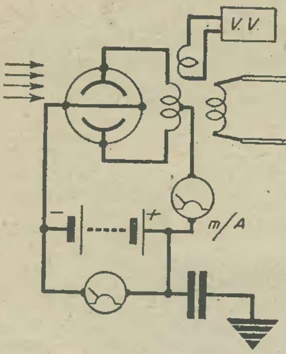


Fig. 7.—Magnetron set up to work as a dynatron mode oscillator for experimental purposes.

First, an investigation with a split-anode magnetron, connected in electronic mode, the set-up being shown in Fig. 6. Lecher wires, made up from ⅛in. copper rod, were made off directly to the anode segments and were supported apart at a distance of 4 centimetres on frequentite insulation.

A valve voltmeter was coupled to these lechers by short stout wires a few centimetres long placed parallel to the main bars, and an adjustable shorting bar consisting of a piece of copper strip was placed across the bars themselves, its centre point being taken to the high-tension supply.

An anode voltage of 300 was first applied to the magnetron and the magnetic field intensity was increased by the control M until oscillations, as indicated by the valve voltmeter, commenced. The adjustable shorting strip was then carefully moved along the lecher bars, away from the anodes, until a maximum reading was obtained. By measuring the distance at which this occurred from the centre point of the anodes, the length of a quarter-wave (λ/4) was determined. Multiplying this result by four gave the wavelength being generated.

The wavelength obtained from the electronic mode is generally very small, as was pointed out in the last article, and much experiment has shown that it is approximately given by the formula—

$$\lambda = \frac{11{,}000}{H}$$

where **H** is the critical field strength in gauss for the anode voltage concerned.

Repeating the experiment for two other values of anode voltage and comparing the practical measurements with those calculated according to the above relation, points out the accuracy of this.

With the specified filament voltage throughout the following are the results obtained. Compare columns 4 and 5, which show practical and calculated wavelengths respectively.

Anode Volts V	Field Strength H. Gauss.	λ/4 cms.	Wavelength λ cms.	11,000 / H
300	110	28.4	112.6	100
400	215	15.2	60.8	51.1
500	285	11.5	46	38.6

By plotting a graph to show the variations in the reading of the valve voltmeter against the angle of the magnetic field it was found that, in general, the angle between the magnetic field and the electrode axis was critical and was not zero. A maximum output was obtained with the field at a small angle, about 3 deg., to the electrode axis.

The experiment was repeated in order to study the factors affecting the frequency drift, and it was found that drift (at the most very small) occurred during the initial fifteen minutes from switching on. Temperature changes during the warming up and the consequent variations seemed mainly responsible: Wide variations in the filament voltage had very little effect upon the frequency generated, however; in fact over a range of 3 volts no appreciable change in wavelength could be detected.

The magnetron was next used to verify the conditions of oscillation when used in the dynetron mode. It was connected up as shown in Fig. 7, the filament and magnetic supplies remaining the same as for the previous experiment. This time the anodes were joined together through a three-turn coil of heavy wire, the electrical centre of this coil being taken to the high-tension supply. The valve voltmeter and the lecher bars were coupled to the anode coil by small single loops, and the magnetic field was zeroed with respect to the electrode axis. The adjustable bar was replaced by one having a small torch bulb connected to its centre point.

As before an anode voltage of 300 was applied and the magnetic field intensity was increased until oscillations commenced. The adjustable shorting bar was now carefully moved along the lecher bars until the bulb was observed to light to a maximum intensity. Noting this position the bar was again moved until a second position of maximum brilliance was obtained. By measuring the distance between these two positions half the wavelength (λ/2) of the oscillations was determined.

The experiment was repeated with two and single-turn toils between the anode segments, and the following are the results obtained.

With nominal filament voltage and a field strength of 145 gauss, the three-turn loop produced a wavelength of 5.3 metres. With double- and single-turn coils the wavelengths produced under similar supply conditions were respectively 3.1 and 1.7 metres. From this it was seen that the values of the anode voltage and field intensity did not depend upon the frequency to be generated; provided that the magnetic field was greater than the point at which oscillations commenced, any frequency could be maintained, subject to a higher limit, without alterations in the field strength.

The smallest wavelength obtained was 1.3 metres; this limit is imposed in the dynatron mode by the transit-time effect.

The wavelength generated by this mode is thus dependent upon external circuit conditions. Variations in anode and filament voltage, and changes in field strength were also found to cause some alteration.

Oscillation amplitude depends upon the angle that the magnetic field makes with the electrode axis. A graph which was plotted during the experiment is given in Fig. 8, where it will be seen that the maximum output occurs for zero deflection.

It is hoped that these articles and experimental results have proved of value to interested readers who are requiring a fundamental knowledge of microwave technique.

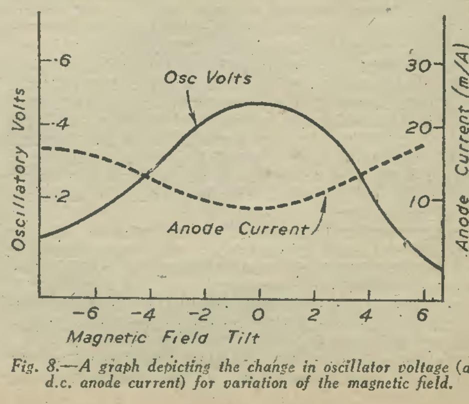


Fig. 8.—A graph depicting the change in oscillator voltage (and d.c. anode current) for variation of the magnetic field.

Short-wave Radio—2

Factors Governing Selection of Components. Negative Resistance. Reaction Circuits. General Considerations. By 2CHW

(*Continued from page 408 of September issue*)

HAVING seen, in the first article of this series (September, 1944), that it is desirable for a parallel-tuned circuit to possess the following features: (a) a high parallel impedance, (b) a high L/C ratio, (c) a low value for R, and likewise a good "Q," we can consider what can be done to satisfy these requirements.

The S.W. enthusiast will do well to put quality before cost; components of inferior design, workmanship and materials cannot be expected to possess the same overall efficiency as those produced to satisfy the exacting requirements imposed by alternating currents of the higher frequency. For example, in addition to losses which can be introduced through "skin effect," the latter can also cause variation in the inductance of a coil with frequency. The quality of the coil former can have a direct bearing on H.F. losses, due to leakage and absorption. The self-capacity of the winding and that of the complete coil is another factor of importance, and it is desirable to keep such capacities as low as possible, as these form a capacity across the coil and can be responsible for loss of H.F. energy and a consequent increase in the resistance of the coil. Condensers, both fixed and variable, should be of the highest quality, and consideration must be given, during their selection, to the part of the circuit in which they are to be used. The capacity of a condenser of doubtful quality can vary with frequency, but generally speaking, this does not apply to those of the air- or oil-dielectric types. The tubular condensers of the rolled paper type can be influenced by an inductive effect, but this can almost be eliminated by design and manufacture, likewise the "non-inductive" fixed condensers, which have been available for some time. Leakage between plates and absorption by the dielectric can also contribute to appreciable losses.

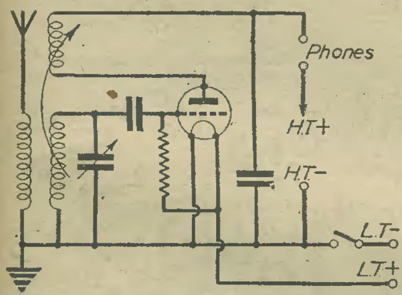


Fig. 1.—The early form of "swinging coil" reaction.

High-frequency chokes must be good if they are to be effective, and as this component is so directly concerned with frequency of a high order, its value of self-capacity becomes almost as important as its value of inductance. For high-efficiency, the self-capacity of the component must be as low as possible consistent with the inductance required, but as a very low value of inductance is required for, say, the frequencies covered by the normal amateur band, and still less for the ultra high-frequencies, it is obvious that the self-capacity must in turn be *very* low, otherwise, the choke effect will be annuled through the H.F. currents being by-passed via the capacity.

To reduce losses due to absorption and leakage, the materials used in the construction of components for U.S.W. and S.W. work must possess the highest possible H.F. insulation, and, where possible, be reduced to the minimum as regards bulk, consistent with the required strength.

All the items mentioned above can affect the value of R, and as we have already seen that R is a very important factor, it becomes increasingly obvious that careful thought must be given to details which, in the absence of any knowledge about (a), (b), (c) and "Q," might otherwise be treated as of minor importance.

Negative Resistance

Let Fig. 1 represent a simple type of single-valver, the aerial input of which is aperiodically coupled to the tuned circuit across the grid and filament. If the tuned circuit is adjusted to resonate with the applied signal, current will flow around it, and the value or strength of the current will depend on the signal voltage and the H.F. resistance of the coil and condenser. The lower this resistance, the greater will be the current at resonance, and, if the conditions relating to selectivity mentioned in the first article apply, the smaller will be the current at frequencies off the resonant point or setting. If, therefore, the resistance can be kept low, the greater will be the selectivity which, in turn, means that the grid of the valve will receive the greatest voltage from across the tuned circuit when tuned to resonate with the incoming signal. Conversely, signals of a frequency off the resonate frequency of the circuit, will set up *very small* voltages *compared* with those produced by the desired signal, thereby reducing interference.

If we can now pass some of the amplified voltages from the anode back to the grid circuit in such a manner (proper phase) that the original voltage across the grid circuit is *increased*, then the result will be similar in effect to reducing the resistance of the circuit. This process, which is widely used in "straight" receivers (and in some form of superhets) is known as *reaction*, and the effect of reaction is to produce regeneration or introduce into the circuit to which it is applied, *negative resistance*.

It is possible to increase the amount of reaction or feed-back until a point is reached when the losses in the tuned circuits are, from a practical point of view, eliminated, and when that condition is reached the selectivity of the tuned circuit and the voltage across it would be approaching the ideal, but, unfortunately, just before one can secure that condition the valve starts to oscillate. However, in practice, a considerable gain is obtained by the use of reaction, while the selectivity of the circuit is improved considerably.

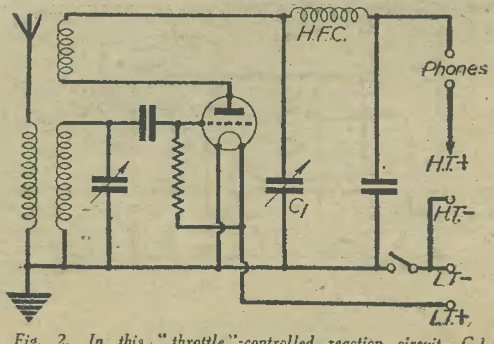


Fig. 2. In this "throttle"-controlled reaction circuit, C.1 varies the degree of feed-back.

Reaction Circuits

Reaction circuits, as most amateurs know, can be classified under three headings: very good, passable and rotten. Under which heading any particular circuit comes depends on its ability to satisfy the following requirements: (1) Perfectly smooth control up to and just past the point of oscillation. (2) Dead silent control. (3) Minimum effect on the tuning of the tuned circuit. (4) Effectiveness over the complete frequency band covered by the receiver. (5) Freedom from "back-lash." (6) Consistent degree of feed-back, i.e., not erratic. Few of us secure the perfect arrangement in practice, but many do get somewhere near the ideal system by paying careful attention to detail.

The circuit shown in Fig. 1 makes use of what might be called the fundamental arrangement, in which the feed-back is provided by the coil in the anode circuit being inductively coupled to the tuning coil in the grid circuit. The position of the anode coil, with respect to the grid coil is variable, thus allowing the degree of reaction to be controlled, but, in addition to its somewhat clumsy construction, the system introduced a serious drawback in the form of detuning the grid circuit every time the reaction was adjusted.

Capacity Control

To overcome the detuning effect it was found better to use a fixed reaction coil, and control the feed-back by varying other factors, such as the flow of the anode H.F. voltages through the coil, the H.T. applied to the anode of a triode, or the screen of a S.G. and pentode valve, or by making use of the electron flow. As the capacity methods seem to be the most common, we will deal with them first.

The circuit shown in Fig. 2 is but a slight modification of Fig. 1, inasmuch that the reaction coil is now fixed, and a good H.F. choke is connected in series with the phones (H.T. pos. line). The condenser C1 is variable, and, bearing in mind the H.F. choke, it completes the reaction circuit from anode through the coil to earth; therefore, the setting of the condenser will govern the amount of feed-back. The arrangement, which is known as "throttle control," can prove very satisfactory, provided good components are used, especially in the case of the H.F. choke, and many amateurs seem to favour it in preference to the Reinartz system.

The Reinartz System

This is another capacity controlled circuit, and it is one which is widely used in broadcast and S.W. receivers. A standard type of circuit is shown in Fig. 3, where it will be seen that the reaction coil is fixed, and that its circuit to earth is completed via the variable condenser C1, which forms the actual control. The condenser C2 is purely a by-pass, sometimes necessary to secure smooth operation, but, as that also depends on the characteristics of the valve, its operating potentials, the reaction winding and the value of C1, the capacity of C2 is best determined by experiment. As before, the H.F.C. plays a very important part; therefore, it must be effective and free from resonance peaks. Given normal conditions, the Reinartz system can be very smooth in operation, but, as in all capacity-controlled arrangement the condenser C1 should (for S.W.s) be of the a dielectric type—perfectly smooth in action and free fro noise.

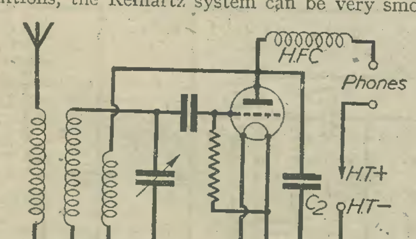


Fig. 3.—The "Reinartz" circuit also has a fixed reaction coil and capacity control.

It is immaterial whether C1 is connected betwe anode and reaction coil, or coil and earth, but th latter is more favoured because it allows the movin vanes of the condenser to be at earth potential, whic helps, to some extent, to overcome hand-capacit effects. In either case, it must be remembered that on set of vanes (usually the fixed) will be at the san voltage as the H.T. on the anode.

H.T. Control

Both of the capacity control methods can be slightl modified to allow a fixed degree of capacity plus a variab H.T. voltage to provide the adjustment of the reactio circuit. The condenser C1 should be replaced by a fixe condenser having a capacity of .0001 mfd., and instea of taking the H.T. side of the 'phones direct to H.T positive, it should be connected to the moving-arm of variable resistance, or a potentiometer, having a valu of, say, 50,000 ohms. One side only of the resistance i connected to the H.T. supply, which should be in th region of 75 volts, according to the valve in use. Th moving arm is then by-passed to earth, by means of .1 mfd. condenser.

If a S.G. or pentode valve is used in the detecto position, the same reaction circuits can be used, bu

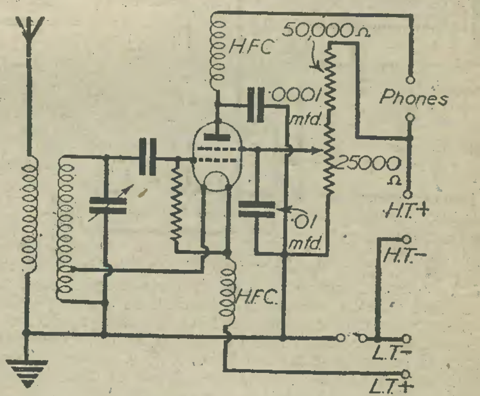


Fig. 4.—A battery version of the "electron-coupled" system of regeneration.

instead of varying the anode H.T., it is better to adjust the screen voltage, and this can be done in the same manner as that used to vary the screen voltage in Fig. 4, provided the by-pass condenser is increased from .01 mfd. to .1 mfd. The results obtained by varying the H.T. can be very satisfactory, provided the variable resistance or potentiometer is good, and capable of carrying the current flowing. There is, however, always the possibility of the control becoming noisy after a certain period of service.

Electron Coupled Circuit

This system can be highly satisfactory, in fact, as readers of my previous articles may remember, I think it is one of the best arrangements, especially when indirectly heated valves are used. The circuit for a battery operated valve is shown in Fig. 4, where it will be seen that the negative side of the filament is tapped into the lower part of the grid coil, while the positive side receives its L.T. via a special low resistance H.F. choke, which can take the form of a separate component, or an additional winding over the earthy end of the grid coil, i.e., below the tapping point. If a mains type of indirectly heated valve is used, the circuit is simplified, as the *cathode only* is tapped into the coil, the heater being connected in the *normal* manner.

The control-grid, cathode (filament) and screen-grid actually form the oscillator or regenerative section, by acting as a modified Hartley circuit, the screen-grid forming the plate and being kept at earth potential, as regards H.F., by means of the .01 mfd. by-pass condenser, which must offer low reactance to the frequencies concerned.

The actual tapping point is somewhat critical and is best determined by experiment, but a rough approximation is 10 per cent. of the grid turns. The variable control is provided by changes in the value of the voltage applied to the screen-grid, and with a little care, very smooth reaction can be obtained. The system has a great deal to recommend it for those who use a receiver of the 0-v-1 type, owing to the fact that a S.G. valve can act as a highly efficient detector, and, in many instances, be better than an ordinary triode plus a transformer coupled stage.

In General

Whichever form of reaction circuit is used, a great deal depends on sufficient attention being given to the layout of components, the selection of the latter, wiring, and careful adjustment of the operating conditions, therefore it is not fair to attempt to make comparisons by using "hook-ups" and only testing on one band of frequencies.

In the case of a simple 0-v-1 arrangement, or any circuit without an H.F. stage, the loading imposed across the tuned circuit by the aerial will influence the effect of the reaction system and its smoothness. It is possible for the aerial to resonate at its fundamental frequency and its harmonics, and the impedance offered is not a constant value over a wide band of frequencies, therefore "dead-spots" are likely to be experienced (when no reaction effect will be obtained) if the coupling between aerial and tuned circuit is too tight. It is usually possible to eliminate these snags by adjusting the aperiodic winding (or primary of the aerial coil), or by inserting in series with the aerial a low capacity variable condenser which can be adjusted until smooth reaction is obtained over all bands.

(To be continued)

DISC SOUND RECORDING

A Few Practical Hints

THE following three suggestions may prove useful to PRACTICAL WIRELESS readers concerned with disc sound recording and reproduction. (1) Old standard size (35 mm.) cine film spools make excellent cable drums when suitably mounted on a bracket with a winding handle and the end of the cable passed through the core and out to a plug or socket fixed *outside*. These drums employed for, say, holding power, microphone, or loudspeaker cables, apart from saving time and temper, avoid tangles and kinks which can easily cause wire breakage.

(2) An old trick to obtain amusing and novel sound effects is to play a recording backwards. With a film or tape recording, this can be accomplished merely by running the "sound carrier" backwards, that is, playing-back without rewinding the spool. (This idea was used recently, but with disc records, as an item in the B.B.C.'s "Monday Night at Eight" feature.) The method often proposed for amateurs to produce this effect, with gramophone records, is to drive a turntable, attached to a spindle but able to rotate freely, by friction from the rim of the usual turntable. The pick-up or sound box is then placed for playing on the opposite side of the counter-clockwise revolving disc on the second turntable. Another more effective way to produce this result is simply to use a synchronous motor of the type requiring a flick of the hand on the turntable to start it. Thus, it is only necessary to rotate it in a counter-clockwise direction, although, of course, the pick-up or sound-box must be remounted on the opposite side of the motor baseboard to permit correct tracking.

(3) If one can acquire some old metal film cans (as used for transporting reels of 35 mm. film to and from cinemas), handy and ready-made containers for storage or transit (with suitable packing) of gramophone records or direct recording discs of the smaller diameters are available.

STANDARD-FREQUENCY TRANSMISSIONS

THE standard-frequency transmissions, made available as a public service by the National Bureau of Standards over its station WWV, have recently been extended and a 24-hours service inaugurated on certain frequencies, with the opening of new transmitters at Beltsville, Maryland, near Washington, D.C.

The latest schedules and frequencies are: 2.5 Mc/s—01.00 to 15.00 D.B.S.T.; 5.0 Mc/s—continuously, day and night; 10 Mc/s—continuously, day and night; 15 Mc/s—13.00 to 01.00 B.D.S.T.

Each of these radio frequencies is modulated simultaneously at accurate audio-frequencies of 440 c/s (i.e., the standard musical pitch corresponding to A above Middle C) and 4,000 c/s, excepting 2.5 Mc/s, which carries only the 440 c/s modulation. In addition, there is a 0.005-second pulse, heard as a faint tick, every second, except the 59th second of each minute. These pulses may be used for accurate time sigals, and their one-second spacing provides an accurate time interval for physical measurements.

The audio-frequencies are interrupted precisely on the hour and each five minutes thereafter, resuming after an interval of precisely one minute. This one-minute interval is provided to give the station announcement and to introduce an interval for the checking of R.F. measurements free from the presence of the audio-frequencies. The announcement is the station call (WWV) sent in code, except at the hour and half-hour, when it is given by voice.

The accuracy of all the frequencies, R.F. and A.F., as transmitted, is better than one part in 10^7. Transmission effects in the medium may result in slight fluctuations in the audio-frequencies as received at a particular location, but the average frequency received, however, is as accurate as that transmitted. The time interval marked by the pulse every second is accurate to 0.00001 second. The one-minute, four-minute and five-minute intervals, synchronised with the second pulses and marked by the beginning and ending of the periods when the audio-frequencies are off, are accurate to one part in 10^7. The beginning of the periods when the audio-frequencies are off are so synchronised with the basic time service of the U.S. Naval Observatory that they indicate accurately the hour and the successive five-minute periods.

Of the frequencies mentioned above, the lowest affords a service to short distances, and the highest to greatest distances. It has been found that, except for certain periods at night within a few hundred miles of the transmitters, reliable reception is possible at all times throughout the U.S.A. and over the North Atlantic Ocean, and fair reception over most of the world.

Information on how to receive and use the service is given in the Bureau's leaflet "Methods of Using Standard Frequencies Broadcast by Radio," which is obtainable on application to the Director, National Bureau of Standards, Washington, D.C., U.S.A.

D. W. A.

YOUR SERVICE WORKSHOP

A Small Quality L.F. Amplifier

A Useful Piece of Test Apparatus

NO radio workshop or "Lab." is complete without some sort of general purpose L.F. amplifier. It is useful in many tests, and if the design is reasonably flexible it may be used to boost up the output of apparatus we are trying out or experimenting with, and therefore it is often unnecessary to incorporate L.F. at all. Thus time, trouble and expense are saved. An amplifier is also indispensable in connection with testing of speakers and pickups, and in the latter case the sensitivity of different types may be measured with the aid of constant frequency records.

Since, for workshop use, colossal power in the amplifier is not required, the sensitivity and power output may be kept to reasonable proportions, but good quality should be aimed at, especially if the instrument is to be regarded as some sort of a standard. For this reason push-pull output has been used in the amplifier to be described. Readers will probably agree that there s something about this method of connection which is far superior to any single triode or pentode output stage where good reproduction is concerned.

The valves used are of the indirectly heated type, so that it is unnecessary to supply separate heater voltages (as in the case of valves usually used for push-pull).

The Circuit

The circuit diagram is shown in Fig. 1 and it will be seen that two inputs are provided in the form of a mixer circuit. Thus, two pickups or microphones, or alternatively a pickup and microphone may be used simultaneously and mixed with one another as desired. This circuit feeds into the grid of V.1, an H.F. tetrode and amplified voltages developed across the load resistor R.4 are passed on via the coupling condenser C.2 to the inter-valve transformer. The secondary of this component is centre tapped and feeds the grids of the push-pull triodes V.2 and V.3. The grid and anodes of these valves are provided with "stoppers" in order to prevent the possibility of parasitic oscillation. Decoupling to the first L.F. stage is provided by R.5 and C.4, and tone control is effected by C.5 and the variable resistor V.R.3. A switch is provided so that the tone-control system may be switched out of circuit. A further refinement is that the output from V.1 may be switched through to phones by S.1. This is also useful where it is required to modulate a service oscillator or in any case where not too much amplification is required. The mixing system will, of course, still be available under these conditions.

Power for the amplifier is fed via the 4-way cable from a separate multi-purpose power unit, which will be the subject of a further article in this series.

Construction

The illustrations will show that the amplifier takes the form of chassis construction. The original measures 13in. × 5in. × 3in., but since the disposition of valves and components is not critical, any chassis of suitable size and shape may be used. The potentiometer V.R.1, 2, and 3 may be of the carbon track type and R.1 and R.2 are $\frac{1}{4}$ watt carbon resistors. S.1 is a Yaxley pattern S.P.D.T. rotary switch and here one should make sure that the centre or moving contact does not make connection with the spindle, and therefore with the chassis. This may also be said of the tone and volume controls. The coupling condenser C.2 should be of high

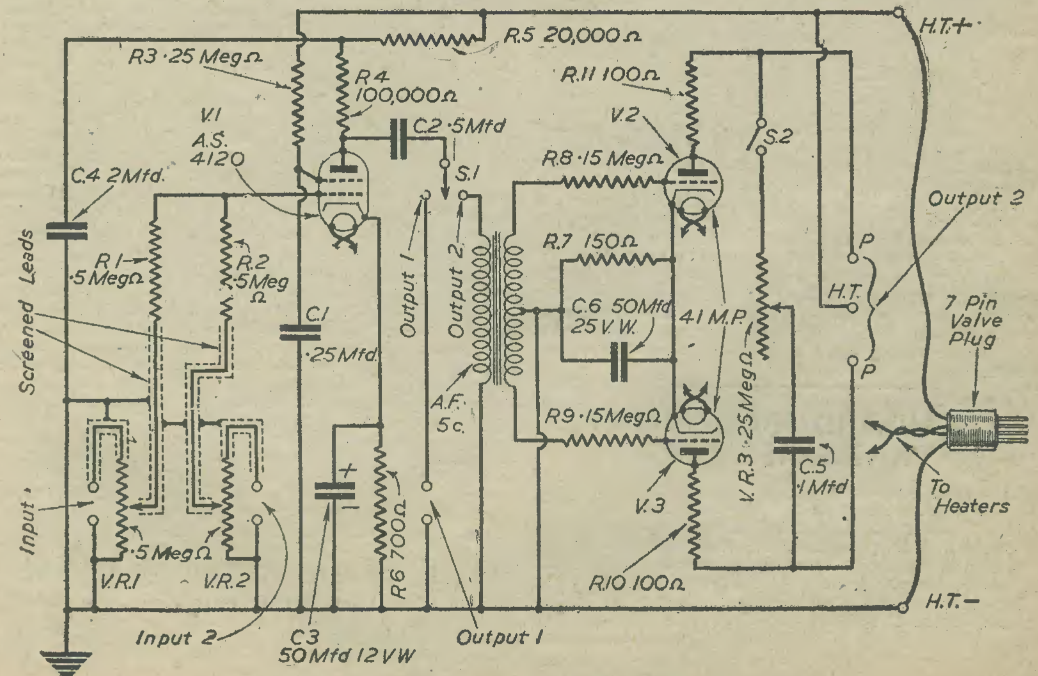


Fig. 1.—The circuit diagram of the push-pull amplifier.

working voltage and *not* of the electrolytic type. Regarding the L.F. transformer; if a special push-pull type is not available an ordinary L.F. model of good quality may be used as shown in Fig. 2. The resistors joined across the secondary may need some experimenting with to get the right value for the particular transformer, but one megohm each is a good average value.

Layout

The construction of the amplifier should present no difficulty. As

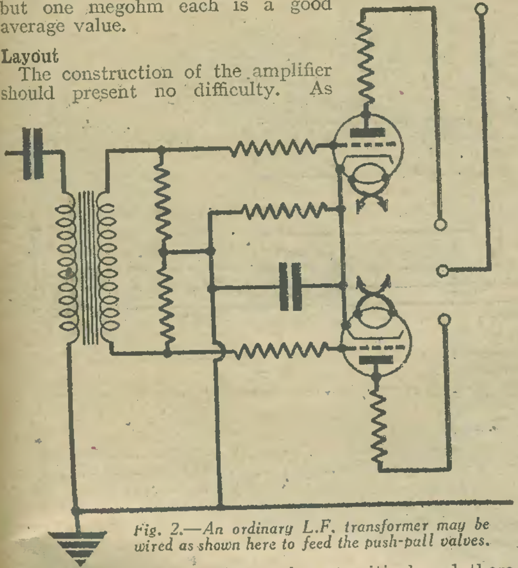


Fig. 2.—An ordinary L.F. transformer may be wired as shown here to feed the push-pull valves.

mentioned before, the layout is not critical and therefore the actual layout shown need not be adhered to too rigidly. It is advisable, however, to adopt the chassis principle and particular care should be taken with regard to insulaton of the various components. When commencing the wiring note that certain leads are screened. The metal covering of these wires should be securely bonded to chassis at one or two points. The tetrode valve used in the model shown has a top-cap anode, and in order to subdue the last remnants of hum it was found necessary to screen the lead to it. If a top-cap grid valve is used, however, the anode lead should not require screening. The heater wiring is unscreened but twisted flex is employed for connections.

Output Valves

A point to note is in connection with the biasing of the output valves. The correct value of bias resistor for the 41 M.P.'s is 300 ohms, whereas in the diagram shown it is 150 ohms. This is because both cathodes are biased by the same resistor, so since the current passed is twice that of one valve the resistance value is halved. This system is quite in order providing the anode current of both valves is practically the same, which is an essential requirement for push-pull operation. If, therefore, the ones used are found to vary in their currents, it is safer and more satisfactory in every way to bias each valve separately. It is often useful, for example, in a push-pull stage, to provide one fixed and one variable bias resistor. The latter should be more in the form of a pre-set control (the spindle is cut off short and a slot sawn in it for screw-driver operation) so that once the apparatus has been finally adjusted one is not tempted to adjust the variable resistor haphazardly, which, of course, is not good for the valve.

Whilst on the subject of the output valves it may be mentioned that there are quite a few alternatives to the Cossor 41 M.P., such as Osram M.L. 4, Mazda A.C./P. or A.C./P.I, Tungsram L.L. 4, Brimar P.A. 1, etc. They all vary somewhat in their characteristics, but are suitable for the job. The P.A. 1's are rather heavy on anode current at 50 m/a's apiece, but if this is available the valves are suitable in every respect. If alternatives are used, it is, of course, necessary to provide for the correct value of bias resistor.

The Tungsram A.S. 4120 used in the first stage is a screened R.F. tetrode and here again, many alternatives may be used. If this is done it is probable that the value of the bias resistor will require altering and it may be necessary to adjust R.3 so that the screen potential is correct. The load resistor is a good average value and should be correct for most valves of this type.

Cover

It was considered unnecessary to provide a cabinet; a suitable cover—to protect valves, etc.—can be made quite easily from perforated zinc. It is advisable to make up a narrow metal framework to fit the top of the chassis and which gives support to the perforated metal. Then, when solder is run along all joints of the cover a perfectly rigid job will result. The illustration gives a general idea of the method of construction.

No provision has been made for switching the apparatus on or off as this is provided for in the power unit to be described. The amplifier will obviously work with any power supply or unit that the constructor may already have, so a few hints on operation may not come amiss. The low tension supply should be 4 v. 4 amps. and the H.T. 220 volts (at 60 m/a's) so that the H.T. actually on the 41 M.P. anodes is 200 volts. Alternative valves may take 250 volts, in which case the more one can give up to the maximum the better, but it is never wise to exceed the rated H.T. on a valve, particularly in the case of the output types.

Testing

After the apparatus has been switched on for a while check anode current of each push-pull valve. If it differs by more than a couple of milliamps or so, it is really advisable to provide for separate biasing, as previously explained. Apart from this point there are no adjustments and the amplifier should work well right away. It is advisable to earth the instrument, and external leads to pick-up and/or microphone should be run in screened cable. This must also be earthed; if it is not, hum is increased considerably and it is better not to employ screened leads at all.

Since one side of each input is at earth potential it is permissible to use single screened cable, in which case the inner wire joins to the "hot" input socket, the metal braiding going to the other.

When using a pick-up of average sensitivity, say 1 volt output, the output from the amplifier will be more than enough, so that it need never be run "all out" and this of course, is advantageous. Regarding microphones, the sensitivity varies according to type, but various moving coil instruments used in conjunction with the amplifier have provided ample power in the output. In this connection it is necessary to remember that if the microphone and loudspeaker are working together in the same room they should be kept well away from each other so that sound-waves from the speaker cannot strike the sensitive part of the mike. If this happens a vicious circle of oscillation is set up, which instantly develops into a low frequency howl. Most readers are probably aware that if a proper mike is not available a midget m/c speaker can be used as an excellent substitute. A transformer of the correct ratio must of course be interposed between it and the input sockets.

Loudspeaker

The loudspeaker to be used in conjunction with the amplifier must be provided with the correct push-pull output transformer, but in the writer's case, use is made of the "Universal Output Unit" which was described in the November 1942 issue of PRACTICAL WIRELESS. This unit has been found almost indispensable in the radio workshop.

In conclusion, it may be stated that the L.F. amplifier described is also eminently suitable for domestic use as the quality is good—considering the small outlay involved—and the power more than sufficient for the average room.

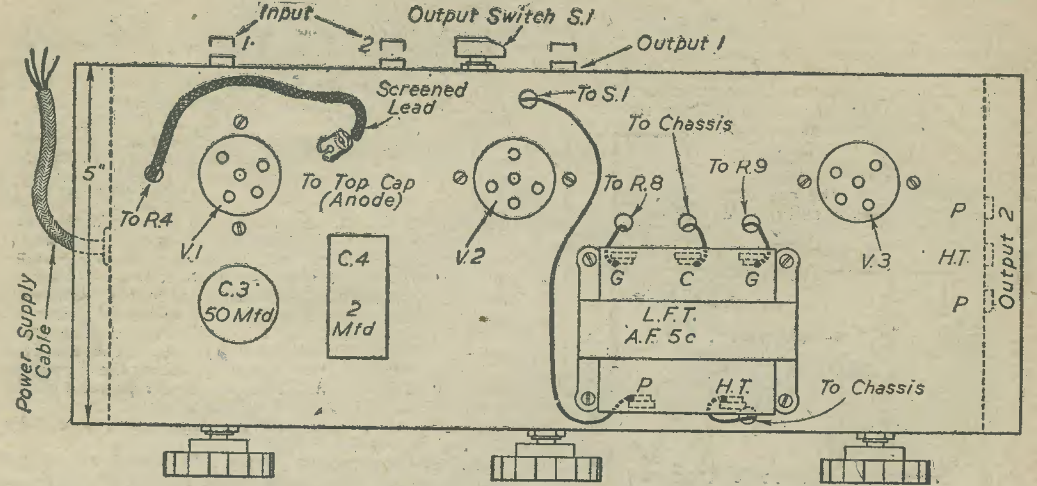


Fig. 3.—Top of chassis layout.

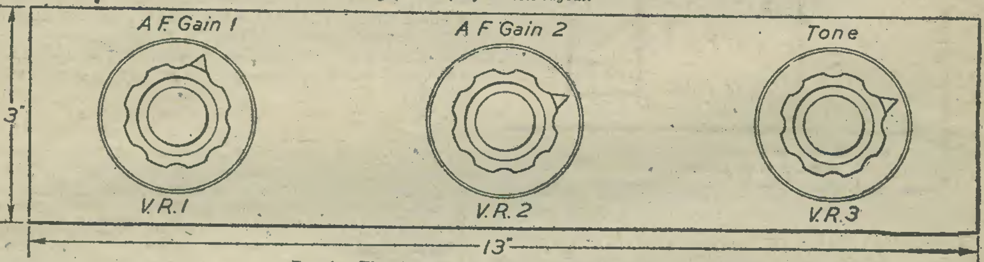


Fig. 4.—The simple layout of the front of chassis.

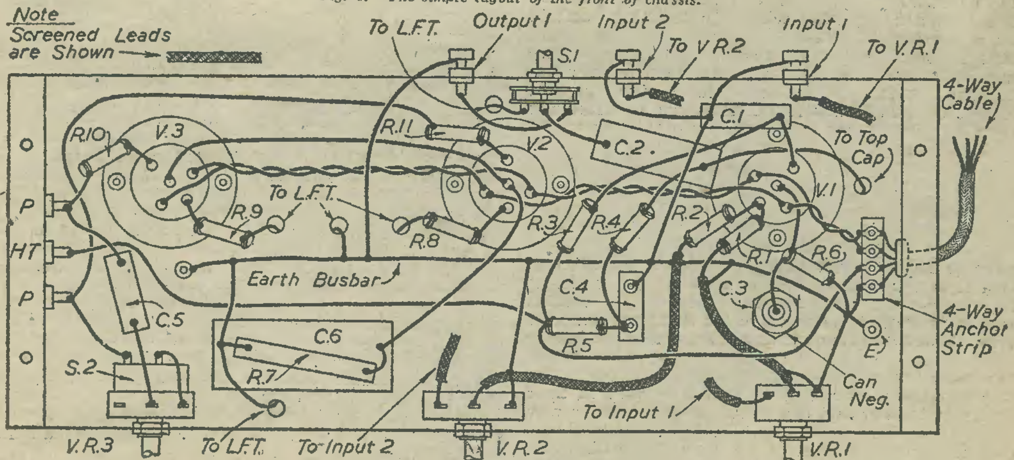


Fig. 5.—Under-chassis wiring diagram and layout.

LIST OF COMPONENTS

One chassis, size 13in. by 5in. by 3in.
Three 5-pin valve holders, chassis mounting.
Two potentiometers, 0.5 megohm.
One potentiometer, with switch, 0.25 megohm.
One L.F. transformer, push-pull type if possible; see text.
One S.P.D.T. Yaxley type switch.
Nine insulated sockets.
Two 0.5 megohm fixed resistors.
One 0.25 megohm fixed resistor.
One 0.1 megohm fixed resistor.
One 20,000 ohm fixed resistor.
One 700 ohm fixed resistor.
One 150 ohm fixed resistor.
Two 0.15 megohm fixed resistors.
Two 100 ohm fixed resistors.
One 0.1 mfd. fixed condenser.
One 0.25 mfd. fixed condenser.
One 0.5 mfd. fixed condenser.
One 2 mfd. fixed condenser.
One 50 mfd. 12 vw.
One 50 mfd. 25 vw.
Screened wire, T.C. wire, sleeving, etc.
Perforated zinc for cover.
Length of 4-way cable and 7-pin valve plug.
Valves: V1 Tungsram A.S.41.20 (metalised); V2 and V3 Cossor 41 M.P.

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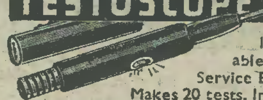

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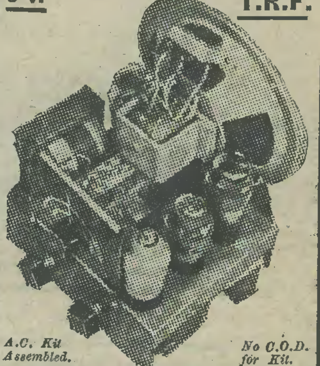

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Aerial Principles and Practice—3

The Need for Matching the Aerial to the Transmitter or Receiver. H.F. Transformer Coupling. Resonant and Non-resonant Feeder Lines. "Zep.", "Y-match" and "Windom" Aerials

THE principle of matching an aerial to the transmitter (or receiver either, for that matter, although it is less critical) is the same as that which governs the matching between two amplifier stages, or between an output stage and the loudspeaker. If the aerial impedance is high, and the load required for the output stage of the transmitter is low, a step-up-transformer effect is required between the set and the aerial. Similarly, if it is required to match an aerial of high surge impedance to a low-impedance circuit, a step-down transformer is necessary.

It will already be understood from what has been written previously in this short series that almost any aerial can have either a low or high impedance, according to the point at which any reading is taken. For example, we now know that the impedance (which for most purposes may be considered as pure resistance) at the centre of a half-wave aerial is about 70 ohms, whilst the resistance at the end of the same aerial generally approximates to 2,200 ohms. Thus, such an aerial may be either current or voltage fed. If the output from a transmitter is fed into the centre of a half-wave aerial, where the resistance is low, the current must be comparatively high for any given power. On the other hand, if the output is fed into the end of the aerial, the current will be low, because of the high resistance, and the voltage must be comparatively high.

That brief and simple explanation, combined with what was written in number one of this series, should be sufficient to give a fairly clear understanding of the problems which are likely to arise in considering the requirements for correct aerial matching. The only other point which will call for further explanation concerns the effect of feeders of the resonant and non-resonant types, which have previously been referred to to a limited extent.

Transformer Coupling

Before studying feeders further, it will be wise to look at a simple circuit (see Fig. 1) which shows the connections between a transmitter and a half-wave aerial. The aerial is in the form of a dipole, and it is centre-fed, or current-fed; this means that it is of low resistance as "seen" by the transmitter. The two aerial leads are connected to the secondary of a step-down transformer. Most satisfactory results are obtained by using a transformer in which there is an electrostatic screen between primary and secondary windings. This ensures that the coupling is purely inductive. Such a screen can be made by *nearly* encircling the primary with metal foil before winding on the secondary.

The number of turns required on the secondary can be found by calculating the necessary step-down ratio, having a knowledge of optimum load of the valve which feeds the tuned tabk circuit, from the formula:

$$\text{Ratio} = \sqrt{\frac{R_L}{70}}$$

R_L is the optimum load in ohms, and 70 is the resistance of the aerial. If the answer were 6, it would mean that the number of turns on the secondary should be one-sixth of the number on the primary.

It will be understood from what has gone before that the lengths of the two halves of the aerial include the lead-ins, and that the purpose of the two variable condensers in the aerial leads is to balance out the reactance of the coupling coil. In setting up such a circuit a thermo-ammeter would be connected at each of the points marked X, and the two sections of the aerials adjusted in length until both meters showed the same reading.

Development of the "Y-Match"

Fig. 2 shows another method of feeding a half-wave dipole, this time using non-resonant feeders made up as a 600-ohm line. In addition to the H.F. transformer in the transmitter output circuit there is another transformer feeding into the centre of the aerial. It will be seen that accurate matching is possible by suitably adjusting the ratios of the two transformers, but it is also evident that it is by no means convenient to have a transformer in the aerial itself, where it is inaccessible and difficult to keep moisture- and weather-proof.

The same result can be obtained by using the so-called "Delta" or "Y-match" aerial illustrated in Fig. 3. In this case the aerial itself acts as a transformer. The two feeders are fanned out near the aerial and are connected to taps on the aerial wire so that the correct ratio is obtained between the impedance of the whole aerial, compared with the impedance between the two taps. Dimensions are rather critical with this type of aerial and feeder, and that factor represents the chief disadvantage. In addition, the system is of little use for any frequency except that to which it is set up. The overall length of the aerial proper is shown as one half-wave, but this should of course be the length after correction for "end effect," as mentioned in the first article of this series. The distances marked X can be found (in feet) by dividing the operating frequency in megacycles into 175, while the distance marked Y is obtained by dividing the frequency in megacycles into 148. The 600-ohm line can be made up by using the formula previously given.

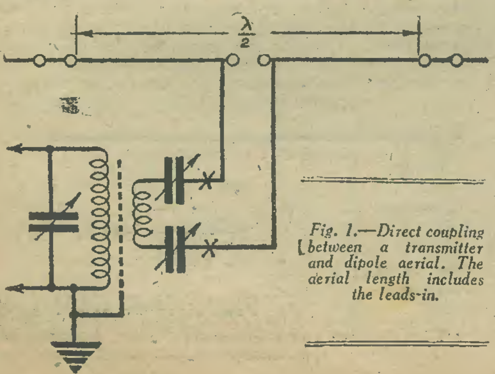


Fig. 1.—Direct coupling between a transmitter and dipole aerial. The aerial length includes the leads-in.

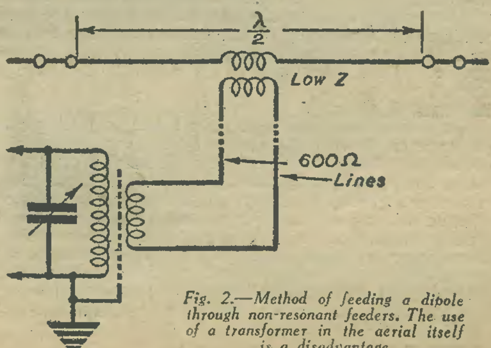


Fig. 2.—Method of feeding a dipole through non-resonant feeders. The use of a transformer in the aerial itself is a disadvantage.

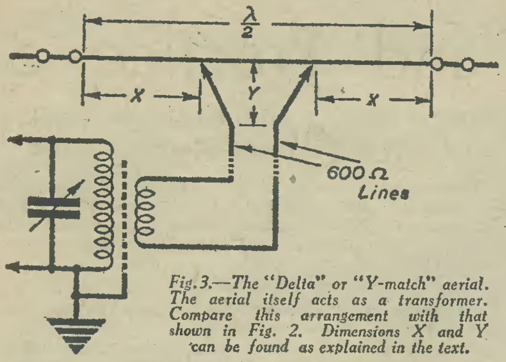


Fig. 3.—The "Delta" or "Y-match" aerial. The aerial itself acts as a transformer. Compare this arrangement with that shown in Fig. 2. Dimensions X and Y can be found as explained in the text.

Checking the "Y-Match"

In practice, slight corrections may have to be made to the calculated dimensions. Tests are made by coupling a thermo-ammeter by means of a small loop to the centre of the aerial; the two halves of the aerial should then be reduced or lengthened by equal amounts until the maximum reading is indicated by the meter. It is also desirable to check the feeders to see that there

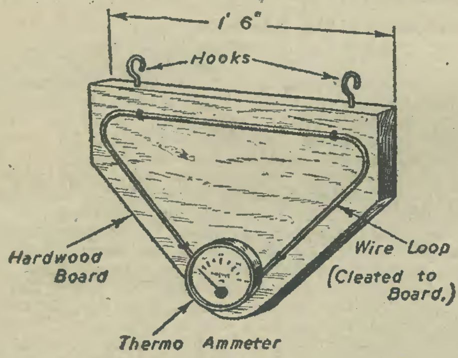


Fig. 4.—A simple device for checking aerial matching and for detecting standing waves and feeders.

is an absence of standing waves, but this is not essential. If done, the method is to couple four ammeters to one of the feeders at separating distances of one-sixth wavelength. The readings of all meters should be approximately the same, but if necessary the aerial taps can be adjusted until this condition is obtained.

A simple form of thermo-ammeter and coupling loop for the purpose described can be made up as shown in Fig. 4. It will be realised that the object is to obtain close coupling with the aerial so that the meter reading will be proportional to the current flowing in the aerial at the point of coupling. Two simple hooks are provided for fitting the tester to the aerial and so that the unit can be slid along the wire.

Resonant Feeders

Resonant feeders are generally made in multiples of one-quarter wave, and have some very interesting properties. Those which are an even number of quarter-waves long can be regarded as behaving as a one-to-one transformer; that is, they match similar impedances. Feeders having a length equal to an odd number of quarter waves show a step-up or step-down effect. Thus, they are used to effect matching between high impedance and low impedance terminations. As an example, a half-wave feeder could be used to couple a high impedance output circuit to the end of a half-wave aerial, or to couple a low impedance output circuit to the centre of the same aerial. Feeders three-quarters of a wavelength long would be used to feed a high impedance output circuit into the centre of a half-wave aerial, or a low-impedance output into the end of such an aerial.

The "Zep" Aerial

The use of resonant feeders is well illustrated in the case of the so-called "Zep" aerial, illustrated in Fig. 5. It will be seen that only one of the feeders is connected to the aerial itself, the other being entirely "open." This may appear very odd until the arrangement is analysed, as shown inset in Fig. 5. It will be seen that the feeders and coupling coil bring the effective length of aerial and feeders to one wavelength. In the centre of one half-wave there is the coupling coil (at a low impedance point), and one side of this feeds into the end of the half-wave aerial proper (at a high impedance point). Thus is the matching obtained.

Fig. 6 shows the same arrangement where half-wave feeders are used, and this can be re-drawn in the same manner as for the aerial in Fig. 5. If that is done it will be seen that the coupling coil is between the high impedance ends of two half-wave lines, and that one of the feeders is connected to the high impedance end of the horizontal aerial.

Figs. 7 and 8 show other methods of employing resonant feeders in conjunction with dipole aerials in conjunction with high and low impedance output circuits. Precisely the same principles apply to those already

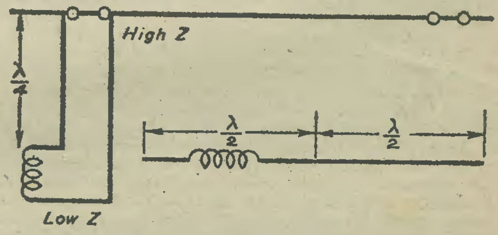


Fig. 5.—The "Zep" aerial with a quarter-wave feeder. The inset diagram explains how a low impedance source is matched into the (high impedance) end of a half-wave aerial.

outlined, and it will be seen that a series-tuned circuit (low impedance) is used with feeders of length equal to an even multiple of one quarter-wave and a parallel tuned circuit is used when the feeders have a length equal to an odd multiple of one-quarter wave.

The "Windom" Aerial

Another fairly popular, and mechanically simple, type of aerial system is known as the Windom, from the name of its originator. It is shown in Fig. 9, and will be seen to consist of a horizontal half-wave aerial with a single feeder tapped in at a point to one side of the centre. This type of aerial calls for critical adjustment, but is rather more efficient than the "Zep," although the losses are somewhat greater than those for aerials of the types shown in Figs. 3, 7 and 8. The distance of the feeder tap from the end of the aerial (marked d in Fig. 9) can be found with fair accuracy by dividing the operating frequency in megacycles into 170, the answer being in feet. It is important that

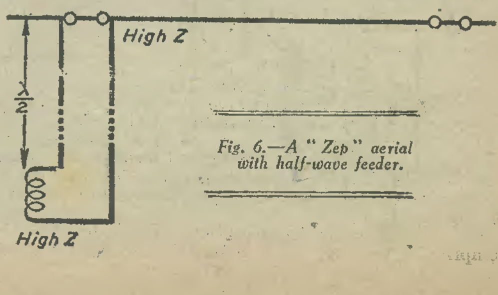


Fig. 6.—A "Zep" aerial with half-wave feeder.

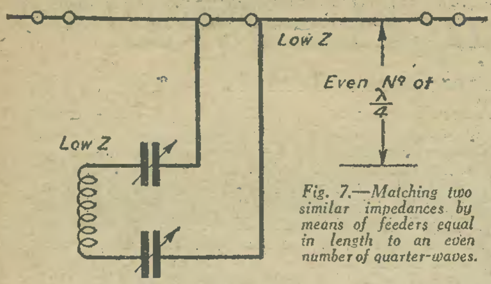


Fig. 7.—Matching two similar impedances by means of feeders equal in length to an even number of quarter-waves.

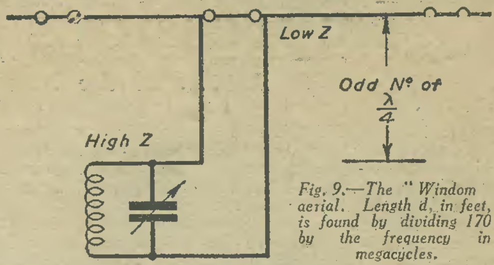


Fig. 9.—The "Windom aerial. Length d, in feet, is found by dividing 170 by the frequency in megacycles.

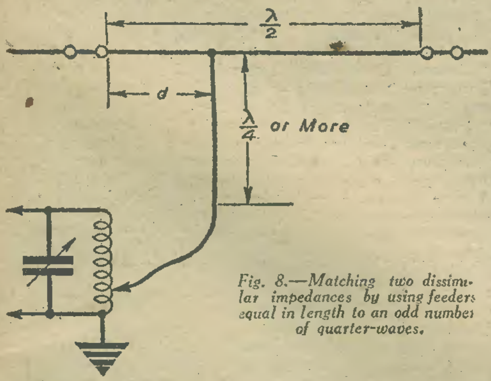


Fig. 8.—Matching two dissimilar impedances by using feeders equal in length to an odd number of quarter-waves.

the feeder shall be perpendicular to the horizontal aerial for a distance equal to not less than one-quarter wave.

To adjust the tap an ammeter should be coupled on each side of the tapping point and close to it, and adjustment made until both meters show exactly the same reading. A test should also be made to check that standing waves do not appear on the feeder. This can be done by ensuring that the current near the tap and at points about one-sixth wavelength apart from it is in every case the same, or as nearly so as can be obtained.

This third article in the series might well be concluded by giving a brief outline of the advantages and disadvantages of resonant and non-resonant line feeders, now that their use is understood. Resonant lines have the advantage of high efficiency provided that they are accurately cut; they provide an easy method of matching without the use of transformers. On the other hand, they are suitable for use only on the frequency for which they are cut or on odd harmonics of that frequency. Non-resonant lines can be of any convenient length in excess of one quarter-wave (if they are shorter than that they tend to act as a condenser only, and if they are exactly one quarter-wave long they become resonant), and the voltages and currents are equal at all points along the lines. Also, high currents and/or voltages are not employed, and the terminating impedances do not require to be chosen very critically.

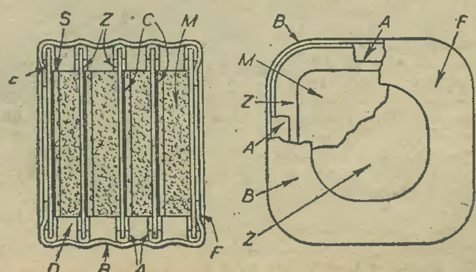
IMPROVED FLAT-CELL TYPE DRY BATTERY

OWING to the demand for a dry battery of reduced volume for a given output, the flat-cell type of battery has recently come into prominence. An important point in the manufacture of this kind of battery is the provision of an effective seal between adjacent cells of the battery, so that internal leakage of the electrolyte does not occur.

As shown in Fig. 1, each cell comprises zinc and carbon elements Z and C, an electrolyte S and a depolariser M, and a number of cells (four are shown in the drawing) are stacked together to form a battery. The carbon element C preferably comprises a coating of carbon on one surface of the zinc plate or element Z. The feature of the construction shown is that the zinc or zinc-carbon elements are made somewhat larger in area than the electrolyte and depolariser elements, so that marginal portions of the zinc plates project beyond the main body of the cells, and a sleeve B of suitable electrolyte-resisting material is placed over the stack of cells and then shrunk on to them so that it embraces the edges of the zinc elements tightly and forms an effective seal between adjacent cells. Preferably a ring A of suitable electrolyte-resisting material is arranged round the marginal portion of each zinc element Z and suitable adhesive may be used to cause adherence both of the rings A to the zinc elements Z and the outer sheath B to the edges of the rings A. The sleeve B assumes the corrugated form shown when shrunk on and will permit some expansion of the air spaces D round the cells to accommodate gases generated in the battery.

In the preferred construction the outer sheath comprises a tube of plastic material, such as polyvinyl chloro-acetate, celluloid or cellulose acetate plastic, which can be swollen by immersion in a suitable liquid, such as acetone; the tube is cut slightly longer than the assembled stack of battery cells and its cross-sectional area is somewhat less than the area of a zinc plate. During manufacture of the battery the tube is swollen by immersing it in a mixture of acetone and water, so that it can be fitted over the stack; it is then dried to cause shrinkage, so that it adheres tightly to the edge of the zinc plates. Contraction of the sheath produces the corrugations shown in Fig. 1, causes the ends of the sheath to turn inwardly, as shown at F, and holds the cells together.

As shown in Figs. 1 and 2 it is preferred to place a ring or band A of suitable material, which may also be a plastic material, round the margin of each zinc to form a cushion between the outer sheath and the edge of the zinc plates and also to protect the margins from the electrolyte. The rings or bands A may be cut from a tube of plastic material and expanded and then shrunk on to the zinc in the manner already described.



Figs 1 and 2.—Details of the new flat cell.

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

ONCE again, H.M.V. make a notable contribution to music lovers by releasing this month a superb recording of Beethoven's "Sonata No. 26 in E Flat Major, Op. 81A—(Les Adieux)," played by that talented pianist Arthur Rubinstein. It consists of two records, *DB*6132-33, the former dealing with the 1st movement (Les Adieux) Adagio-Allegro, and the latter with the 2nd and 3rd movements (L'Absence), Andante espressivo and (Le Retour) Vivacissimamente.

Arthur Rubinstein shows a complete understanding of the composer's thoughts, and these he interprets with that fine detail and expression which is the hall-mark of a great artist.

I am hard put to find the word which would adequately describe that "something" which, in addition to an exceptionally fine tenor voice and perfect diction, Webster Booth possesses, and which places him several degrees higher than many of his contemporaries. What I have in mind is obvious in his latest recording on *H.M.V. C*3402, for which he sings "Oh Loveliness Beyond Compare" from Act 1 of "The Magic Flute," and "Constanze Constance" (Die Entfuhrung aus dem Serail)—Mozart. He is accompanied by the Liverpool Philharmonic Orchestra, conducted by Basil Cameron.

Another fine vocal is *H.M.V. C*3404, as it contains a delightful recording by Gladys Ripley, with the Liverpool Philharmonic Orchestra, singing "Fair Spring is Returning," from Act 1 of "Samson and Delilah," and "O Fatal Beauty," from Act 3 of "Don Carlos." Miss Ripley possesses a voice of great charm.

The Sadler's Wells Orchestra, conducted by William Walton, have recorded, in two parts, "Sheep May Safely Graze," which is from the Ballet Suite of "The Wise Virgins"—Bach—Walton. The record is *H.M.V. B*9380. "Hutch" contributes "Long Ago (and Far Away)," from the film "Cover Girl," and "A Lovely Way to Spend an Evening," from the film "Higher and Higher," on *H.M.V. BD*1085.

"In Times Like These" and "Nobody Else But You" are the two numbers selected by Joe Loss and his Orchestra for their latest recording on *H.M.V. BD*5852. Two quite good dance tunes.

Eric Winstone and his Band offer a good slow foxtrot, "Do Nothin' Till You Hear From Me," and a foxtrot "The Music Stopped." These are on *H.M.V. BD*5853, and they are nicely presented.

Tommy Dorsey and his Orchestra, on *H.M.V. BD*5851, play "I'll See You In My Dreams," and "How Am I To Know," both ideal for foxtrots. Dinah Shore puts up a very good show with "Now I Know" and "Smoke Gets In Your Eyes" on *H.M.V. BD*1084.

Finally, we have Swing Music 1944 Series, Nos. 589 and 590, on *H.M.V. B*9382. These are played by Artie Shaw and his Orchestra, and consist of "This is Romance" and "Any Old Time."

Columbia

A 12in. Columbia record which I recommend most strongly to all who enjoy a solo pianoforte performance of outstanding merit is *Columbia DX*1159, on which that great artist Cyril Smith has recorded "Naila Waltz" by Delibes, arranged Dohnanyi. The recording, which is in two parts, is in itself superb, while the rendering of this delightful piece leaves nothing to be desired. The technique, expression and undoubted capabilities of Cyril Smith are strikingly evident.

The first 10in. Columbia I take up is, strangely enough, another pianoforte recording, but in this instance it is a duet played by those ever-popular and talented artists Rawicz and Landauer. The record is *Columbia DB*2148, and the pieces are two of Mendelssohn's works—arr. Rawicz and Landauer—entitled "The Bees' Wedding" and "Scherzo."

Albert Sandler and his Palm Court Orchestra have made an exceptionally fine record from "The Lilac Domino—Selection," on *Columbia DB*2147.

Another in the *DB* series this month is by Frank Sinatra, singing "You'll Never Know," featured in the film "Hello, 'Frisco, Hello" and "Sunday, Monday or Always" from the film "Dixie." In both numbers he is ably supported by a fine chorus. The record is *Columbia DB*2149.

Turner Layton is well on form this month, on *Columbia FB*3035, for which he has recorded "Long Ago" and "Mother's Silver Wedding Day," with, of course, himself at the piano.

"Carroll Calls the Tunes," No. 28, introduces "Tangerine," "You'll Never Know," "Dearly Beloved," "Chattanooga Choo Choo," "As Time Goes By," and "White Cliffs of Dover." These are recorded, as one would expect from the title, by Carroll Gibbons at the piano, and I must say the result is a most pleasing record, the number of which is *Columbia FB*3036.

Victor Silvester and his Ballroom Orchestra have made two records this month, both of which I include in my selection. They are *Columbia FB* 3040, "Time Alone Will Tell"—slow foxtrot—and "Someday I'll Meet You Again"—a quickstep. On the other record, *Columbia FB* 3039, they have recorded "Amor, Amor," a rumba, and "Night of Biarritz," also a rumba.

Dorothe Morrow's Aristocrats have recorded "The Old Grey Mare is Back Where She Used To Be" and "It's Love, Love, Love," on *Columbia FB*3037.

Parlophone

I AM not so greatly impressed with the two works which Richard Tauber has selected for his recording this month. They are translations by Whistler of Brahms "Vain His Pleading, Op. 84, No. 4" and "O Golden Age of Innocence, Op. 63, No. 8," which Tauber sings in English with a piano accompaniment by Percy Kahn. The number is *Parlophone RO*20530.

Geraldo and his Orchestra offer two good recordings, on *Parlophone F*2027, the numbers being "If I Had Only Known" and "Goodnight Wherever You Are," both foxtrots and both well presented, and on *Parlophone F*2033 they play "Long Ago (and Far Away)" and "I'm Going to Build a Future World," two more foxtrots.

"Tin Pan Alley Medley, N. 63" is on *Parlophone F*2031, and Ivor Moreton and Dave Kaye introduce "I'm Sending My Blessing," "The Music Stopped," "Don't Sweetheart Me," "I Saw You First," "In Times Like These," and "If I Had Only Known."

Billy Thorburn's "The Organ, the Dance Band and Me," have taken two film features for their record—*Parlophone F*2032—namely, "Don't Ever Leave Me" and "Sweet Rosie O'Grady," slow foxtrot and waltz.

*Parlophone R*2943 is the record for those who enjoy the 1944 Super Rhythm-style Series, as it contains Nos. 35 and 36, both by Harry James and his Orchestra. On one side—No. 35—they have recorded "Flash" and on the other "I Found a New Baby."

Regal

BOTH of the Regal records included in my list this month are good, one being by the ever popular George Formby, on which he has recorded "The Old Cane Bottom Chair" and "The 'V' Sign Song," which, of course, he accompanies with his ukulele in addition to orchestra. The number is *MR*3736.

The other record is by Lou Preager and his Orchestra, from the Palais de Danse, Hammersmith, who play in tip-top style "The Quack, Quack Song," a quick waltz, and "It's Love, Love, Love" in Jive tempo. These are on *Regal MR*3737.

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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).

Station WCBX

SIR,—I would esteem it a favour if your readers could give me any information about station WCBX, broadcasting from New York, U.S.A., as I do not know its wavelength. Other S.W. stations I have received are WLWK, 49.50 m.; WCBO; Vatican Radio; WRYL and WOOW.—B. C. BIDDULPH (Dawley).

Experiences With "Economy Three"

SIR,—I have just constructed the "Economy Three," by F. C. Rayer, and results were very good. I did not use headphones, but a speaker tapped for five different impedances. The coupling used was for 3,500 ohms impedance, 31½/1 ratios; reception was received at normal speaker strength. I tried my set on Saturday, July 22nd, and at 1.30 p.m. I logged a station reading a message in English, asking for correspondence as to signal strength, etc. The announcer gave the call "Hallo, Romo," repeated several times. I believe this was a new station. If any reader also logged this station I would be pleased to communicate with him (or them). I was unable to catch the beginning of the programme, but I shall listen for this station again; the range was 22.49 m.

To conclude my letter, I would gladly welcome any letter from all interested in S.W. DX work.—E. FITZAKERLEY (Doncaster).

The "Rapid Two"

SIR,—I am a beginner in radio, and I have learned all I know about it from your excellent journal, which is not excelled by any contemporary publication. I am sorry that your query service has ceased, as I found it very educating. I must compliment "Thermion" on his sound, commonsense views, which reflect the opinion of all sensible people.

I have recently constructed the "Rapid Two" receiver, which gives very gratifying results as regards quality and volume. But one thing worries me. This morning I switched on at about 8.45 on 285 m., when the set worked perfectly. At approximately 9.2, however, the speech seemed to slow down, until I had to wait for nearly a minute between words.

I wonder if anything such as automatic speed control (A.S.C.) can be incorporated in such a simple circuit as this? I am sure that if any constructor has solved this difficulty the result would be of great interest to all my fellow-readers.—S. B. HAWKES (Clevedon).

Sensitive Signal Analyser: A Correction

THE recommended valves for the Sensitive Signal Analyser described in our last issue are: V1, V2, V3—SP41 (Mazda); V4—MH4 (Osram); V5—MSP4 (Osram); and V6—KT41 (Osram). The special inductances should consist of 90 turns of 28 s.w.g. enamelled wire, single layer close-wound on the ½in. former; the length of the winding being 1¼in. In the description of the negative feedback arrangements an error occurred in the notation of the resistors. The feedback voltage is actually developed across R32 and R31, not R27 and R28.

"The Universal Two"

SIR,—In a recent issue of PRACTICAL WIRELESS, details were given of a midget receiver, the "Universal Two," which I decided to build. It was soon found, however, that the high capacity electrolytics specified were unobtainable, also that I could not get a 25B8GT to match the 70L7GT in hand. To utilise the latter valve, together with other parts I had purchased, the circuit as published was redesigned as a triode detector coupled to the 70L7, and the result is a midget set, using easily obtained parts, which gives loudspeaker results at good strength and quality. The set tunes the medium waveband, uses only a short "throw-out" aerial and is of the type which would, I think, appeal to many of your readers.—F. D. CLARKE (Lincoln).

(*We should be grateful for details.*—ED.)

Licensing Repair Depots

SIR,—I thoroughly agree with the views expressed by "Serviceman" of Barrow on the subject of licensing radio repair depots.

It is extremely important that readers act in unison to protest, through the medium of your journal, to prevent the imposition of such a licence.

I for one would not mind an examination by an *independent* body, but I know a good many dealers who would.

What it means is that any old botcher can do repairs if he's a dealer, but a highly skilled serviceman will not be able to, if the dealers oppose his application (as they surely will).—F. BOTTO (Bournemouth).

Shady Dealing?

SIR,—I read in an issue of your paper PRACTICAL WIRELESS that you would be interested to hear of any instances of shady dealing with radio shops. I will quote you my own case as I would like some advice as to what I can do about this matter.

I took a miniature radio receiver (Western) to be repaired by a firm in March and obtained an estimate for a repair for £3 10s. including two new valves. I paid this and received the set back. Six weeks later the set broke again, and as this firm advertises that repairs are guaranteed for three months I said that I wished the set to be repaired under the terms of the guarantee, but was not willing to spend more on it. The next time I called in I was told the repairs would cost £2 12s. 6d., as a different valve was faulty and another condenser. I refused to pay this and demanded the set back as it was when I brought it in the second time. After a lot of unpleasantness I got the set back.

On testing the set when I got it home I now found that two valves were faulty, one of these being a valve I had had replaced on the first occasion.

It is clear to me that this valve has been purposely substituted, a faulty for a good valve.

I have got the estimates written on paper with details of the repairs required and so have proof that on the second occasion only one valve was faulty.

I have also carefully examined the set and it is clear to me that the amount of repairs estimated was grossly exaggerated, as it is easy to see which is original soldering and which has been recently repaired.

I have written about this matter to the firm but obtained no satisfaction and I consider I have been cheated.

I should be glad of your advice as it is hardly worth taking legal action, but I feel that this sort of behaviour is too common nowadays and a stop ought to be put to it.—P. H. BEALES (N.3).

(*The only real remedy is at law.*—ED.)

B.L.D.L.C. Member's Report

SIR,—I have not been able to spend many hours at the Rx; instead I have been making plans for the new shack, including building a 20- or 40-metre doublet (not yet fixed which length). Your articles in PRACTICAL WIRELESS, March, 1941, entitled "Planning Your Receiving Station" are proving useful. I am also reading

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(Continued top of next column.)

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PRACTICAL WIRELESS, October, 1944.

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