INSTABILITY IN SUPERHETS

Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

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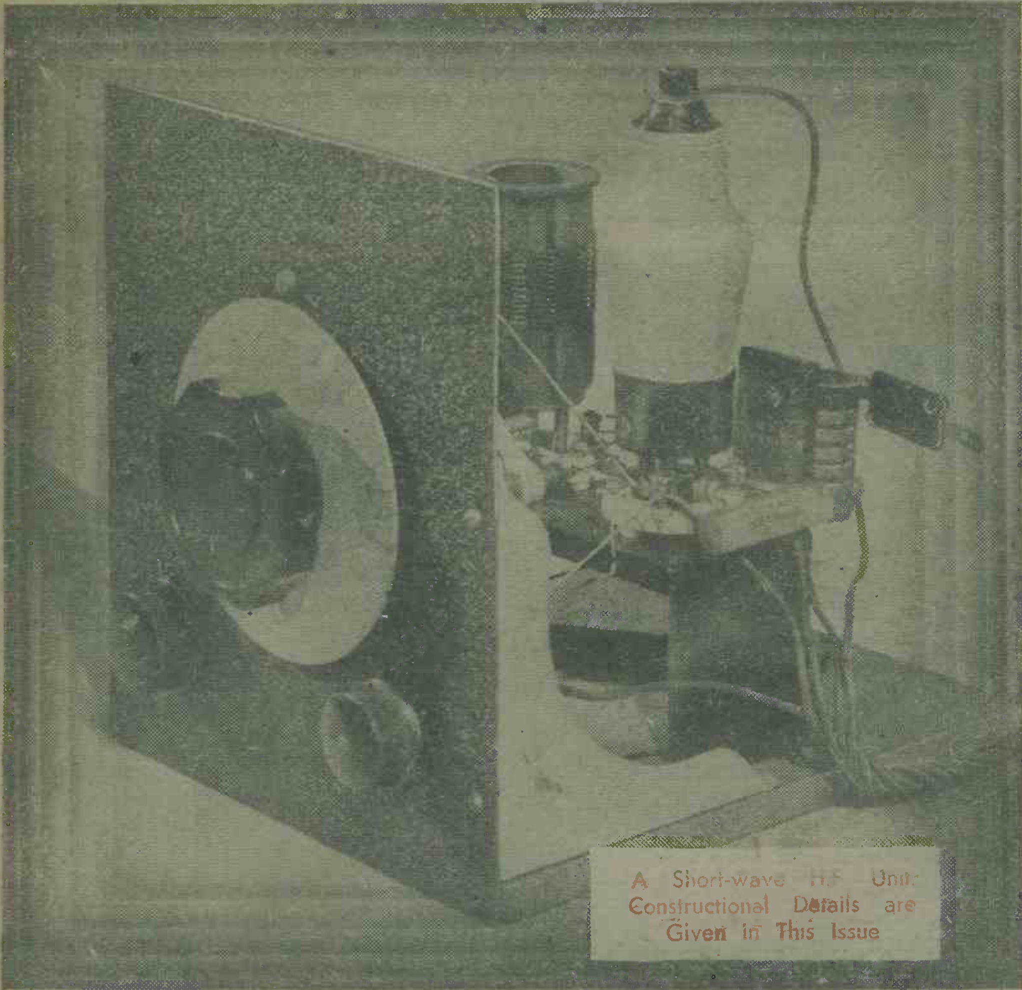

A Short-wave H.F. Unit: Constructional Details are Given in This Issue

Practical Wireless
and PRACTICAL TELEVISION
13th YEAR OF ISSUE
EVERY MONTH.
Vol. XXI. No. 463. JANUARY, 1945.
Editor F. J. CAMM

Comments of the Month

By F. J. C.

Post-war Development

THE British Institution of Radio Engineers have recently issued the second part of their Post-war Development Report, Part I of which was reviewed in an earlier issue.

The chief recommendation of Part I was the proposal for the formation of a British Radio Research Institute covering anticipated development in the application of radio science. All development, however, is dependent upon an adequate supply of trained personnel. Hitherto, discussion on the future of education and its relation to technical training has been concerned mainly with principle and policy. The New Education Act has disposed of this, and it is now necessary to bring into prominence practical considerations of which technical training is not the least important.

The Report points out that the New Education Act, while providing sound foundations, is not immediately operative, so that a large number of people will never benefit from it as they will have left school before it starts to function. We concur in the view expressed that a further Bill must come before Parliament in due course as a charter for adult education, and for technical education of senior grade. The Government has already laid plans for the foundation of an Aeronautical College, and we suggest that they should not ignore the equally important claim of radio and television for a similar College.

Aeronautics and Radio

AERONAUTICS has performed a great service for the Allies, but it could not have been possible without radio in its various branches. The President of the Board of Education has announced the appointment of a Committee to consider the needs of higher technical education in England and Wales, and the contributions made by universities and technical colleges. This Committee will make recommendations as to the means for maintaining appropriate collaboration between universities and technical colleges.

We support the belief of the Institution that graduation facilities in physics and radio engineering in our universities must be greatly augmented—a suggestion made in the Report of the Parliamentary and Scientific Committee. Courses of study in radio engineering and servicing must be more widely provided in our technical colleges, and these courses should lead to a nationally recognised examination in radio science. It cannot be denied that substantial modifications of the existing National Certificate Scheme are long overdue. The status of the craftsman should not be lower than that of the technician, and his educational needs should receive equal consideration.

In radio engineering there are broadly five main categories of workers, including senior research workers, ancillary staff recruited from those who are up to Higher School Certificate standard, technicians up to matriculation standard, skilled craftsmen, semi-skilled, and unskilled labour.

National Training Scheme

THE training of skilled craftsmen has hitherto been the responsibility of industry itself, and this state of affairs is not satisfactory. There should be a national scheme behind the training of craftsmen. There should be more schools in industrial works, part-time release of workers to attend day or evening classes in technical colleges, and half-time schemes, enabling the individual to put in half his time in study.

The Institution's Memorandum to the Ministry of Education advocating National Certificates in radio engineering stresses this matter, for the rapid development of radio science has emphasised our inadequate provision in pre-war years of courses of instruction in radio engineering. It is hoped that future syllabuses will be adapted to modern requirements and will not reflect obsolete practice.

National Certificate Courses are at present based upon part-time study of about 7½ hours a week, while National Diploma Courses involve a full-time day attendance of 30 hours a week at a Senior Technical College. This falls far short of the ideal, and does not give sufficient opportunity to a sufficiently large number. We approve the suggested Certificate Course in Radio Engineering. Second and third years should follow a first year which is common to all branches of engineering. Of course, there will be divergence of opinion on some of the recommendations of the Report. It is a move in the right direction, and it should be implemented without delay.

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

ROUND THE WORLD OF WIRELESS

B.I.R.E. Meeting

AT a meeting of the British Institution of Radio Engineers (North-Eastern Section) held at the Neville Hall, Westgate Road, Newcastle-on-Tyne, on November 15th, a paper on the "Theory of Rectification" was read by A. H. Hoult, an associate member.

New B.B.C. Appointment

MR. BASIL E. NICOLLS has been appointed Senior Controller of Programmes. Mr. Nicolls has been controller of programmes since 1938. The new controller of programmes is Lindsay Wellington, who returned to this country from New York in June after acting as B.B.C. North American director.

His experience of American broadcasting may influence programmes.

The appointments, which indicate an expansion of programme planning, may be connected with the post-war introduction of more home services.

Mr. Wellington, who is 43, joined the B.B.C. in 1924, the same year as Mr. Nicolls.

Proposed Radio Club for Leeds

FOLLOWING up the proposal to reform the Leeds Radio Society, or to inaugurate a new club, late members of the Society or interested readers residing in the Leeds district are asked to communicate with E. Benden, 40, Grosvenor Terrace, Blackman Lane, Leeds 7.

Railway Radio in U.S.A.

IT is reported that one of the chief railways in the United States, the Kansas City Southern, is installing radio equipment over 560 miles of its main line operating in the western parts of America. In addition to radio, induction telephony will also be employed, utilising carrier current wires along the track. The system is intended to provide end-to-end communication on trains, as well as between stations and trains en route.

Colour Television Sets!

ACCORDING to Mr. J. L. Baird, a combined sound and television set for the home, with colour television and stereoscopic effect, is likely to be produced after the war for about fifty pounds. Mr. Baird was also of the opinion that with mass production the price of a black and white receiving set may well become much less—possibly in the neighbourhood of fifteen pounds.

Obituary

THE death is recorded of E. P. Roper, chief designer of the Transformer Department of the Witton Works of the General Electric Co., Ltd. Mr. Roper joined the staff of the G.E.C. in 1929, having previously been with the British Electric Transformer Co.

Indian S.W. Radio

ACCORDING to a recent announcement two high-powered short-wave transmitters, each of 100-kW, are now in regular service by All-India Radio. Some of the transmissions from Delhi are radiated by these stations from an aerial system directed towards this country.

"To You, America"

AMERICAN music, classical and light, American verse and extracts from the speeches of famous Americans, were included in "To You, America," a Thanksgiving Day celebration held in Britain on the day set apart for thanksgiving by the pilgrims after their first harvest in America.

This tribute to our great ally, by the best of British artists, took place at the Royal Albert Hall on the evening of Thanksgiving Day, and the second half of the programme was broadcast before the nine o'clock news.

John Barbirolli conducted the London Symphony Orchestra, with Shulamith Shafir, Malcolm McEachern, Swales Atkinson, Arnold Grier at the organ, the Scots Guards Band, the Kneller Hall Trumpeters and the Alexandra Choir.

Speakers were Henry Ainley, Celia Johnson, John Laurie, James McKechnie and Michael Standing. The script was by Stephen Potter, and the production by Squadron-Leader Ralph Reader.

"The Big Show"

"THE Big Show" is a new programme which started on November 26th, and will be broadcast at intervals throughout the winter and spring for our Forces overseas. Present in His Majesty's Theatre for each performance will be the wives of men serving abroad, with a smaller number of the Forces in this country, all chosen by the Welfare Departments of the three Services.

The cream of the entertainment industry will broadcast in each performance. Such talent as the B.B.C. plans to present is not frequently available, hence the intervals. The second of "The Big Show" series will be heard on Christmas Eve.

Each programme will last an hour, and, at the end of the first, on November 26th, Cicely Courtneidge, one of its stars, was heard talking from the stage with a serving man in Cairo, who just listened to the five acts which make up the bill. This discussion was impromptu, and was broadcast by means of a radio link between

A loudspeaker lorry being used in a recent broadcast talk to Germans in the front line. Note the soldier with the microphone in the foreground on the right.

the British and Egyptian capitals. It is the B.B.C.'s intention to bring to the microphone in this series not only stars of the stage and screen who are familiar to listeners for their radio work, but others who cannot often be heard in its programmes.

All-star Band

VAN PHILLIPS and his Concert Orchestra was the all-star band of over 30 players, which besides accompanying the artists, played three special arrangements during the programme.

Gerry Desmonde was Master of Ceremonies, and production was by Vernon Harris.

A recorded repeat was heard in the G.F.P. on November 29th and again on Friday, December 1st in the Home Service. These repeat broadcasts were arranged so the British Forces overseas wherever they may be all had a chance of hearing "The Big Show."

B.B.C. Orchestra Comes to Town

THE B.B.C. Symphony Orchestra is coming to town. Sir Adrian Boult, its conductor-in-chief, is to conduct the Orchestra in nine concerts, a series of seven monthly ones to be given at the Royal Albert Hall on Sunday afternoons in collaboration with Harold Holt, and two on Saturdays, December 9th and March 17th, under the ægis of the Royal Philharmonic Society, and also at the Albert Hall.

The Orchestra has not been heard in London "in the flesh" since May, as the last weeks of the Jubilee Season of Promenade Concerts in which it should have played were cancelled owing to flying bombs. The reappearance of this famous orchestra in London will do much to heighten interest in the forthcoming musical season.

"Country Magazine"

FRANCIS DILLON, producer of "Country Magazine," has many good stories to tell about how he finds the characters for the programmes. In his journeys all over Britain he has met hundreds of interesting people with some tales which, although hard to believe, are, nevertheless, true.

In Suffolk he met a man whose life-long hobby was growing stones—ordinary stones. This man would pick up a large stone and say "That is an inch and three-sixteenths bigger than when I first got it. It looks lovely and round to you, and that's its proper shape, but it's been neglected. You see, there's a bulge; that's because I didn't turn it regular."

This magazine programme includes people from all over Britain, and is sometimes devoted to one particular county. In a general number Vic Armstrong was heard. Vic, now a farm labourer, has had a varied career. He started life in an engineering shop, but wasn't interested in lathes and machine tools, and after 12 months ran away to join Barnum and Bailey's Circus. He trained for four years as a trapeze artist, looking after horses and other animals at the same time, and, with the circus, he toured most of the world, but while he was in Belgium his wife was killed in an act. Vic left the circus at once.

Wagon and Two Horses

HE came to England with a wagon and two horses, and travelled about for six years, working on farms. He couldn't settle, and selling his horses and wagon, he joined a trawler going to Iceland. After 18 months he returned to Liverpool, where he worked on the Mersey Tunnel. His health suffered through this, and he returned to work on the land.

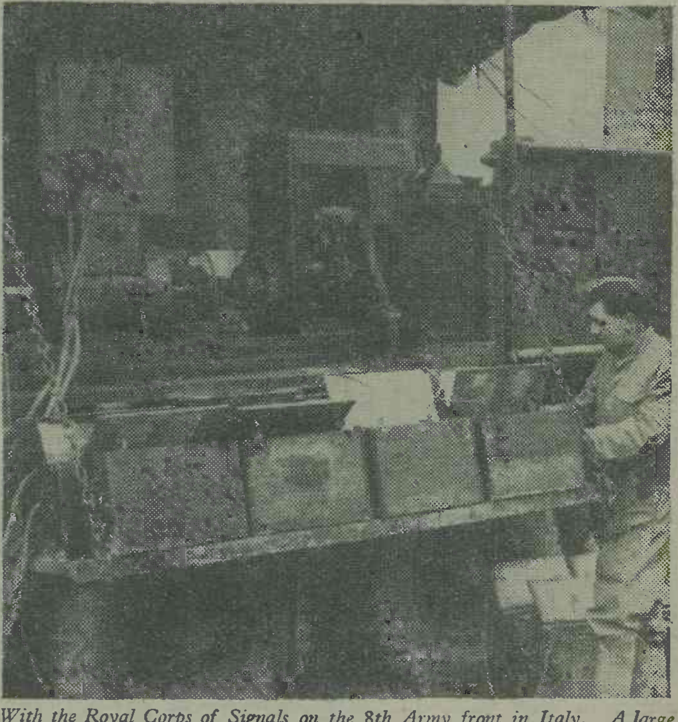
Michael Beary, whom most people remember as a jockey, has appeared in "Country Magazine." Michael now prefers to be known as a farmer and horse-breeder. His story of his early days concerns a hunt in Ireland, when he was promised a ride on a good pony which did not turn up. Michael, very disappointed, started to cry. His grandfather said he could have "Charlie," a horse which at that time pulled the family plough. The hunt moved off, Michael put "Charlie" to the test, and the horse finished alone far ahead of the rest of the hunt.

"The White Steed"

PAUL VINCENT CARROLL'S play, "The White Steed," was the starred programme (Home Service) on November 13th.

Set in a small seaside village in Ireland, it told of the conflicts aroused in the place by the clash of varying temperaments, and also of the troubles that are caused by the interference of the young Father O'Shaughnessy, who comes to administer the parish when the old parish priest, who knows every member of his flock intimately, is suddenly incapacitated by an attack of paralysis.

"The White Steed" is a finely written play, and should have provided excellent listening for lovers of strong drama. As is fitting it was produced by an Irishman, Fred O'Donovan.



With the Royal Corps of Signals on the 8th Army front in Italy. A large battery charging plant which deals with 80 batteries a day.

New Appointments

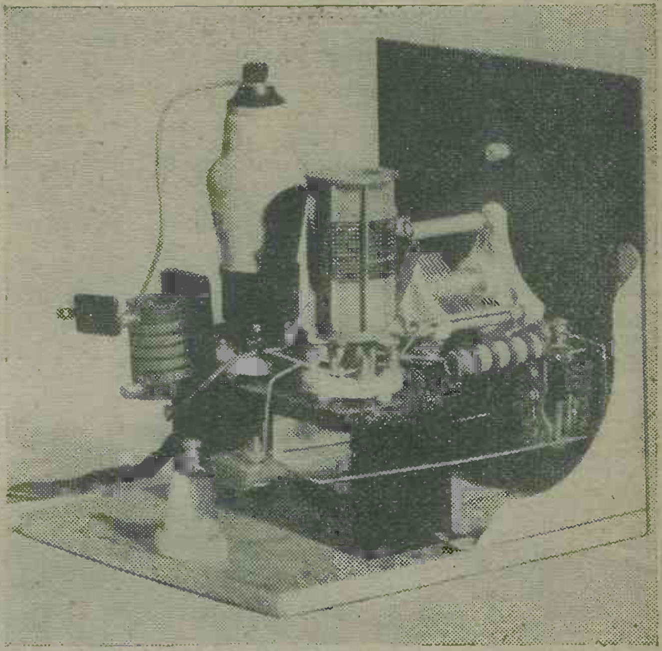
F. A. WINGROVE and W. Holmes, M.C., have recently been appointed to the board of Wingrove and Rogers, Ltd. Mr. Wingrove has had long service with the company as buyer, and also as manager of their B.E.V. electrical industrial truck and locomotive departments. Mr. Holmes has been on the radio side of the business for many years, and is well known in the trade in connection with the sale of Polar condensers.

Short-wave Radio—5

Adding a Third Valve. H.F. or L.F. Amplification? Tuned or Untuned. Making an Efficient H.F. Unit.

By 2CHW

(*Continued from page 12, December issue.*)


The H.F. unit.

THE owner of a two-valve straight S.W. receiver begins to wonder what effect the addition of another valve would have. This is a perfectly natural step in the sequence of progressive events which form one of the interesting features of S.W. work, and it happens no matter how good the existing set may be. The two-valver already described is fully capable of doing exceptionally good work, bearing in mind its simplicity, but after it has been in use for a few months, and after the operator, assuming he started from scratch, has acquired sufficient experience to get the utmost out of it, a feeling will arise that even better results could be obtained if the circuit had a shade more pull or sensitivity. Would the addition of another valve provide that "plus something" and, if so, how should it be coupled to the existing circuit? These are the questions which are bound to present themselves, and it is possible that the beginner may have some little trouble in answering them.

With the normal o-V-1 type of receiver there are two ways in which another valve could be employed. It could be connected between the aerial and the detector, when it would act as an H.F. amplifier, and the circuit description would then become 1-V-1, or it could be wired in the circuit between the detector and the output pentode, in which case the line-up would read o-V-2. (For the benefit of beginners, the figures and letter used above to denote the valve sequence of a circuit are interpreted in the following manner. The first figure indicates the number of H.F. stages preceding the detector; the capital V is always used instead of writing detector, and the last figure tells how many L.F. stages follow it. Example: o-V-2 indicates a three-valve circuit which does not include any H.F. stage(s), but consists simply of a detector followed by two L.F. stages.)

H.F. or L.F. Amplification

Knowing the alternative arrangements, the next thing is to decide which will give the greater over-all increase in efficiency, and this problem can only be solved by comparing the effect of each on the existing circuit.

A leaky-grid detector is sensitive to weak signals; if efficient reaction is applied the sensitivity is increased, but from a practical point of view, the limits of usefulness of such a detector are bounded by those conditions when the signal or input is too powerful, in which case bad overloading and distortion are produced, and when the signal is too weak to allow a satisfactory output rectification to be obtained. In the first case, it is a simple matter to provide some form of pre-detector input control, or modify operating conditions, but in the second case, when the signal is very weak, the rectified and amplified signal in the anode circuit will be too small to satisfactorily operate a pair of headphones; therefore, if the transmission is to be received (for practical purposes one can say that a signal is not received if it is not audible), another valve must be used to amplify the weak signals sufficiently to make them powerful enough to operate the 'phones. This is quite satisfactory up to a certain point, but unfortunately, transmissions are not always free from unwanted disturbances in the form of atmospherics and man-made static, and the ratio of signal to noise will become greater as the signal becomes weaker, until eventually the signal is rendered unintelligible. Supposing, therefore, that this state of affairs exists so far as the signal is concerned at the anode of the detector, and suppose that a stage of L.F. amplification is added, well, the result will be much the same only louder, and to all intents and purposes, the logging or entertainment value of the transmission is lost. This is, of course, an extreme case, but in principle it applies, and it is used to show that L.F. stages should not be added haphazardly under the impression that only the signal is going to be amplified.

It seems, therefore, that the better method would be to use a stage of H.F. amplification, so that the strength of the signal can be increased before it reaches the detector, provided some means are incorporated in the circuit to prevent the latter being overloaded when a powerful signal is received. Assuming that reception conditions are bad, as in the case of the L.F. example, the aerial will still be affected by the desired signal and the unwanted interferences, and it would seem that if both are amplified by the H.F. stage, then matters will be worse at the grid of the detector than before. Fortunately, however, it does not quite work out like that in practice. The H.F. stage will have the effect of making the circuit more sensitive and, bearing in mind what has been said in past articles in this series about selectivity, the ratio of amplification of signal and noise will swing over in favour of the signal, therefore that will become the more powerful of the two. This will be more readily appreciated if it is remembered that the greatest voltage to reach the grid of the H.F. valve—and in turn the detector grid—will be that whose frequency corresponds to the resonant frequency of the tuned circuits, and assuming that the aerial is tuned, there will be two tuned circuits to consider. Apart from this, the very fact that an H.F. stage has been inserted between the detector and the aerial will have the effect of increasing the selectivity of the detector's tuned circuit, as the damping normally imposed by the aerial will considerably be reduced. The voltages set up across the tuned circuits by the noise signals or interference will be small, as they will be off the resonant frequency, but even so, owing to the very nature and characteristics they do crash through when conditions are really bad.

From the above, it is safe to deduce that, for a straight set at least, the ideal line-up would take the form of 2-V-1, but unfortunately in practice two stages of tuned H.F. amplification are not too easy to secure. Little snags crop up in the shape of instability and ganging, etc., which so often result in the gain being reduced to such an extent to eliminate the troubles that better results can be obtained from one efficient H.F. stage. This brings the circuit back to 1-V-1, or, if care is taken in the design, 1-V-2. (Superhets are not being included in these considerations.)

An H.F. Unit

To enable the S.W. receiver described in the two previous issues to be extended to a three-valver, here are the details of an efficient unit. Its theoretical circuit is the same as that shown in Fig. 1, where it will be seen that provision has been made for a variable bias to be applied to the grid of the valve. This, in conjunction with a valve, either S.G. or H.F. pentode, of the variable Mu type provides a very satisfactory form of pre-detector volume control. In many circuits of the 1-V-1 type, the H.F. stage is untuned, but in this unit a switch of the low-capacity type has been incorporated, so that the aerial circuit can be tuned or coupled to the grid of the H.F. valve as an untuned circuit. This makes the arrangement more versatile and considerably simplifies tuning, as will be shown later.

Below approximately 40 metres, the actual gain secured by the use of an H.F. stage is small, but above that wavelength the value increases and becomes more evident, especially if the grid circuit is tuned. This does not mean that the valve acts solely as a "passenger" below 40 metres, as the over-all sensitivity of the circuit is definitely increased by virtue of the "buffer" effect—between aerial and the detector tuned circuit—already described. In practice, therefore, selectivity, sensitivity and reaction are improved, even with an untuned H.F. stage, and more so if it is tuned.

The Circuit

The aerial input, after passing through the small pre-set condenser, is taken to the moving arm of one of the single-pole double-throw switches. The other contacts on this section are taken to one end of the aerial coupling winding on the Eddystone four-pin coil and to one end of the aerial S.W. H.F. choke, thus allowing the aerial to be switched from coil circuit (i.e., tuned) to H.F.C. for untuned. The second section of the switch is another single-pole double-throw switch, and this is used to change over to the grid of the H.F. valve, to the grid coil and its associated condenser, or to the H.F.C. Both sections are combined in one switch unit, therefore they are ganged together, and the whole operation takes place when the switch knob is turned.

Across the grid coil is connected a 0.00015 mfd. variable condenser, but it should be noted that whereas the moving vanes of that component are returned direct to earth, the earthy ends of the coupling and grid coils are returned through a 0.01 mfd. fixed condenser. The fixed condenser is necessary as the coils cannot be connected to the common negative earth line in a direct D.C. sense, owing to the G.B. voltages being applied through them to the grid, but so far as the H.F. alternating voltages of the signal are concerned, the condenser offers little or no opposition to their return to the earth line.

If the variable condenser is fitted with a large diameter knob or, better still, a good slow-motion drive, there is little call for band-spread tuning as employed in the original detector circuit. However, if so desired, a band-spreader condenser, say 50 m.mfd., could be connected in parallel with the 0.00015 mfd., though it would be more advisable to use a 0.0001 mfd. for the band-setter in such instances, thus keeping the total capacity within the 0.00015 mfd. limits.

The screen electrode of the valve receives its H.T. potential, 60-80 volts positive, from a separate tapping on the H.T. battery, and an H.F. by-pass to earth is provided by the 0.1 mfd. fixed condenser. In the anode circuit, another S.W. H.F. choke is connected in series

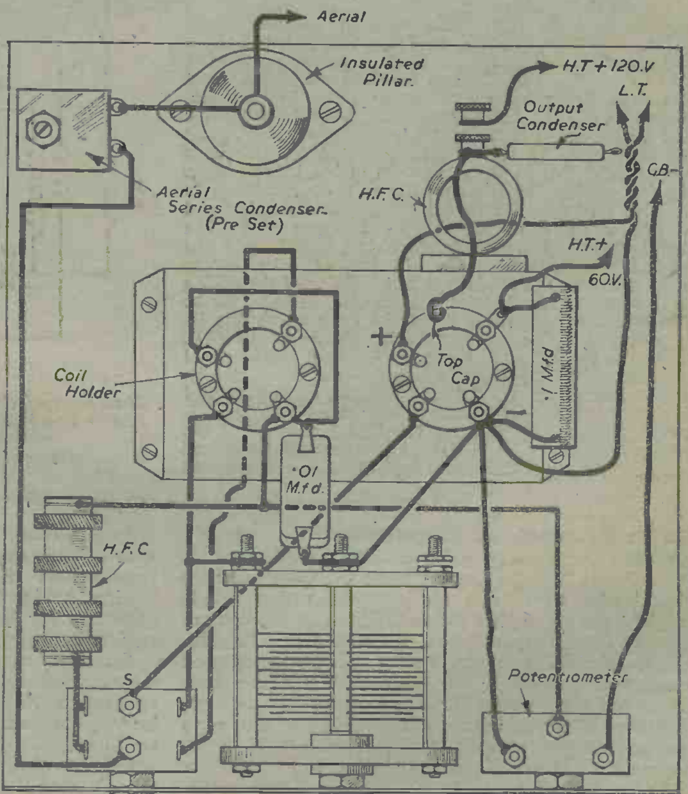


Fig. 2.—Wiring diagram and component layout of the S.W. H.F. unit. The coil and valve-holder platform allows the critical wiring to be kept short.

with the 120-volt positive H.T. supply line, and it is advisable to see that this component is of a different make or type from that used in the grid circuit, to prevent the possibility of them resonating or "peaking" at the same frequency. Should this occur, instability will result, the cause of which might not be too obvious. The output from the unit is taken from one side of the 0.0001 mfd. fixed condenser connected to the anode of the valve. The valve quoted is a satisfactory average, but if the detector tuned circuit, i.e., the original aerial circuit, is not fitted with an aerial series variable condenser, better coupling adjustment and selectivity will be obtained by replacing the fixed condenser with a variable. The output is taken to the aerial terminal of the receiver, while the aerial lead-in is connected to the aerial terminal on the H.F. unit. It will be noted that no actual earth connection is shown, as this is really unnecessary, as the earth return for the circuit will be secured through the L.T. and H.T. negative line, via the receiver.

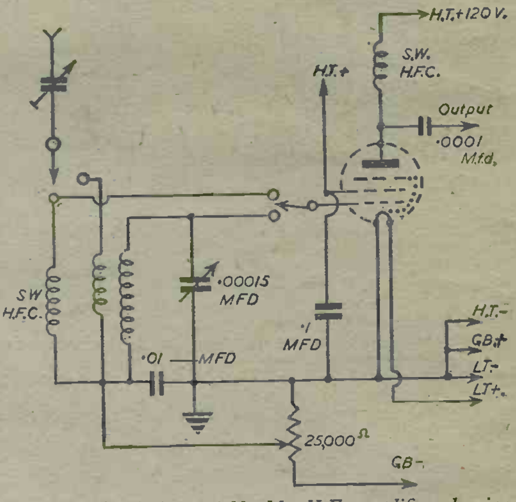
Construction

The illustration accompanying this article shows that the completed unit makes a neat and serviceable assembly, while the layout and wiring of the components are clearly depicted by the plan view, Fig. 2. The metal panel is 7in. × 8in. and the wooden baseboard is the same size × 5/16in. thick. To enable the coil and valve holders to be located close to the variable condenser, a small sub-baseboard or platform 5in. × 2¼in. × 5/16in. is supported on two metal brackets cut out of stout gauge tin plate. These are 2in. high with a ⅜in. wide turn at each end (in opposite directions) to form fixing strips. Cut the wood strip to size, smooth up and stain, and screw on coil and valve holders, noting position of grid terminals. Cut the two brackets out of tin, bend and drill fixing holes, and screw them to platform, taking care to see that all is square. After drilling panel and mounting on it the variable condenser, switch and potentiometer, fix it to baseboard, and for this it is always advisable to use some form of brackets to make the job rigid. Before fixing the coil, etc., platform in position solder to the switch the required number and lengths of 18 or 16 S.W.G. tinned copper wire. Fix the platform and then complete wiring, and if, as in the original model, bare copper wire is used, take care to make a neat job of the layout and bending of the wiring to remove any possibilities of short-circuits being made. The potentiometer must be of the type which has its spindle and fixing shank "dead," otherwise the G.B. supply to the grid will be short-circuited, as the panel is connected to the common negative line of the circuit. The switch also has a "dead" spindle, and consists of two single-pole double-throw actions, but, if so desired, one section can be dispensed with by connecting the grid end of the aerial H.F.C. to another aerial terminal and changing over the aerial lead-in when the untuned circuit is required. The switching method, provided the switch is of the low-capacity type, is obviously the better.

It should be noted that, although the anode H.F.C. and the output fixed condenser is shown fixed to the coil and valve-holder platform, these two components, in the actual model, are fixed on the right-hand inside of the case housing the unit. It is purely for clarity, and because the unit is out of its case, that the parts are shown fixed to the platform. A wooden case is used, and to the outside of the right-hand side of it is screwed a thin sheet of aluminium—perforated zinc will do—to form a screen between the H.F. and detector sections.

Operation

The battery supplies can be taken from the same batteries which supply the receiver, with the exception of the G.B. battery for the H.F. valve. It is advisable to use a separate one for this purpose. The H.F. unit can be placed close to the left-hand end of the receiver, so that all leads are kept reasonably short. Transfer the aerial lead-in from the receiver terminal to the aerial terminal on the unit, and connect the output condenser to the aerial terminal on the set.



The circuit of the variable Mu H.F. amplifier, showing how a tuned or untuned aerial circuit is obtained by switching.

(*To be continued.*)

Radio Gramophone Circuits

In our November, 1944, issue we published an article entitled "Radio Gramophone Circuits," and we would like to correct an impression this article might have given that the modulated oscillators are exempt from the provision of the Defence Regulations. We wish to make it clear that the modulated oscillators described are considered by the Post Office to be within the scope of Defence Regulations, Statutory Rules and Orders Nos. 1688 and 9 of 1939 and 1219 of 1943, which prohibit the acquirement, possession and use of transmitting apparatus without the specific authority of the Postmaster General.

As indicated in the article oscillators of this type are actually low power transmitters and readers will understand that the radiation set up by such apparatus cannot be confined within an ordinary dwelling house. There is consequently a risk of interference not only with reception of broadcast by neighbours of the user of such apparatus, but with vital Service communications that may be received on sensitive equipment in the vicinity. In the circumstances authority for the use of these oscillators has been withheld during wartime.

Our article was, of course, of a theoretical nature intended to explain the operation of certain circuits, and was not intended to convey to the reader that he may construct and use it. It would be an offence to do so.

Dispensation has, however, been conceded with regard to testing oscillators provided that radiation is suppressed by electrically screening the instrument and by the use of screened connections between them and the apparatus under test. It was, of course, this type of equipment which our contributor had in mind when writing his articles.—F. J. C.

The Royal School of Signals

Details of the Methods Used for the Higher Technical Training of Personnel

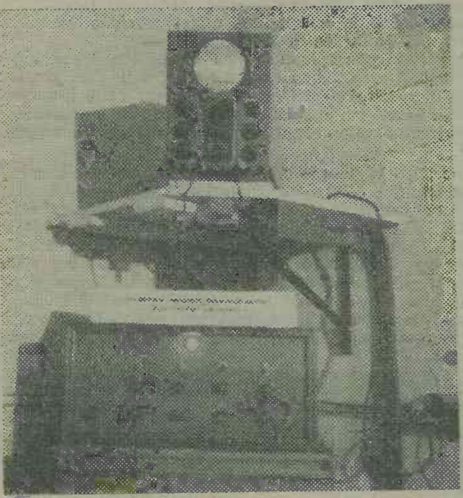


Fig. 1.—Fourier's analysis demonstration.

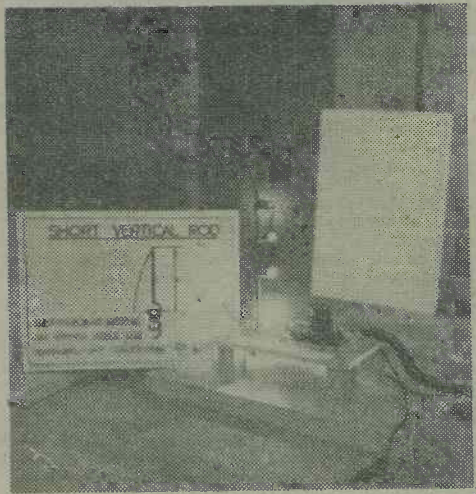


Fig. 2.—Current distribution in short vertical aerial.

THE School of Signals, located at Catterick, Yorkshire, is responsible for the higher technical training of personnel for the Royal Corps of Signals. In addition, the school provides courses of training for Instructors for all units of the Army. In passing, it may be noted that the training for recruits in the Royal Signals is taken care of by a separate organisation known as the Signal Training Centre.

Through the courtesy of the War Office an opportunity was recently provided for members of the Technical Press to visit the School of Signals to see the latest signalling equipment which has been adapted for army use, and also to visit the instructional laboratories where higher technical training is given in all branches of army signalling.

Details of the radio, telephone and telegraph signalling equipment will be given in a separate article. The following notes are devoted to the work of the School of Signals:

The school is organised into four wings.

In the Royal Signals Wing, which carries out the higher technical training, the principal courses are:

Officers' Adv. Lines Courses Officers' Adv. Wireless Courses	To train officers for higher technical appointments
Foreman of Signals Courses	To train highest type of technical NCO

There is little need to emphasise the important part played by commuuications in modern warfare. During the battle of El Alamein there were no fewer than 6,000 wireless sets in use. To-day the number of wireless and other types of signalling equipment is vast indeed, and the importance of thorough training for officers and NCOs who are concerned with the supervision of signalling equipment is self-evident.

Although most of the army signalling equipment now in use is from two to four years old in basic design, several noteworthy developments have taken place, notably in the field of carrier telephony. The British group modulated system enables four circuits to be obtained from two wires, whereas, until quite recently, the U.S. army has had to use four wires for the same number of circuits. This new development of group modulation provides one example of the need for thorough training of those who are to be responsible for its proper functioning under field conditions.

In this connection it may be mentioned that students of the different courses vary in rank from the brigadier to the lance-corporal.

During our correspondent's visit to the laboratories and demonstration rooms one basic fact applicable to all the courses was clearly evident. The guiding principle which had been followed in planning these instructional courses is:

(a) Practical demonstration by the instructor

(b) Practical experiment and manipulation of the apparatus by the student.

In one workshop laboratory, for instance, devoted to training in fault-finding and maintenance on field wireless sets, each student was provided with a set, whilst behind the instructor was displayed a large wall chart showing the conventional diagram of the set. As the instructor explained the function of each valve and other component, each student could identify the component on his set and could also observe the result of incorrect adjustment or functioning of any component.

Seated beside each student was another man who had already passed through the same course, which, incidentally, was an instructor's course. The class thus served a double purpose in providing the more advanced student with the necessary experience in instructing others. After the set operation and method of fault-tracing had been explained, the beginner students were sent out of the room whilst their instructors introduced a number of faults on each set. Five or six artificial faults were introduced into each set, and the students on returning were allowed a maximum of 15 minutes to restore their sets into perfect working order. A well-trained operator was expected to clear all faults in about six minutes.

Another example of the essentially practical methods employed was seen in Set Demonstration Room 2.

Here was shown a breadboard layout of a conventional superhet receiver for C.W. and R.T. reception on 4-8 mc/s.

Apart from the normal gain and tuning controls, optional negative feedback is provided for demonstration purposes. A motor is provided indicating AVC operation by two alternative methods.

A second meter indicates L.O. grid current over the range.

The layout is used (a) to demonstrate components; (b) to exercise elementary students in the application of circuit reading; (c) to demonstrate the effects of a particular fault or maladjustment.

In this case all the components of the set in question were laid out on a large board, the location corresponding to the conventional wiring diagram so that students had no difficulty in identifying components and taking readings at different points in the circuit to observe the effects of any fault.

Space does not permit of our dealing in detail with the laboratories devoted to voice frequency apparatus (which enables telephony and duplex telegraphy to be transmitted over a single pair of lines), or to the carrier laboratory in which instruction is given in the various types of carrier telephone equipment, enabling three or more telephone conversations to be conducted simultaneously over a single line.

The Demonstration Laboratory

Turning to matters of wireless interest, the engineering instruction demonstration laboratory has been planned to demonstrate to advanced students by means of the cathode ray oscillograph many of the fundamental theorems which formerly could only be appreciated by those having a knowledge of higher mathematics. One cathode ray set is designed to show the effects obtained by combining radio waves of different frequencies.

Five oscillators are used, working at frequencies of 1, 2, 3, 4 and 5 kc/s.; the relative phase and magnitude of each output may be varied, the phase variations covering at least one cycle. The outputs are connected in series to a CRO beam which shows the result of adding together a number of sinusoidal waveforms. Particular waveforms may thus be built up—e.g., square wave, rectified current, etc. A speaker may be connected across the output to demonstrate the fact that a change in the relative phase of two frequencies cannot be detected by ear.

Other cathode ray oscillograph tubes are fitted up to demonstrate the exponential curve obtained when a condenser is charged or discharged through resistance; and that damped oscillations occur if there is inductance in the circuit. The condenser can be discharged by a neon lamp or a valve connected across it. If the neon lamp is used, discharge will take place whenever the voltage across the condenser reaches the striking voltage of the neon lamp, causing it to flash at a rate which may be controlled by varying the series resistance. Alternatively the valve may be connected across the condenser; it is normally biased to cut-off, but conducts during the fly-back of the CRO beam, thus discharging the condenser.

A Novel Form of A.C. Bridge

For certain types of work in this laboratory it is necessary to have an accurate and rapid method of checking the output level from a valve oscillator. An ingenious modification of the well-known Wheatstone Bridge has been devised for this purpose.

The variable resistance arm of the bridge contains a small metallic filament lamp. The resistance of such a lamp varies according to the current passing through it, i.e., according to the temperature of the filament. The output from the oscillator is connected across two corners of the bridge and head telephones are connected between the other corners of the bridge. The output from the oscillator is then varied until no sound is heard with the telephone. This provides a quick and accurate method of checking the output level and obviates the need for a calibrated level meter.

Aerials Demonstration Room

Probably the most spectacular of the demonstration rooms is devoted to scale models of different types of aerials. This room has the floor covered with wire netting and sheets of wire netting are arched underneath the ceiling to simulate the heaviside layer. A valve oscillator generates a carrier wave of 150 mc/s.

The output from this oscillator can be fed into miniature aerials of various designs, e.g., dipole, vertical rod, horizontal rod. It can also be fed to a comparatively long transmission line which may be open circuited or connected to a load as required. To show the students exactly what is happening under various conditions two types of indicator are used.

One type consists of a pea lamp, the terminals of which are connected to a small ring aerial. The presence of a high-frequency electro magnetic field induces a current in the ring aerial and the brightness of the lamp provides indication of the strength of the electro magnetic field.

The other type of indicator is a pea lamp, the terminals of which are connected to a small capacitance. This detector responds to a high-frequency electro static field. When the carrier wave oscillations are applied to the transmission line the presence of a standing wave can be clearly demonstrated by moving either the current indicator or the voltage indicator slowly along the line immediately above or below it.

The presence of nodes and anti-nodes is shown by the lamps being extinguished or glowing brightly.

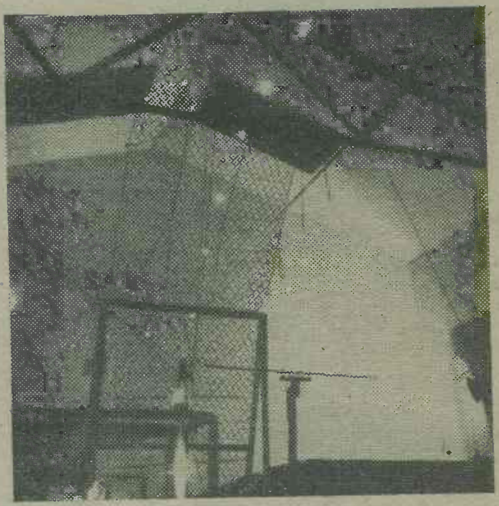


Fig. 3.—Polar diagram of dipole aerial. The brightness of the various lights indicates comparative strength of radiation in different directions.

By using one detector of each type it can also be shown that where the electro static field or voltage is maximum, the electro magnetic field or current intensity is minimum, and vice versa.

Generations of students have had to accept this as a fact because mathematical calculations showed that it must be so. The staff of the School of Signals have now devised a method making it plain to everyone whatever their mathematical acquirements may be.

The carrier wave from the oscillator can be fed into various types of aerials and small lamp indicators in various parts of the laboratory indicate the field strength and at the same time emphasise to the student the importance of erecting a field aerial in the correct manner if optimum results are to be obtained.

Fig. 3 illustrates the equipment being used to test the strength of radiation from a horizontal dipole aerial, whilst Fig. 2 shows the current distribution in a short vertical aerial which is being fed from the oscillator. The feed cable can be seen on the right of the picture.

Stand-by "All-dry" Receivers

Some Notes on the Construction of Simple Miniature Receivers

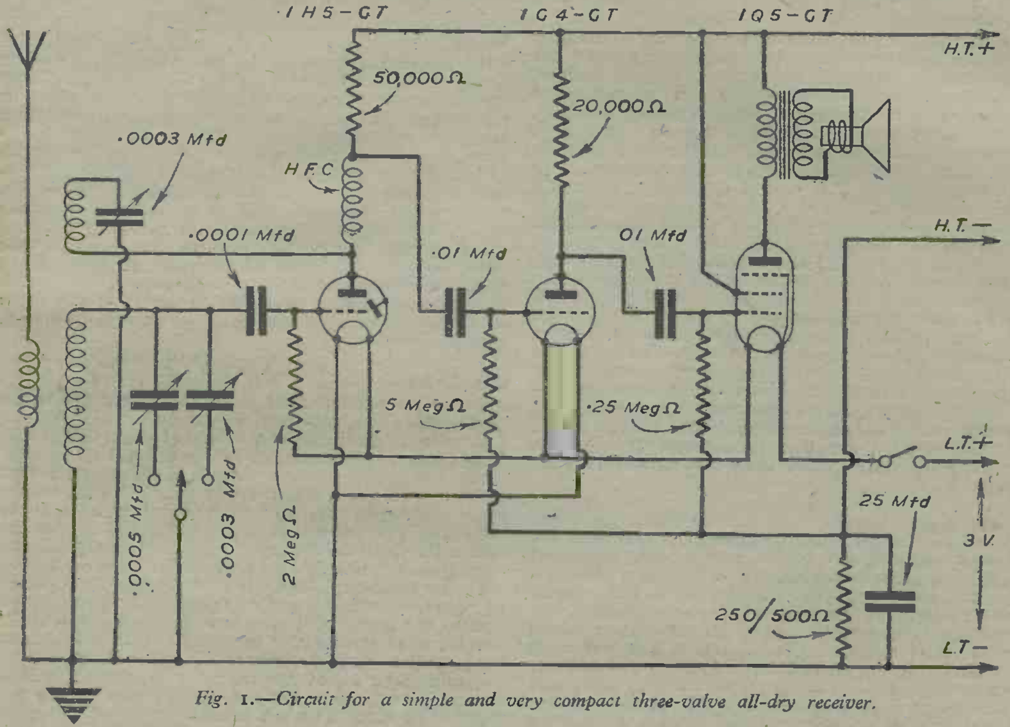


Fig. 1.—Circuit for a simple and very compact three-valve all-dry receiver.

THE chief disadvantages of so-called "all-dry" receivers are that they are not normally quite as efficient, valve for valve, as are other types, and that suitable batteries are not always easily obtained in present conditions. Because of the first-mentioned disadvantage it is generally necessary to use a superhet circuit if good reception of a wide range of programmes is required. In addition, it is generally necessary to accept a lower output than that expected from a mains receiver—or even from a battery set with 2-volt valves.

But to offset any disadvantages, the "all-dry" receiver has many important advantages, especially when easy portability and freedom from battery-charging troubles are important requirements. There are few amateur constructors to-day who would have any real fears regarding the construction of a superhet, provided that they could obtain suitable components. Unfortunately, the required parts have been in extremely short supply during the war, and many of them are virtually unobtainable.

A Compact Three-valver

In consequence, there is a good case in favour of making a "straight" receiver of the simplest possible type, which can be built around components that are in reasonably good supply. An "all-dry" three-valve receiver was recently made, using the simple circuit shown in Fig. 1. The object was to produce a very compact set that could be used anywhere, could be carried around easily, could be made almost entirely from components to be found in the spares box, and which would be very economical in the way of battery-current consumption. It was built in a box measuring about 6in. by 8in., but the overall size is governed largely by the types of battery available and the output required; if telephone reception only were required, the containing case need be no more than about 6in. cube.

The last point calls for an explanation. It is that these 1.4-volt valves can be operated, although at comparatively low efficiency, from an H.T. voltage as low as 9; with 22½ volts H.T. results are fairly good on a speaker in many areas. For good speaker reproduction, however, it is desirable to raise the H.T. voltage to 90. It will be seen that the overall size of the receiver is thus governed very largely by the voltage, and therefore the size, of the H.T. battery.

Pre-set Tuning

Having settled that point, we can look at the circuit and see how it differs from the usual three-valve battery set. A standard type of aerial tuning coil is used, and reaction is of the usual Reinartz type. Two pre-set tuning condensers are shown, however, with a single-pole-double-throw switch for bringing either into circuit. This arrangement is fairly convenient in these days of "Home and Forces only," although it can be criticised on the score that tuning is affected by the setting of the reaction condenser. But if the same aerial is used throughout, the two pre-sets can be adjusted separately with the reaction condenser set to its optimum point for each frequency.

If the two pre-set condensers are mounted on the back of a metal front panel drilled in line with the adjusting screws, readjustment as and when necessary is a simple matter. The two pre-sets and the change-over switch could, if desired, be replaced by a small tuning condenser of the ordinary type and rated at .0005 mfd. The reaction condenser is an ordinary bakelite-dielectric one, and is shown as having a maximum capacity of .0003 mfd. Should it be wished to operate the set habitually on less than 22½ volts it would be desirable to replace the reaction condenser shown by one of .0005 mfd.

Valve Types

The detector valve shown is a diode-triode, but only the triode portion is used, the diode anode being left disconnected. This type of valve was used because of its high amplification factor and low anode-current consumption. A standard triode is used as first L.F. amplifier and this is followed by a pentode with a rated maximum undistorted output of 270 mW. (with 90 volts H.T.). Decoupling is not used, and was found unnecessary when working from a 45-volt H.T. battery; should a higher voltage be used it may be found desirable to introduce a little decoupling in the detector anode circuit, but this is often not essential.

The speaker employed was a 3½in. P.M. moving coil. It was chosen because of its small dimensions and because it was easily obtainable, but a larger unit is better if space permits. It will be seen that automatic bias is provided for the two amplifier valves, this being obtained by the voltage drop through a resistor in the H.T.-negative line. The bias resistor is by-passed by a 25 mfd. electrolytic condenser of 25 volts rating—one of the few types of electrolytic condenser not normally very difficult to obtain. Due to the use of resistance-capacity coupling throughout, there is no need for transformers other than that attached to the speaker.

Filament Connections

It will be noticed that the filament connections are somewhat unusual, due to the valves being connected in series-parallel. The first two valves have filaments which take .05 amp., while the filament of the pentode takes 0.1 amp. This method of filament connection was chosen simply because it was found convenient in the receiver under consideration to employ a 3-volt cycle lamp battery for supplying L.T. This battery would just fit conveniently into an odd corner of the set; two metal contact strips were fitted to the side of the wooden box and a metal stirrup was fitted so that the battery could easily be pressed into place, and just as easily removed for replacement. If it were preferred to use a 1.5-volt cell the valve filaments would be wired in parallel. The method of connection shown, however, offers another slight advantage, in that the bias supplied to the output valve is slightly higher than that to the triode because its filament is 1½ volts positive in respect of the earth line.

Grid Bias

Reverting to the question of bias voltage, it will be seen that the bias resistor is shown as having a value between 250 and 500 ohms. This value is not critical, but it is better to use the higher value for H.T. voltages over 60, while the lower one is to be preferred for lower voltages. If the set were to be operated on an H.T. voltage of less than 22½, it would be best to remove the bias resistor and by-pass condenser entirely, and to connect the grid leaks from the two amplifier-valve grids directly to earth.

Coil and H.F. Choke Data

For those who wish to make the coil, the following details will be helpful. Use a 3½in. length of 1¼in. diameter paxolin tube and wind on 110 turns of 30-gauge enamelled wire for the grid coil; this will take up a length of about 2in. Cover this with a piece of Empire cloth, oiled silk or shellac-varnished paper and wind on 50 turns of similar wire for the reaction winding. About ⅛in. from the top (grid) end of the grid winding commence to wind on 30 turns of the same kind of wire to provide the aerial-coupling coil. If all three windings are in the same direction, the connections to the coil will be as follows: upper end of aerial winding—earth; lower end—aerial; upper end of grid winding—grid; lower end—earth; upper end of reaction winding—reaction condenser; lower end—detector anode.

The H.F. choke can be made by winding 500 turns of 30-gauge or 36-gauge enamelled wire on a small spool formed by fitting two 2in. diameter fibre or stiff cardboard discs on a ½in. length of paxolin tube of the same diameter as that used for the coil.

Valves

In Fig. 1 the valve types shown are for American components, but the 1H5-GT (or G) could be replaced by an Osram HD14 and the 1Q5-GT (or G) could be replaced by an Osram N14, if available. Various other combinations of valves are possible, but that shown proved very satisfactory. For example, the triode shown in the first amplifier stage could be used as detector; the output pentode could be a 1C5-GT (or G). Alternatively, pentodes such as the 1A5-GT could be used in the first two stages by connecting their auxiliary grids directly to the H.T. positive line. If this were done, however, it would be desirable to increase the anode load resistor in each case to at least 100,000 ohms, and it would then be necessary to use an H.T. voltage of not less than 45 if reasonably good, signal strength were to be obtained.

The Aerial

So far, no particular reference has been made to the aerial. This can, naturally, be merely a 20ft. length of "throw-out" insulated wire. On the other hand, it may be possible to use a normal indoor or outdoor arrangement. Obviously, the best possible aerial should always be used, as there is "nothing to spare" in the way of aerial efficiency. If a "throw-out" wire is to be employed the pre-set tuning system will be useless, due to the fact that the aerial will have slightly different capacities each time it is used. A useful hint in connection with the tuning condenser is that a midget component of .00015, or even .0001 mfd., may be used by arranging a fixed condenser of similar capacity to be switched in parallel with it in order to cover the wavelengths of both medium-wave programmes. If the Home Service programme on about 450 metres is required it will be necessary to increase the number of turns on the grid winding by about 25 when using this method of tuning. With this number of turns it should be possible to tune to both 291 and 450 metres, using the .00015 mfd. condenser alone.

It is desirable to use an earth lead when convenient, but this is not essential. A good earth will tend to increase signal strength, however, and will also remove any trouble due to hand-capacity effects.

YOUR POST-WAR RECEIVER

COMPETITION RESULTS

THE competition set in the October issue, in which readers were invited to give their specification for Post-war Receivers, produced an enormous entry. The judges have now completed their task of analysing the specifications sent in and of deciding which, by popular vote, was the type of wireless receiver likely to prove most successful after the war.

The various features are set forth below in the order of popularity decided by the voting:

TYPE .. .. Radiogram
Table Model (Horizontal)
Table Model (Upright)
Portable
Console
Transportable

POWER .. .. A.C. ..
A.C./D.C.
Battery

WAVEBAND .. Medium Short and Television Sound
Medium and Short
Medium
Long

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

DIAL MARKING Both
Wavelength
Station Names
Frequency

LOUDSPEAKERS High Fidelity
Electro Magnet
Permanent Magnet
Dual Speakers

REFINEMENTS Tone Control
Switching for Internal and External Speakers ..
Tuning Indicator
Gramo. Attach.
Designed for Quality, Reproduction and Mediocre selectivity
Separate Speaker
Remote Control
Automatic Volume Control
Variable Selectivity

Only one reader sent in an entry with a specification agreeing with that decided by the voting, and accordingly he takes first prize. There was a tie for second place, and so we have increased the prize list, so that each of those tying for second place receives two guineas.

FIRST PRIZE £5 . 5 . 0

Norman Dean, 22, Redruth Street, Rusholme, Manchester.

TWO PRIZES OF £2 . 2 . 0

E. W. Palmer, 34, Greenwood Close, Thames Ditton, Surrey.
G. Thompson, c/o G.P.O., West End, Southampton.

W.B. SPEAKERS

Charles B. Cox, 13, Forfield Road, Coventry.
J. Rowson, 49, Woodstock Road, Leicester.
G. J. Stowe, 194, Bacchus Road, Winson Green, Birmingham, 18.
B. Wilson, 41, Curzon Road, Southport, Lancs.
P. B. Longton, "Garth Howe," 31, Black Bull Lane, Broughton, Nr. Preston.
A. Earnshaw, 52, Hilton Lane, Litton Hulton, Nr. Bolton, Lancs.
E. J. A. Booth, 11, Burntwood Grange Road, Wandsworth Common, S.W.18.
N. B. Greenall, 31, Wood Lane, Prescot, Lancs.
F. H. Duggins, 11, Edgware Road, Stockland Green, Erdington, Birmingham, 23.

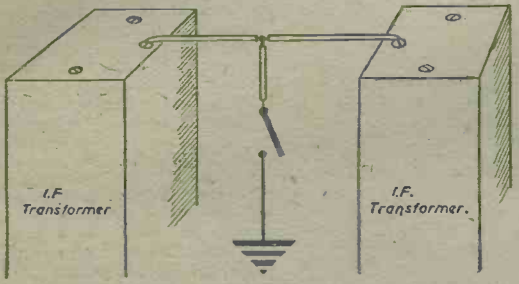
BOOKS

R. S. Moyle, Hilltop, Pennsylvania Hill, Exeter, Devon.
R. L. Eastleigh, 38, Radnor Terrace, South Lambeth Road, Vauxhall Park, London, S.W.8.
Mrs. H. Duff, 4, Hailliday Grove, Upper Armey, Leeds, 12.
A. S. Evans, 56, Malden Court, West Barnes Lane, New Malden, Surrey.
S/Lt. (A) Holt, R.N.V.R., 170, Fort Austin Avenue, Crownhill, Plymouth.
A. J. Hatton, 34, Beckett Avenue, Mansfield.
F. Thorneloe, Robinsons Cottage, Union Street, Burton-on-Trent, Staffs.
D. W. Binge, 250, Waterloo Street, Glodwick, Oldham, Lancs.
R. Lawson, 182, Manchester Road, Newcastle-upon-Tyne, 6.
1015403 L.A.C. Robertson, J. A., Radar Section, R.A.F., Tuddenham, Bury St. Edmunds, Suffolk.
J. McCrorie, 3, Hamilton Street, Kilwinning, Ayrshire.
T. H. F. Wagstaff, 59, Dumbleton Avenue, Leicester.
J. C. Flind, 15a, Borneo Street, London, S.W.15.
J. Martin, 252, St. Clair Street, Kirkcaldy, Fife.
W. Grimmer, 1, Western Road, Eastdene, Rotherham.
C. E. Matthews, 50, White Avenue, Langold, Nr. Worksop, Notts.
F. R. Bull, 9, South Lodge Drive, Southgate, N.14.
115197 Sgt. Plater, 43, Timber Hill, Norwich, Norfolk.
P. Pardey, 13, Thorpe Hall, Eaton Rise, Ealing, W.5.
G. E. Duffin, 15, Marlait Lane, Redditch, Worcs.
E. L. Simpson, 4, Gray Street, Workington, Cumberland.
J. D. Leggett, 9, Stoats Nest Road, Coulsdon, Surrey.
N. A. Chatelain, 11, Raglan Street, Hulme, Manchester, 15.
G. Stratfull, 52, Radcliffe Road, Harrow Weald, Middx.
O. Heggs, Junior, The Briars, Fulshaw Avenue, Wilmslow, Cheshire.
T. Price, High Street, Patingham, Wolverhampton.
1678 T. Elholm, R.N.A.F., 50, Hanover Square, Manningham Lane, Bradford.
J. Westgate, 1056, Harrow Road, Willesden, N.W.10.
A. McAulay, 46, Roberts Street, Patricroft, Nr. Manchester, Lancs.
Wring, F. H., 624077 Cpl., Elect. Sect., R/1, 83 G.S.O., R.A.F., Bognor Regis.
E. Lowe, 33, Monks Walk, Penwortham, Preston, Lancs.
H. H. Barnes, 14, Darrel Street, Liverpool, 5.

Practical Hints

Receiving C.W. on a Superhet

MANY broadcast superhet receivers incorporate short-wave bands, but unfortunately no provision is made for the reception of C.W. signals. In most of these receivers there is not sufficient space to build a B.F.O. A simple dodge for overcoming this difficulty is to couple the two I.F. transformers by means of a short length of insulated wire. It is not necessary to connect this wire in any way. In the case of I.F. transformers where the "flying lead" is not used, it is sufficient to thread about ½in. of wire through the hole normally occupied by this lead, taking care to use no force.



Coupling two I.F. transformers for receiving C.W. signals on a superhet.

The centre of this wire may be earthed through a switch when the B.F.O. is not required. This stops the feedback. The note may be adjusted by a slight manipulation of the I.F. trimmers. This has no appreciable effect on the set as a broadcast receiver

The form of coupling may be varied to suit the type of I.F. transformer in use, but it has never been found necessary to make any direct connection.—J. DANIEL (Callington).

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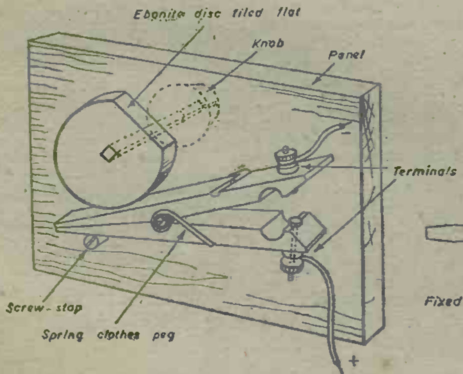
>
> All hints must be accompanied by the coupon cut from page iii of cover.

An Improvised L.T. Switch

THE accompanying diagram shows how a simple, but efficient, L.T. switch can be made from a few parts out of the junk-box. The contacts are made from a spring peg and two terminals bolted securely at each end. The switch is operated by means of a spindle fixed to an ebonite disc, part cut away as shown. A knob is fitted after assembling the parts to enable the disc to be turned.—R. KING (Dagenham).



A simple L.T. switch made from odds and ends.

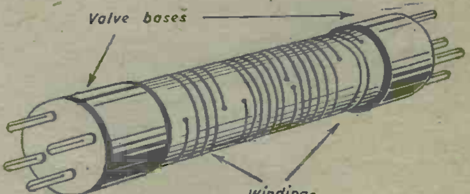
Double-ended Plug-in Coil

I HAVE found a way by which I can have a coverage of four coils, on my short-wave set, by only using two coils.

The coil former is made by winding thin cardboard to fit tightly into a valve base socket, which supplies the connecting pins for plug-in purposes. One of these sockets at each end of the cardboard makes a rigid former, and if this is made sufficiently long, two sets of windings may be wound on it and connected to the opposite ends. Thus the one coil covers two wavelengths.

The coils containing two windings and four prong sockets, for simple regenerative sets, may be made 4in. long to accommodate the two sets of windings. Coils containing three windings and six prong sockets should be 5ins. long.

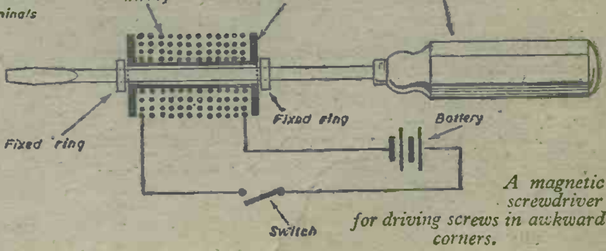
When the coils have been wound, the connecting wires should be soldered to the valve base pins, and the ends of the former cemented into the bases to make the assembly rigid.—T. C. IRVING (Shrewsbury).



A double-ended plug-in coil.

Magnetic Screwdriver

I RECENTLY constructed a midget set for my bicycle, and after the first trial I discovered the loudspeaker was loose, owing to the loss of two screws. To replace them I would have had to dismantle the cabinet, and as this trouble often happens I decided to construct a magnetic screwdriver. I used one of the long variety, but the idea will do equally well for any sort. I fixed on to it a bobbin which was free to rotate between two fixed rings, or collars. If steel screws are used then they will stay fixed to the end of the screwdriver when a current is passed through the coil. The current is switched off when the screw is in position, in order to avoid accidental extraction and excessive use of the accumulator.—H. O. WILLIAMS (Esher).



A magnetic screwdriver for driving screws in awkward corners.

Direct Disc Recording—3

Systems Used for Cutting the Blank

HAVING discussed the requirements for a good quality blank, we come to the question of cutting the blank. The author would like to say at this point that it is essential to obtain consistently satisfactory results with unmodulated grooves before even considering the question of any actual recording.

Constant Amplitude or Constant Velocity?

One point we must decide upon is the relationship between the stylus movement with modulation displacement and the amplitude of the modulating signal. This relationship may be either of two distinct types; i.e., constant amplitude or constant velocity.

The first type means that, given a constant input

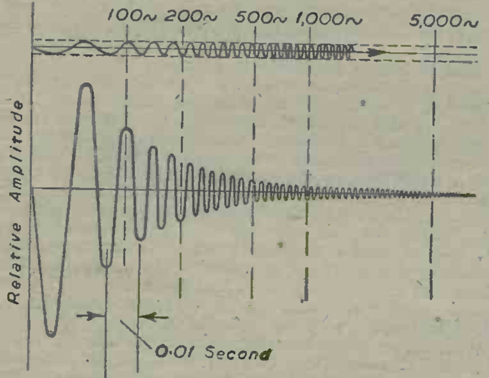


Fig. 1 (a)—Constant amplitude waveform; (b) Constant velocity waveform.

to the cutter head the amplitude of the cut will be constant regardless of frequency. In other words, the stylus will move the same distance to right and left of an imaginary centre line regardless of frequency and will speed up on the higher frequencies so as to travel the additional distance required to execute the increased number of cycles per second. It will be seen, therefore, that increased power must be applied to the cutter head as the frequency increases to maintain the required amplitude.

In the constant velocity types of recording the stylus travels at the same speed, but swings out widely on the lower frequencies, shortening its travel on the higher, so that it covers the same linear distance. Fig. 1a shows the wave pattern of a constant amplitude type of recording and Fig. 1b that of a constant velocity.

Which system we are to use? Before making a decision let us discuss both systems in a little more detail. No definite reason for not choosing one method as a standard can be given. There are many who advocate the constant amplitude method because they say it gives an apparently greater volume range and better signal noise ratio under certain conditions; furthermore that a crystal cutter and playback unit without any equalisation will cut a constant amplitude record and give first class reproduction so that all the bother of frequency correction, equalisation and compensation is cut out. On the other hand a record so cut cannot be reproduced on the more usual playback systems using constant velocity characteristics.

Against this is the fact that all commercial records and those made in the "private studios" and in fact practically all records have always been made using a constant velocity characteristic, or strictly speaking a modified form of constant velocity. There is no reason to suppose that there will be a general change over to constant amplitude, although it is quite possible that for home uses, certain laboratiory uses, and even inside self-contained organisations, such as a broadcasting station where recordings are made for internal use only, the use of this system may become more general.

The home enthusiast, at any rate, for all practical purposes, would do well to stick to the more conventional modified constant velocity system and rest content in the knowledge that he is in the majority and can deal with all the more usual classes of records.

Modified Constant Velocity

The reader will no doubt wonder, after saying that there are two systems to choose from, why we discard one and complicate things by talking about a modification of the other. Let us therefore clear this point and see why such a modification is necessary.

We have already seen that the constant velocity system depends upon the stylus swinging out widely on the lower frequencies and shortening its travel on the higher ones. If we look again at Fig. 1b we see that the lower end of the scale as compared with the higher end has a very considerably greater relative amplitude. We must prevent the lower frequency response from being too great, in other words we must put a limit on the amplitude, or volume which we can record and this limit must be the amplitude of the lowest note we wish to record. If we do not do this and we desire to increase the volume of the record we should be in danger of the low frequencies increasing to such a size that one groove would cut into the next. As an example let us take a 1,000 c.p.s. note and let us fix the amplitude at which this is to be cut at 0.004ins. Reference to Fig. 2 will show the basic conditions we have described. The distance A-B is 0.004ins., the amplitude of the cut. C-D is, as we learnt in Article 1, page 446, one cycle and as we have chosen a frequency of 1,000 cycles per second, this represents 1/1,000 of a second. As we have already learnt, if we employ a constant velocity characteristic the amplitude is inversely proportional to the frequency. Therefore the amplitude of a 500 cycle note, providing the input to the cutter is kept constant, would be double that of the 1,000 cycle note, or in terms of inches, 0.008. Likewise, that of a 2,000 cycle note would be half that of the 1,000 cycle note, or 0.002in.

It will therefore be seen that the lower frequencies, using a constant velocity characteristic, will be increased in amplitude in direct proportion to the frequency reduction. All records have some background noise, whether the groove is modulated or not, and we have to arrange that the recorded matter is of such a volume as to overcome sufficiently this inherent background noise and so produce a good signal to noise ratio. If we do this with the constant velocity characteristic, it will be

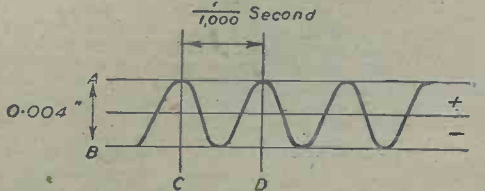


Fig. 2.—Diagram illustrating the amplitude waveform of a single note.

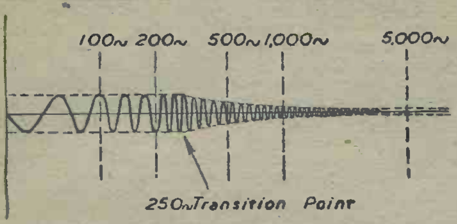


Fig. 3.—Modified constant velocity.

seen that, as the higher frequencies will be of very small amplitudes it will be necessary to increase the amplitude until a sufficient volume level is obtained for satisfactory playback and that when this is done, the low frequencies will have been increased to such an extent that the grooves will cut over.

Compromise

It is therefore necessary to make some form of compromise and this is achieved by using a constant velocity characteristic from the highest frequency down to some point in the region of 1,000 cycles per second or lower in some cases. In actual fact this point varies between 250 c.p.s. and 1,000 c.p.s. with perhaps 400 c.p.s. being the most used. Below this point a constant amplitude characteristic is used with a loss of approximately 6db per octave. All these figures vary slightly depending upon the conditions of recording and playback and the ideas of the company or engineer in charge. Fig. 3 shows a modified constant velocity wave pattern. The frequency range of the normal commercial records is in the order of 60 c.p.s. to 6,000 c.p.s. with a transition point about 250 c.p.s. below which a drop of about 6db per octabe is used, being some 18db down at 60 c.p.s. Above the transition point the response is reasonably level to about 4,500 c.p.s. when it begins to fall off to some 10db down at 6,000 c.p.s. Modern tendency is rather to record more top above the 1,000 c.p.s. mark so as to make the resulting recording more brilliant and capable of being used with a top cut to reduce background noise. Even so the shellac pressing is a very poor specimen above 5,000 c.p.s. when compared with a modern well recorded direct disc which is capable of first class reproduction up to at least 8,000 c.p.s. with ordinary care and can easily be extended to 10,000 and even 12.000 c.p.s. The question of frequency response and the "ideal" recording characteristic will be discussed more fully when we come to the question of playback, because it is obvious that it is no use recording what cannot be correctly reproduced.

Having decided upon a modified constant velocity characteristic, we must ask ourselves if there are any other limitations we must look for before discussing the shape and size of the groove we are going to cut. The answer is "Yes," there is the limitation of the inside groove diameter which we can cut for a given maximum high frequency. This will be gone into thoroughly in the article dealing with playback and reproducing needles, etc., but it should be mentioned at this stage, as it affects the actual recording.

Suppose we draw a straight line from the outer edge of the disc to the centre as X–Y in Fig. 4. If the disc is revolving at the standard speed of 78 r.p.m., or, of course, at any other speed, any point on the line X–Y we care to choose will take the same time to complete one revolution, but we know that the speed at the outer edge of the disc is much greater than that at the centre. Now, suppose we draw a line A–B, representing a frequency of, say, 5,000 c.p.s. at the outer edge and at C–D representing the same frequency, but recorded nearer the centre. We shall see that A–B takes the same time to complete one revolution as does C–D, but that A–B has much more material between its ends for the stylus to engrave the wavelength of the frequency being recorded than has C–D, and that at a point still nearer the centre E–F it is seen that so greatly is the groove compressed that it would be impossible for a playback needle to track the groove, even if it could be properly cut. We see, therefore, that there is a definite limit to the inside diameter at which we can record for successful reproduction. We must not forget that whatever we record must be capable of being traced by the stylus of the playback which we are going to use.

The generally accepted "inside diameters" are 7½in. for 33⅓ records and 3¾in. for 78 r.p.m. records, although the author prefers a 4in. minimum for the actual recorded matter on the 78 r.p.m. records. A few figures will perhaps be of interest to the reader at this stage, concerning the groove or spiral lengths, linear speeds of the disc, etc. An average 12in. disc has a spiral at least 600ft. in length and the linear speed at the outside edge is of the order of 240ft. per minute, whilst at the innermost diameter 86ft. per minute. The figures given in Table 1 for tangential velocities are only approximate, and serve as an indication of the varying speeds to be expected. The reader who would like to work out his own speeds should use the following formula:

$V=\frac{\pi D}{60}N$ where V=needle velocity in in. per second. D=diameter of recording in in. (*not* the disc). N=the number of revolutions per minute of the disc, and π=3.1416; the resulting figure will be in in. per second.

Outside to Inside, or Inside to Outside?

Another point to be considered is the question whether to record from outside to inside, or inside to outside. Let us consider the merits and demerits of each method before making a decision. Gramophone records in all countries have always used the outside to inside method, and a habit has been established that would be very difficult to break, especially if one considers the number of automatic changers and automatic stops in general use. The system has only one other point in its favour, and that is, that if one starts recording at the outside, no matter how short the recording is, the best part of the blank will be used, i.e., the part from the outer edge to about half way to the centre, where the higher linear speed is helpful to good reproduction.

With direct disc recording, cutting outside to inside means that some form of swarf remover is essential, otherwise the stylus will foul the swarf which is thrown towards the centre and tends to stick to the blank due to the electrostatic charge peculiar to "acetate" discs. If we cut inside to outside the swarf is left behind, and no trouble is experienced at all. So much for the mechanical considerations.

From the electrical point of view, inside to outside has an advantage in that when playing back the new stylus has a better chance of tracing the compressed waveform found at the centre of the disc, particularly of the higher frequencies, than it would have on a disc cut outside to inside, where it would have been subjected to wear for the greater part of the record. The author must explain here that the reader must not confuse this point with the question of the ability of any one reproducing needle to reproduce any specific high frequency, which is governed more by the radius of

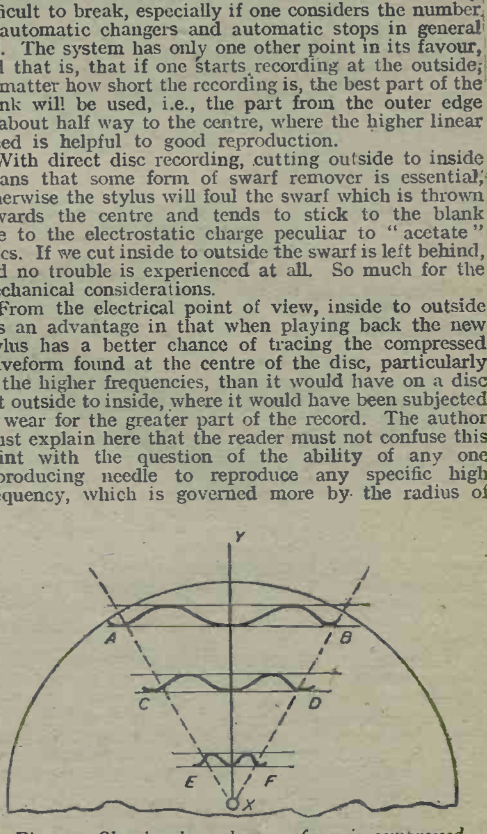


Fig. 4.—Showing how the waveform is compressed as the recording approaches the centre.

curvature of the groove and the stylus tip than by the groove wavelength, a point we shall discuss more fully in the article dealing with playback. In this particular instance we take it for granted that we have recorded on the disc only that which it is possible to reproduce, and which we wish to do with the minimum amount of loss, particularly towards the centre of the disc. The reader may have noticed when playing commercial records a tendency towards a falling off in quality, and in volume, particularly of the higher frequencies, when approaching the centre of the recording. This is sometimes referred to as "centre fading," and is due to the inability of the reproducing stylus tip to follow the waveform found at the centre of the record.

To the home user and the recordist who can use a suitable playback the author recommends without any hesitation the use of the inside to outside method of cutting as being the easiest and most suitable in every way for direct disc recording. The point about using the best part of the disc should not arise if the matter to be recorded has been properly rehearsed and timed. It is just as easy to start at a given distance from the centre, so as to be sure to use all the best part of the blank as it is to stop at a given distance from the centre when using the outside to inside method.

Playing Time

The amount we can record on a disc, and, hence, the playing time, is, of course, governed by the size of the

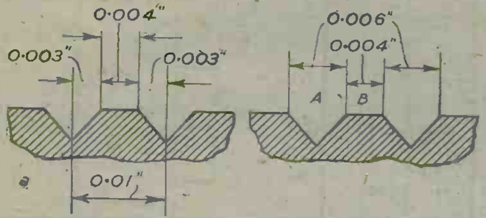


Fig 5 (a).—See text; (b) Normal cut for 96/100 cuts/inch. Known as a 60/40 cut.

disc and the speed at which it revolves. But there is another factor, and a very important one, which must be considered; that of the number of lines or grooves per in. that we record. If we record a large number of grooves per in. the disc will play longer than if we use a smaller number. The reader will probably think that is such an obvious fact as not to be worth mentioning, but the author wishes to emphasize that there are definite limitations to the number of grooves per in that can be cut.

Commercial records are fairly standard at 96/100 per in., although 112 and 120 are frequently used in direct recordings. Table 2 gives an indication as to the playing times at different grooves per in. for the usual sizes of discs.

The number of groove per in. which can be recorded is governed to a great extent by the amplitude used. As stated earlier, it is necessary to record as great a volume as possible so as to give a good signal to noise ratio. It will be obvious, therefore, that if we keep the amplitude to a minimum and the grooves per in. to a maximum a point will be reached when the signal noise ratio becomes too low for good reproduction. This occurs at approximately 150 grooves per in. for lateral recording, using the conventional sized recording and playback stylii.

It should be mentioned here that a considerable amount of experimental work is being carried out on the application of recording and reproducing stylii with smaller tip radii, but as there are already enough variables in disc sizes, speeds and grooves per in., etc. the author is doing no more than mentioning this point, as to go more fully into it in this series of articles would only confuse the main purpose.

As an example of the inter-relationship of grooves per in. and amplitude, let us assume that we have a standard recording machine set for 100 grooves per in. Each groove is, therefore, 0.01 in. from the next. The usual groove width is 0.006in., so that the total uncut part or "land" between grooves will be 0.04in. This is known as a 60/40 cut, and is the usual for 96/100 grooves per in. This expression as a percentage is of no value unless the grooves per in. are also stated. Looking at Fig. 5 we see that from the centre of one groove to the centre of the next is 0.01in., i.e., half one groove 0.003in. plus land 0.004in. plus half next groove 0.003in. If the amplitude is 0.004in., then there is 0.002in. on each side of an imaginary centre line. The 0.004in. amplitude + the 0.006in. groove width = 0.01in., so that the groove walls must meet, and would represent the maximum amplitude. In actual fact, this condition could not be used, and a smaller amplitude would have to be chosen, so as to leave sufficient wall between grooves. Fig. 5b shows the correct groove cut; A being 0.006in. and B the wall or "land" of 0.004in. This latter will be dependant on grooves per in., but the groove width should not vary from 0.006in., except in special circumstances with which we are not at present concerned.

In the next article we shall go further into the cutting of the groove, and deal fully with the cutting stylus, its size, shape, life, etc.; the cutting-head, angle, weight and general design.

TABLE 1

Table Showing Tangential Velocities at Various Parts of a Record. Speeds in inches per second.

	78 r.p.m.	33⅓ r.p.m.
Inside	16.25	13.5
Middle	31.5	20.5
Outside	46.5	27.5

These figures are approximate, but show the average speeds which can be expected under normal conditions.

TABLE 2

Table Giving Approximate Recording Time for Various Sizes of Blank Cut at 96 or 120 Grooves per inch.

No. of grooves per in.	r.p.m.	8in.	10in.	12in.	16in.
96	78	2-15	3-30	4-30	
	33⅓	—	—	—	13
120	78	2-50	4-20	5-50	
	33⅓	—	—	—	16

No figures are given for 33⅓ speeds below a 16in. disc as there is little point in using a disc smaller than 16in. at this speed. Likewise no figures are given above a 12in. disc at 78 r.p.m. as the speeds at the outer edge above these figures are reaching too high a figure for safety under normal conditions. The figures given take into consideration a minimum centre diameter for recording of 7½in. at 33⅓ and 4in. at 78 r.p.m. They will vary slightly under differing conditions, but can be taken as being perfectly safe to work to, allowing ample margin for run in and run out grooves. Times are in minutes and seconds.

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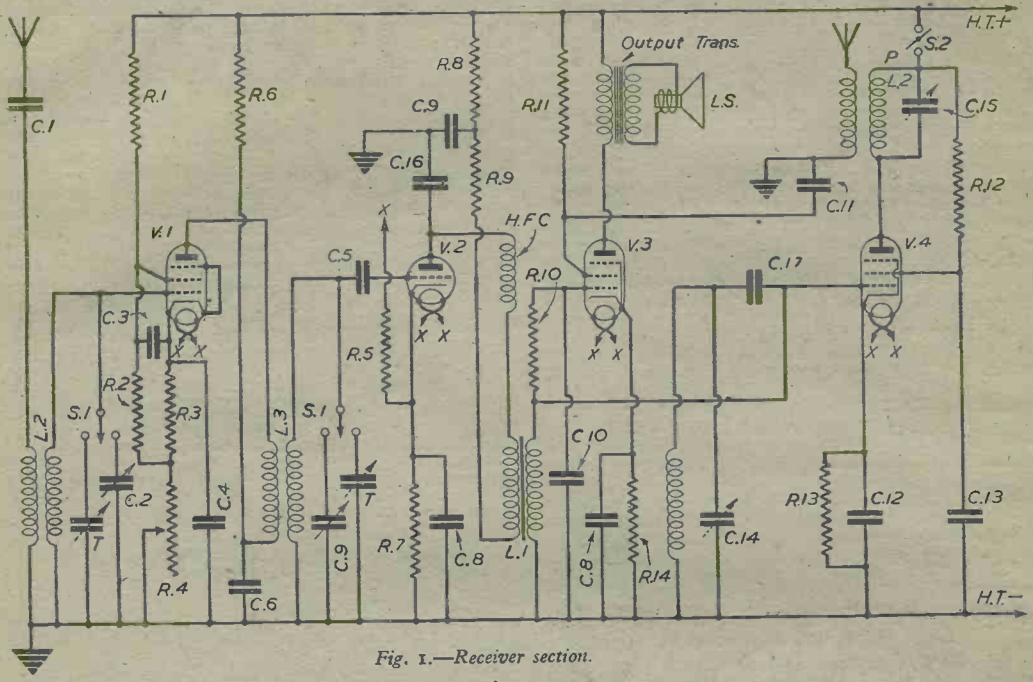

Fig. 1.—Receiver section.

THIS receiver can be used for sending messages or music to other rooms in the house and affords a good deal of practice in simple and practical construction. If there are any weak sets in the house which are unable to pick up low power stations, such as the A.E.F., with any strength, the receiver can be used to pick up the weak station. (*See page* 50.)

Provision is made for gramophone and microphone inputs, the volumes of both being controlled by a single control. Push-button tuning is employed as well as tuning by means of a variable condenser. Three of the six buttons are used for tuning to different stations and the other three are for mike, gramophone, and variable condenser.

A set of valves from the Mullard "E" series are found very satisfactory for the receiver as they are both small, and screened. They are also quite easy to obtain. Wearite coils are used and these should be placed on top of the chassis. Four are required. The coils should not be screened.

Power Supply

The mains transformer should have a secondary capable of giving 250-0-250 volts at 120 mA., and also 6.3 volts at 3 amps. If a 6W5G cannot be obtained, any equivalent will be satisfactory. If a six volt full wave rectifier is unobtainable, a four volt one will have to be got. For this valve another winding will be necessary on the secondary. Smoothing is straightforward, using two electrolytics and a low frequency choke. Care should be taken to see that the electrolytics are connected the right way round and are not internally broken down, or else damage to the rectifier will result. If the heater winding is centre-tapped the tapping should be connected to earth. The circuit is shown in Fig. 3.

The Circuit

The receiver is quite straightforward and a circuit of it is shown in Fig. 1.

A trimmer may be used instead of C1, but a .0001 mfd. is quite satisfactory when using a short aerial. All switches marked S1 are taken off the push-button unit. By pushing one button, two switches should operate—one for the aerial trimmer and one for the H.F. trimmer. Different stations may be tuned into by different settings of the trimmers. A variable-mu H.F. pentode is used for the first stage—the EF5. This has its bias altered by R4 and thus alters the volume of output. The EBC3 is used as a detector employing a leaky grid. The two diodes in the valve are left unconnected. A good quality intervalve transformer should be used to drive the output valve—the EL2. This valve gives all the power needed for normal use and drives a 7in. moving-coil speaker with ease.

Secondary Section

Before attempting to operate the secondary section, first make sure that the receiving section is working well. The switch S2 (which should be of the QMB type) should be switched on with a milliameter in position P. (After the transmitter is tuned the milliameter may be removed.) A current will be seen in the meter. Tighten trimmer C14 till nearly tight; then slowly tighten C15 until the meter needle suddenly falls to about half the original reading. Continue to tighten slowly until a minimum reading is obtained. The valve is now functioning. Whatever station is

(*Continued on page* 63)

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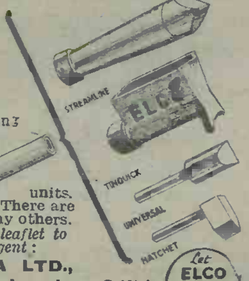

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Fig. 2.—Switching arrangement.

being picked up by the receiver will be being retransmitted on the wavelength set by the trimmers. When the valve is transmitting the audible output of the set will drop very low. This is because the power is being taken by the output valve. The most satisfactory wavelength from the point of view of not being near other stations is about 250 meters.

First try transmitting with no aerial and if the power is not sufficient, increase the length by about 2yds. at a time. After each change in length of the aerial it may be necessary to alter the trimmers slightly before obtaining a minimum reading on the milliameter. The secondary of the coils should be used when wiring up and the primary for the transmitting aerial only.

Construction

In constructing the set try to get as many of the components as possible under the chassis. All the coils, however, should be on the top. Size of the chassis should be about 12 by 8 by 1½ins., if the mains section is to be built separately, and correspondingly larger if it is built on the same chassis.

For all inputs and outputs the use of jacks and jack-plugs is advised as this leads to both neatness and simplicity. The trimmers should be mounted firmly under the chassis with the buttons protruding through the side of the chassis. This involves a lot of accurate drilling, but it is worth it from the point of view of a strong job.

Single strand push-back wire is very satisfactory for wiring, but if the constructor prefers tinned copper wire and systoflex, the wire should not be thinner than 20 gauge s.w.g. The EF5 and the EBC3 are coated with metal screening, which is connected to the No. 1 pin. This should be connected to the chassis.

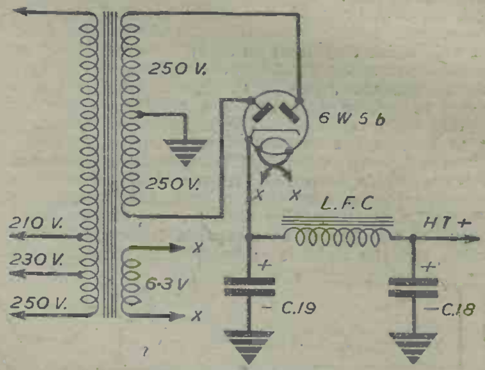


Fig. 3.—Power circuit.

If unsatisfactory results are obtained with an ordinary aerial (which is very unlikely) try connecting the aerial to a radiator. This may improve reception and will confine all the signals to the house.

All the values of resistances and condensers need not be strictly adhered to, alterations in value being left to the constructor himself.

LIST OF PARTS

Condensers:
- Five .0001 mfd. mica (C1, C5, C10, C16, C17).
- Three .1 mfd. tubular (C3, C4, C13).
- Two .5 mfd. tubular (C6, C11).
- One 2 mfd. fixed (C9).
- Two 8 mfd. 450 volt electrolytic (C18, C19).
- Three 50 mfd. 25 volt electrolytic (C8, C8, C12).
- One .0005 mfd. variable condenser, with trimmers (★2 gang).

Resistances:
- Five 30,000 ohms ½ watt (R1, R2, R8, R9, R10).
- One 3,000 ohms 1 watt (R6).
- One 1,000 ohms 1 watt (R7).
- One 200 ohms 1 watt (R3).
- One 1 meg ½ watt (R5).
- Two 7,000 ohms 1 watt (R11, R12).
- Two 250 ohms 2 watt (R13, R14).
- One 10,000 ohms wire wound potentiometer with switch (R4).
- One 1 megohm potentiometer.

Miscellaneous:
- One H.F. Choke.
- One L.F. Choke, 20 Henries.
- Three Wearite Coils, PA2.
- One Wearite Coil, PHF2.
- One Intervalve transformer.
- Valve bases, wire, sleeving, chassis, etc.
- One Mains transformer, 250-0-250 volts 120 mA.; 6.3 volts 3 amps.

Valves:
- V1 EF5 Mullard Side Contact.
- V2 EBC3 Mullard Side Contact.
- V3 EL2 Mullard Side Contact.
- V4 any 6 volt output pentode or tetrode.
- V5 6W5G (Octal).
- One 6 push-button tuning unit, with two banks of switches.

"Front" and "Back" Wave Reception

Another Angle on Aerials

SHORT-WAVE listeners will be aware that the aerial system has a profound effect upon the results achieved. High frequency technique obeys certain unalterable laws, and we must arrange the aerial to fit in with these laws if the best reception is to be secured.

The laws themselves, in regard to a length of wire suspended in space above the earth (an aerial) are quite simple. They have to do with the nodes of voltage at various points along the length of wire, the voltage being, of course, picked up from the distant station. All aerials have these nodes; but not all utilise them to the best advantage.

Vertical Aerials

Consider the case of Fig. 1. This represents a vertical aerial, half a wavelength long, the lower end going to earth through the receiver. When a wavefront strikes such an aerial it induces equal E.M.F.s all over the aerial. Now it can be taken as a general rule that an aerial is only efficient, as a supplier of voltage to the receiver, if the E.M.F.s are out of step at various points along the wire, corresponding to the A.C. nature of the wave. How then is it possible for a vertical aerial to act?

The solution of this problem is simple. Assuming the velocity of propagation of a wave disturbance in the wire to be that of light, a finite time will be taken before the cause at Y produces an effect at Z, and by the time it arrives it will be lagging 180 deg. on a disturbance starting at Z, since the distance is half a wavelength. The waves from intermediate points will arrive at Z lagging by intermediate angles, the whole causing the E.M.F. at Z to vary.

Such an aerial would be omnidirectional, that is, would receive equally well from all directions. This is not a desirable feature in an aerial for some purposes, since there are whole stretches of territory from which no signals emanate (such as the North Pole) and it is desirable to receive well from one particular direction in certain circumstances. The majority of amateurs trust to luck in the erection of their aerials, "front" and "back" wave orientation being equally unknown. This is deplorable, because a properly designed aerial is no more trouble to erect than a haphazard one.

"Front" wave reception will, for the remainder of this article, be defined as reception from the chosen direction, i.e., the aerial is so designed that it offers the maximum pick-up from the "front."

The null effect due to the lagging waves from the upper end of the wavelength aerial can be countered by tilting the aerial forward in the direction of the transmitter. When this done (Fig. 2) and when the bottom of the aerial is half a wavelength farther away from the transmitter than the top of the aerial, the induced voltage at Y will be 180 deg. ahead of that at Z; the latter will therefore be lagging in phase, and will give the best reception. The E.M.F. will be at a maximum when the tilt is such that the length of the wire is half a wavelength longer than the distance between a point immediately below Y (Fig. 2) and Z.

Now suppose that through considerations of space we are compelled to make the length of the aerial, say, .7 of a wavelength, or approximately 44ft. The length of the wire should be still half a wavelength longer than the distance between a point on the ground immediately below Y, and Z; this implies that the tilt is altered to a more acute angle towards the vertical.

Since the tilt angle will only be correct for waves advancing from one direction, it is clear that the aerial has directional properties, and these can be put to good use.

Fig. 3 illustrates the addition of a second tilted wire, the whole forming an inverted "V." One side of the aerial is earthed through a resistance, which may be of 400 ohms. Each side of the inverted "V" is one wavelength long, and the same relationship with regard to the spacing of the top and bottom ends of the aerial is maintained as with the single wire.

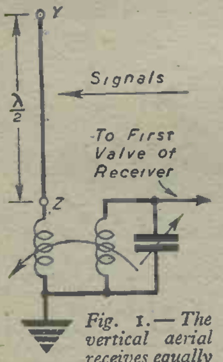


Fig. 1.—The vertical aerial receives equally well from all directions.

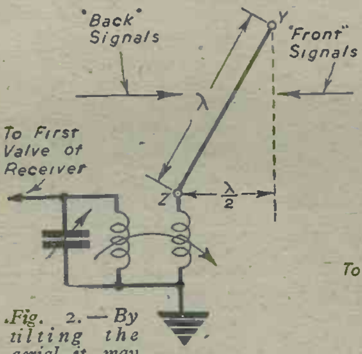


Fig. 2.—By tilting the aerial it may be made more responsive to front waves.

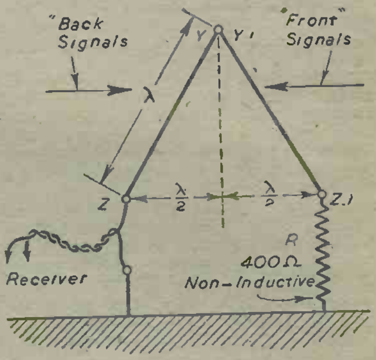


Fig. 3.—The V-type aerial.

It can be stated that a horizontal aerial is the least satisfactory for S.W. working. To be effective and directional, the horizontal aerial should be several wavelengths long, and obviously this is impracticable for normal use. The strongest signal will be received from a transmitter situated in the direction along which the long wire points. If one end of the aerial is terminated in a resistance, a signal arriving from the opposite direction will initiate oscillations in the wire in a direction travelling away from the receiver; in this case the energy of the back wave will be absorbed by the terminating resistance, and the pick-up at the receiver will be very small or negligible. For a transmitter situated at right angles to the length of wire serving as an aerial, equal in-phase E.M.F.s will be produced at points at different distances from the receiver, and the strength of the signals will be relatively weak.

A much more promising type is the tilted wire aerial, which may be regarded as the logical development of the horizontal aerial. If the wavefront is not tilted downwards, or if there is no horizontally polarised component of the wavefront, very little effect will be produced in the horizontal aerial. It must be tilted up to meet the wave, and for best results the angle of tilt is quite a definite one.

In Fig. 1 we saw that the best results were secured when the vertical aerial was half a wavelength long. That is, the E.M.F.s lagged 180 deg. as between Y and Z. It is easy to see that if the wire were a wavelength long the lag would be 360 deg. and there would be no field at the foot of the aerial.

In Fig. 3, the wire tilted towards the transmitter has a phasing of induced voltage which lags progressively from Y to Z. In the wire tilted away from the transmitter the voltage leads from Y_1 to Z_1. Considering the two wires separately, this means that the effect at the top of one wire is the same as that at the bottom of the other; in other words, the two elements of the "V" are additive in the proper phase relation.

This gives an increase in signal strength, and in addition the inverted "V" may be arranged to give good "front" and "back" wave reception; or it may be so arranged that back waves are almost entirely cancelled. In front wave reception, travelling waves are set up in the direction of the receiver, and waves from the other direction are absorbed in the resistance, R. In back wave reception travelling waves will proceed towards R, where their energy is absorbed.

Practical details: In Fig. 1 the lead-in from the lower end of the aerial should be as short as possible. The same applies to Fig. 2. In those cases where the location is suitable, an inverted "V" type aerial may be erected by using the chimney of the house as the apex of the "V," the sides going down on either side of the house to ground level. In this case a long lead-in is inevitable, and it will be necessary to fit a weatherproof transfeeder at the foot of the aerial, or to take the connection by twisted cable, as in Fig. 3.

Television Practice—1

Basic Principles, Simple Picture Transmission and Theory of Scanning. By S. R. KNIGHT

THE end of the war in Europe will mark the beginning of the television era in the realms of radio science. It could be said that it will mark, not the beginning, but the continuation of television from that point in 1939 where it had to be abandoned. Undoubtedly it will with regard to commercial design and manufacture, but from the point of view of the man in the street the early post war period will be marked as the real beginning of popular "everyman's" television. All the great behind-the-scene advances and improvements to television technique built up in specialised form during the conflict will ensure that television of the future will become as popular as the commonplace cinema and sound-only radio of to-day.

This short series of articles is written to cover the principles and practice of the system of television which

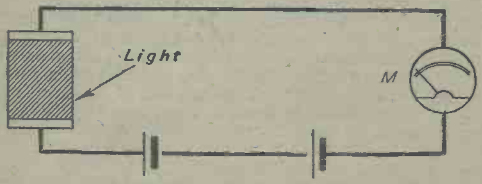


Fig. 1.—A simple selenium cell causing current changes in accordance with the intensity of incident light.

is most likely to be encountered after the war. While they will therefore concentrate mainly on the system of wholly electrical transmitting and receiving devices, brief notes on mechanical ideas and simple light-sensitive cells will be included in order to provide a groundwork upon which the more advanced techniques may be based and understood.

The electrical transmission of a picture depends upon the principle of systematically exploring the picture area and transmitting at each instant a current that is proportional to the light intensity received from the small area undergoing exploration at that instant. A picture or a scene cannot be transmitted en bloc; elementary exploration is necessary in order to obtain the electrical counterpart of all the shades and tones making up the complete picture in a form that may be used to modulate the aerial current of the transmitter. At the receiving station the received electro-magnetic energy is amplified and detected in the more or less conventional manner, and is then employed in such a way that a spot of light, moving over a screen by successive elementary areas corresponding to those at the transmitter, is varied in intensity in accordance with the changes in the magnitude of the received energy, i.e., is proportional at any instant to the light intensity of the small area being explored at that instant by the transmitting device. By speeding this process of systematic exploration up to a sufficient degree the effect of a motion picture is obtained after the manner of cinematography, a series of complete areas, or frames, being presented to the eye in rapid succession. This is where television as it is generally inferred, differs from the radio transmission of a "still" photograph, though the fundamental principles are exactly the same in both cases.

Light Sensitive Devices

Selenium is an element whose electrical resistance is affected by light; a simple selenium cell consists of a small plate of some insulating material such as mica or glass coated on one surface with a thin, even layer of the element. When such a cell is connected in circuit as shown by Fig. 1, electrodes making contact with each end of the selenium layer, the reading of the micro-ammeter M will vary with the intensity of illumination falling upon the selenium, becoming greater as the light intensity becomes greater, and less as the light intensity becomes less. The increase of current (decrease of selenium resistance) accompanying an increase of illumination takes place, however, more rapidly than does the decrease of current (rise of selenium resistance) accompanying a decrease of illumination. This time lag is a disadvantage of the selenium cell, which is otherwise quite a sensitive device. The use of the name selenium "cell" is apt to be misleading, for the device is not a cell in the sense that it is a source of electrical potential and e.m.f. but merely a resistance with the unique property of changing its ohmic value in accordance with the intensity of the light incident upon it.

Another, and perhaps more common, light-sensitive device depends for its action on what is known as the

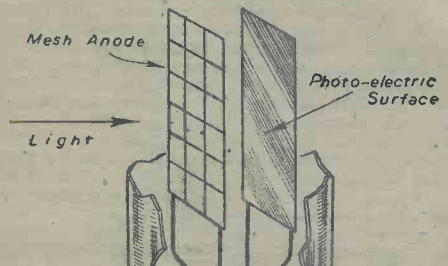


Fig. 2.—The construction of a simple photo-electric cell.

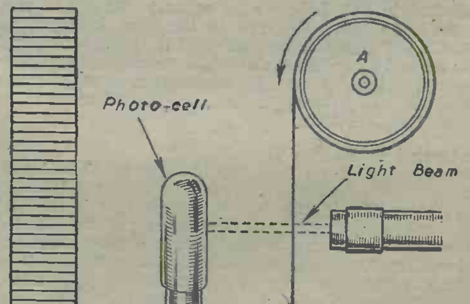


Fig. 3.—How a narrow strip of paper marked by horizontal lines may be electrically transmitted to a distance receiver.

Fig. 4.—How a picture area is covered by a system as in Fig. 3.

"photo-electric" effect, and for this reason is called a photo-electric cell. When light is incident upon certain substances, particularly caesium, potassium and other alkaline earths, some of the electrons in the metals acquire such high agitation velocities that they break away from the surface and are emitted into the space surrounding the material in a manner similar to the escape of electrons from the heated filament of a thermionic valve. The more intense the light the greater is the rate of electronic emission and a space charge quickly gathers over the surface of the material.

By arranging a "cathode" plate, coated with the metal caesium (or one of the other photo-electric substances) in an exhausted glass bulb with a skeleton "anode" consisting of a coarse mesh or grid facing its active surface as shown in Fig. 2 a form of photo-electric cell is made. A battery connected between anode and cathode as the figure depicts maintains the anode at a high potential with respect to the cathode; therefore when light falls upon the inner surface of the cathode the electrons released are attracted across to the positive anode and an electric current flows round the external circuit in the direction indicated by the arrows. An increase in the intensity of the light results in a greater number of electrons being emitted from the caesium, and therefore in an increased circuit current. The photo-electric cell is, in fact, a light controlled diode, the variations in anode current being brought about not by changes of anode voltage but by changes of light intensity incident upon the cathode.

When connected into a circuit such as Fig. 1 the photo-electric cell behaves in exactly the same way as a selenium cell, variations in the light falling upon it causing variations in the reading of the micro-ammeter. It has an advantage over the selenium cell in that there is no appreciable time lag consequent upon sudden changes of light intensity; but, on the other hand, it is much less sensitive.

Introduction to Picture Transmission

Suppose that a long strip of thin paper is marked with dark horizontal bands in the manner shown in Fig. 3A and a picture of this strip is to be transmitted electrically to a distant receiving station. A simple piece of apparatus may be set up as shown in Fig. 3B, where the paper strip is fed mechanically between the spools A and B, passing on the journey between a strong source of light and a light sensitive cell. As the strip moves steadily from A to B the intensity of the light falling upon the cell varies with the shading of the strip, these light variations being converted by the cell into corresponding electrical changes. These current variations are amplified and transmitted in the ordinary manner to the receiving point where they are detected and fed to a form of electric lamp whose brightness they are made to control. The light from this lamp is focussed on to a strip of light sensitive paper moving between spools at exactly the same speed and in the same manner as the paper strip at the transmitting end. When the process is completed the strip is developed by chemical means as is an ordinary roll film and a replica of the original horizontal bands appear upon it.

This is the basic principle of all picture transmission whether it is known under the name of television or otherwise; the example clearly shows the necessity of a systematic exploration of a large area before it can be practically transmitted. A simple extension of the above system enables us to send a complete picture on the principles we have already discussed. Suppose that a black-and-white still photograph is to be transmitted, its measurements being, say, 10in. long by 6in. wide, and that the beam of light passing through it to the the light sensitive cell is cross-sectionally rectangular in shape, say $^1/_{10}$th inch by $^1/_{10}$th inch. Then, if the photograph passes once vertically downwards across the beam in the manner of the strip above, a strip of irregular shading, 6in. in length and $^1/_{10}$in. in width will be transmitted (or rather, its electrical counterpart will) from the sending aerials and duly recorded at the distant receiver. But this is only one small part of the photograph; to transmit the complete thing it must be passed downwards across the light beam 100 times. moving $^1/_{10}$in. sideways after each vertical traverse, The whole area will then have been covered in the manner shown by Fig. 4, 100 successive strips, each variously shaded, having been transmitted in the form of electro-magnetic waves whose intensity is varying in accordance with the amount of shading. The receiver detects these waves, amplifies them, and causes them to control the brightness of some form of electric lamp in the manner mentioned above. A sensitised photographic plate, or paper sheet, is moved vertically downwards before this lamp, whose light is focussed on to an area of the plate measuring $^1/_{10}$in. by $^1/_{10}$in., exact synchronism being maintained with the transmitter regarding the rates of movement both vertically and horizontally, so that 100 strips, each 6in. in length and $^1/_{10}$in. in width, are caused to lie side by side over the area of the plate. At the end of the process the plate is developed photographically and a facsimile of the original picture is obtained upon it.

The process of exploring a surface to obtain a current that varies with time in accordance with the light intensity of successive elementary areas of the surface is known as scanning. All forms of television involve one system of scanning or another, the area of the light spot, or *aperture*, which is exploring the surface generally being very small in relation to the complete area of the picture. This condition is essential if what is known as aperture distortion is to be avoided. It is fairly obvious from the simple example treated above that the finite size of the light spot cutting through the photograph at the transmitter introduces distortion by making it impossible to transmit details finer than the area that the cross section of the beam represents, in our case $^1/_{10}$in. by $^1/_{10}$in.$=^1/_{100}$sq. in. Consider a clearly defined chess-board as the area being scanned by a spot of light of the same size as one of the squares (Fig. 5). As the light spot moves, say, from left to right, it will be seen that the *average* light intensity of the area enclosed by the spot varies *gradually* instead of abruptly from bright to dark, thus causing the receiving device to produce a distorted, or muffled, pattern as shown in the second diagram of Fig. 5.

(To be continued.)

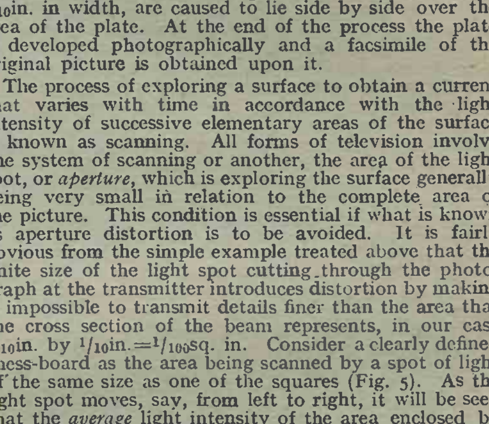


Fig. 5.—A chess-board pattern before and after transmission, showing the effect of aperture distortion due to the finite size of the scanning spot.

Sound Amplifying Equipment—5

Two, Three and Four Input Mixer Circuits

(*Continued from page 10, December issue*)

AN essential part of any sound amplifying equipment capable of satisfying general requirements is an efficient mixer which will control the volume of and blend two or more inputs. It is possible for a suitable circuit to be incorporated in a pre-amplifier, or, if separate pre-amplifiers are used for the various input lines, it can be built in the main or power amplifier section. A third method is to make a mixer unit or panel as a separate item, thus allowing it to be brought into use on the particular circuits which call for mixing, and providing greater flexibility or versatility as regards the equipment. Much, of course, depends on the design of the sound amplifying apparatus, the chief uses to which it will be put and whether or not additional input lines are likely to be handled. Different opinions exist as to what forms the ideal arrangement, and as most operators seem to have their own personal fancies, the writer is not going to attempt to make an issue out of such divergence of views, but rather explain the various circuits, as distinct from how they are embodied, which can be used. To avoid repetition, the letters A, B, C and D are used to indicate the various inputs, and a safe average value for the potentiometers across such inputs can be taken as 0.25 megohms.

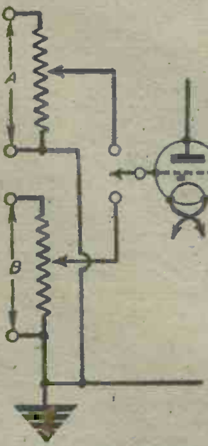


Fig. 1.—Two distinct input circuits, each having their own volume controls. Only suitable for switching from one circuit to another. No mixing.

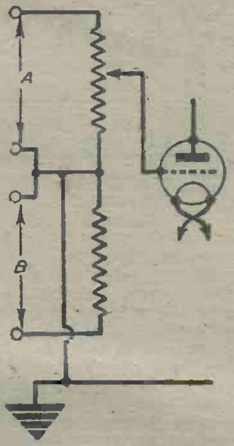


Fig. 2.—No switching required as use is made of a "fader" type volume control. This allows fading from one input to another but not mixing.

Two-circuit Change-over

The simplest form of two-circuit input control is shown in Fig. 1, where it will be seen that A and B have their own independent volume controls, and that one or the other is brought into the grid circuit of the input valve by means of a simple single-pole change-over switch. This system cannot provide mixing, but a skilful operator might produce quite reasonable fading, though there is always the danger of the switch click being heard, or an appreciable break in the continuity of the fade-over. It is, of course, quite suitable for use when the needs merely call for one circuit or the other.

Two-circuit Fade-over

This is shown in Fig. 2 and it is preferable to Fig. 1, inasmuch that it will do the work of the first arrangement, i.e., control A or B, plus the provision of a perfectly satisfactory fade-over from A to B or vice versa, but it will not provide mixing of the two. The two resistance elements usually take the form of one strip of, say, 0.5 megohms, fitted with a centre connection which forms the zero setting for the two halves of 0.25 megohms. The component, is, to all intents and purposes, identical in shape and size with a normal potentiometer, except for the additional soldering tag provided for the centre-tap connection. Owing to the above, and its simplicity of operation and wiring, it forms a very useful and effective item, and should always be embodied in any input system concerned with, say, two gramo pick-ups.

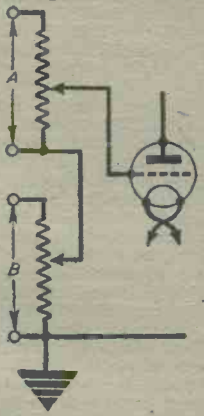


Fig. 3.—The simplest form of mixer circuit, suitable for two inputs. Provides volume control, fading and mixing.

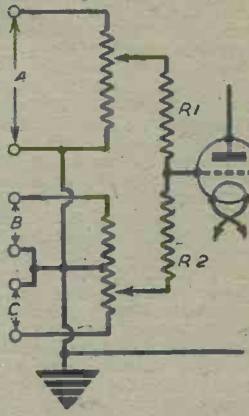


Fig. 4.—A three input arrangement mixer on two and fader on two. Better than that shown in Fig. 3.

Two-circuit Mixer

The circuit shown in Fig. 3 can be considered as the most simple arrangement which will provide actual mixing of two inputs, and while it is quite widely used, it cannot claim to be highly efficient. There is always a tendency for "top-cut" to be present on the B input, while both sides of A are more likely than not to be

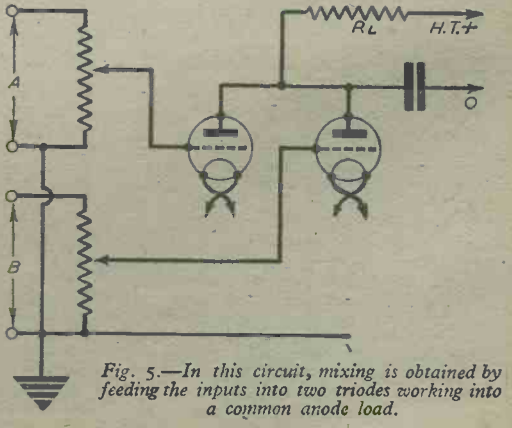


Fig. 5.—In this circuit, mixing is obtained by feeding the inputs into two triodes working into a common anode load.

above earth potential, and unless considerable care is taken with the wiring and screening, hum can be introduced into the grid circuit. All leads should be screened, and if the potentiometers are of the metal cased type the cases should also be earthed, but it is always advisable to make tests in individual arrangements, and avoid more screening than is necessary, otherwise the capacity to earth set up by such methods may have an adverse effect in the form of providing a by-pass for the higher frequencies.

Two or More Inputs

A system which can be used on two or more input circuits is shown in Fig. 4. The scheme depicted caters for the mixing of two-three channels, plus fade-over on two. The "fader" used on B could, of course, be replaced by an ordinary potentiometer, in which case, plain mixing would be obtained on only two inputs. It is usually worth while to make B a fader, as this increases the applications of the whole circuit, by making possible the following combinations: Mixing of A and B, or A and C. Fade-over between B and C, or A and B or A and C. It will be noted in this arrangement, that the earthy end of each control is tied down to earth potential by a direct connection, a very desirable feature to ensure perfect stability and reduction of hum. The grid of the input valve cannot be shorted to earth, even when the controls are in their minimum position, owing to the resistors R1 and R2, which should have a value of 0.25 megohms with the potentiometers mentioned in the opening of this article. Another advantage offered by this method is that it can be applied to more than two inputs, and it lends itself to the construction of a neat and compact unit, which, if so desired, could incorporate a single-stage pre-amplifier. It is suggested that the assembly be housed in a metal case, suitable plugs and jacks being used for the individual inputs and output. A unit such as this, with or without valve, will be found most useful, as it can readily be introduced into the input channel to allow additional lines to be controlled.

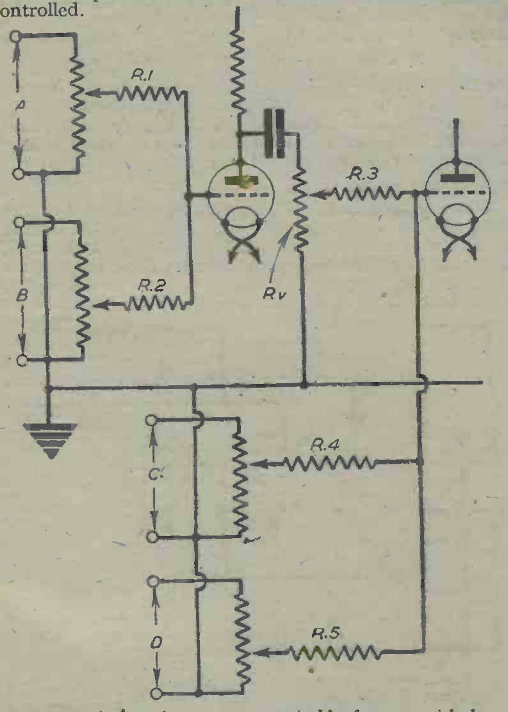


Fig. 7.—A four input system suitable for use with low and high inputs, and good mixing.

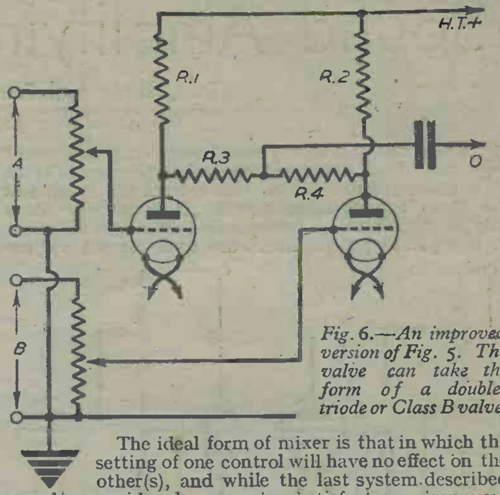


Fig. 6.—An improved version of Fig. 5. The valve can take the form of a double-triode or Class B valve.

The ideal form of mixer is that in which the setting of one control will have no effect on the other(s), and while the last system described can be considered as very satisfactory, improved operation will be obtained if the controls could be isolated from each other. This desirable feature can be achieved quite easily by feeding the inputs into two valves having a common anode load and output. The simplest form is given in Fig. 5, where it will be seen that A and B are each fed into the grid circuit of independent triode valves, the anodes of which have a common anode load R_L, and output condenser. To obviate the necessity of using two valves, etc., it is usual to make use of one of the double-triode or Class B types of valve, as these operate under such conditions quite satisfactorily, and, of course, simplify the constructional work. There is one main snag with the circuit as shown in Fig. 5, and that is, the voltage output has to be on the low side if distortion is to be avoided. This is due to the fact that the anodes are in parallel and the anode load is common to both. However, this trouble can be overcome by a slight rearrangement of the circuit, which brings us to Fig. 6. In this, it will be seen that each anode has its own load resistor R1 and R2, and the anodes are isolated from each other by the high-value resistors R3 and R4. The output condenser is taken to the junction point of these two components. Suitable values are in the region of R1 and R2, 100,000 ohms each, and R3 and R4, 500,000 ohms each. The inputs A and B are controlled in the normal manner, and appreciable gain is obtained from the triode sections. Pentodes can be used in place of triodes; in fact, greater efficiency will be obtained, and if the valves are of the high-efficiency type, the circuit given in Fig. 5 could be used, as isolating resistors will hardly be necessary owing to the high impedance of the pentodes.

It is not usually feasible to arrange for all inputs to be equal as regards signal voltage, though it is very desirable to try and keep a reasonable level in the early stages of the sound amplifying equipment. Instances so often arise when one has to deal with the outputs from, say, microphones of different degrees of sensitivity, and/or microphones and pick-ups.

With the two-valve pre-amplifier, the description of which was completed in the previous issue, its circuit was arranged so that a low-level microphone can be fed into the first valve and be amplified by both stages, whereas a high-level "mike" or a gramo pick-up can be plugged into circuit after the first stage, thus reducing its amplification by a very appreciable amount. A somewhat more elaborate system than that used in the above is shown in Fig. 7. The inputs A and B represent those which would be used with low-level inputs, R1 and R2 being 0.25 megohms. Two high-level channels can be connected across C and D, these being applied to the grid of the second valve.

(To be continued.)

ON YOUR WAVELENGTH

By THERMION

Post-War Reunion?

A NUMBER of readers in the Services who have every reason to believe that the war will not last beyond the end of 1945, have suggested that when they are released from the Services a Reunion Dinner should be held in London, and that I should take the chair. You probably remember the old Chinese custom in which the newly-born infant is kissed upon that part of its anatomy concerned with the plans for its future. For example, if the parents want it to be a great philosopher they kiss the infant on the scalp. If they wish it to be a great singer they kiss it on the throat. I am unaware as to what part of my anatomy was kissed by my progenitors, but I am certain I am not a good chairman.

I do, however, applaud the idea of a Reunion Dinner, an idea which has already been mooted in connection with other hobbies. The only trouble is that we do not know whether the food restrictions will be relaxed. Those societies who are still running annual dinners are finding it extremely difficult to persuade hotel proprietors to take more than a limited number—150 at the outside. I foresee that some form of food control will run through 1945, and there will be many reunions which will add to the burden of the hotel-keeper. Plans would therefore need to be laid well in advance. I have no idea at the present time how many readers would wish to attend such a function, and in order that I may gauge the possibilities I shall be glad to receive an intimation from those interested. Tickets would cost at least 12s. 6d. at to-day's prices, and I am prepared to organise such a reunion if it is within the realms of practical politics.

Readers anticipating the post-war period and our return to weekly publication suggest that we should maintain our present size, which seems to be preferred to the larger size and format we adopted before the war. It is too early for us to know when paper control will be relaxed or abolished. Certainly control will continue until some time after the war, and although the paper position may be a little easier, our raw material will not be available in the unlimited pre-war quantities for some time. That factor alone may compel publishers to maintain present sizes, although I understand that the pocket-size journal has been generally approved. Certainly, when they are bound, journals of this size make handier volumes.

One curious result of the war is that more readers are having copies bound, and perhaps a shortage has made them a little more appreciative of the value of periodicals.

Automatic Speech Control

I SEE that a few correspondents have been contributing to our pages on the matter of automatic speech control. I am astonished to find that other correspondents have taken these letters seriously! They are obvious leg-pulls, for, of course, it is not possible along the lines suggested to vary the speed of a broadcast transmission, except by recording it and retransmitting it. If speech can be controlled in this way so as to increase the speed, we could reach the point where we receive the signals before they are transmitted because the receiver would be speaking the words faster than the transmitter! We should thus be able to listen in to future broadcasts!

The Editor had a twinkle in his eye when he published those letters.

Front Page News

K. T. H., of Birkenhead, writes as follows apropos my paragraph on this subject in the previous issue:

"Why criticise news editors for the manner in which they make up their front pages? They are only striving to give the public what it wants, and far too large a section of the public consider the antics of the B.B.C. of at least equal in importance to battles in which thousands of their fellow countrymen are giving their lives in our common preservation.

"Or is it that it is the B.B.C., rather than the general public, which has this strange complex? And that for some reason difficult to understand, the news editors are willing to assist the B.B.C. in its efforts to educate the public as to its own outstanding world importance? And that of many of its alleged artistes, producers, Brains Trusts, band leaders and organists, and 'discoveries'? Most of our Ministries are inclined to offer the Press their advice as to what may, or may not, be usefully published, and to submit their own constructions of the facts of the times, as being the most desirable to feature on front pages."

Misprints

THE letter from a reader pointing out a small slip in a recent article reminds me of the following jingle:

The typographical error is a slippery thing and sly,
You can hunt till you are dizzy, but it somehow will get by . . .
The boss, he stares with horror, then he grabs his hair and groans;
The copy reader drops his head upon his hands and moans.
The remainder of the issue may be clean as clean can be
But that typographical error is the only thing you see.

Our Roll of Merit

Readers on Active Service—Forty-ninth List

R. Stevens (Capt., R.A.S.C.).
V. F. Gerrard (Q.M.S., C.M.F.).
J. Easton (A.C.1, R.A.F.).
D. Claridge (Pte., R.A.O.C.).
A. J. Woolford (Lt., R.A.).
J. F. Keefe (L.A.C., R.A.F.).
W. S. Ralph (Cpl., R.A.F.).

LET'S TELL THE WORLD

When war is o'er, competitors
Their trades will boost by propaganda.
Let's not forget that "Sauce for Goose"
Is every bit as "Good for Gander."
Nor all too modest, hang our head
And find our "markets" largely fled.

Our British goods are often best—
A fact which we already know.
But other nations will forget
Unless we plan to let them know.
And, since we need not ask permission,
Proclaim their merits by world-wide transmission.

A light beneath a bushel hid
In vain will strive to spread its light.
To sell you've got to advertise—
We've got to get this axiom right.
Ether and radio enlisting in our aid
Keep Britain advertised. We're sunk if too afraid.

Let nation unto nation speak.
In search of Trade, need we be dumb?
Solicitation thought bad form—
How can we hope that trade will come?
Broadcast at length, seek world-wide test,
And prove that British goods are best.

"TORCH."

Quality Reproduction

Post-war Plans: A Discussion on the Requirements for Post-war Broadcast Transmission and Reception, and on the Ways and Means of Meeting Them

WHEN war started the general public was becoming increasingly "quality-conscious," and was beginning to take a greater interest in high-fidelity amplifiers and loudspeakers. During the war, largely because of the broadcasting arrangements forced upon us by tactical considerations, "quality" has not been so much in evidence. But that is no reason why its importance should be forgotten, nor why we should not seek it even more diligently after the war.

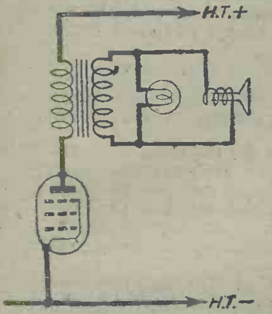


Fig. 1.—The simplest form of contrast expansion or volume expansion; a 2.5 volt bulb connected in parallel with the speaker speech coil. When the bulb filament is cold (low output, soft passages) it has low resistance and shunts away some of the power from the speech coil. The shunting effect is reduced on greater output, when the filament is hot. More details were given in the April issue.

And if we are to have reproduction truly deserving the name "fidelity" there are many changes that will have to be made these are not concerned wholly with receiver, amplifier and speaker design, but also with the planning which must lie behind our broadcasting systems.

Broadcast Channel Band-width

With broadcast channels in the medium-wave band covering a width of only 9 or 10 kc/s there was a definite limitation upon the audio band-width that could be transmitted. It was known that 10 kc/s was insufficient, but it was equally well known that a certain number of transmitters had to be crowded into a very narrow frequency band—the old story of the quart and the pint pot! It may be argued that the selfsame problem will remain after the war. But will it? Or can the matter be tackled differently and a better result achieved?

It should be possible to overcome the difficulty to a great extent by curtailing the number of transmissions allowed in the medium-wave band, and by making increased use of the high-frequency and ultra-high-frequency bands. How can this be done? Well, there are various committees on post-war planning, both national and international in character, and even before the war there was an important European organisation set up to control broadcasting, with its headquarters in Geneva. Let us have a fully representative European committee, subscribed to by every European country, to say which frequencies shall be allocated to the various countries, and how much power shall be used when operating on those frequencies.

The cynic will point out that we had all this before the war. But he will remember that all European countries did not pay attention to the rulings of the organisation. There must be a means of enforcing any regulations laid down. Not an easy matter, but surely no more difficult than the prevention of countries which are at present our enemies from re-commencing the manufacture of arms!

Wider Channels

Between 200 and 600 metres we have a frequency band of 1,500 to 500 kc/s. If a standard frequency separation of 20 kc/s were agreed to, 50 transmitters could be accommodated within that band. To ensure fair distribution of those frequency channels, on a "population" basis, would probably mean that only two or three would be available for the British Isles. But if each transmitter were to operate on not less than 100 kW we should obtain ample coverage, with easy separation and with an ample band-width for high-quality transmission. With such an arrangement it should be possible to ensure that good reception—on a "quality" basis—would be possible from at least one of those stations at any point in the British Isles; in fact, "quality" reception of two transmissions should be within the bounds of possibility. Such a small number of transmissions would clearly limit the variety of our programmes, and that is something to be deplored. Nevertheless, it is considered that the majority of listeners would prefer that to the pre-war system whereby there was a wider choice of material, but far less scope for high-fidelity reproduction—at least, they would prefer it after having become accustomed to "real" reproduction.

In any case, with the fewer stations in Europe, and with the higher power of each, there would be still a very wide choice of programmes of a type which should be worth listening to. Additionally, one may conclude that the present enemy countries would be largely controlled by the Allies for some years after the war, and we might even expect that announcements would be made in both the tongue of the countries, and in English.

"Local" Services

It is not suggested, however, that the two or three medium-wave transmitters would provide the only

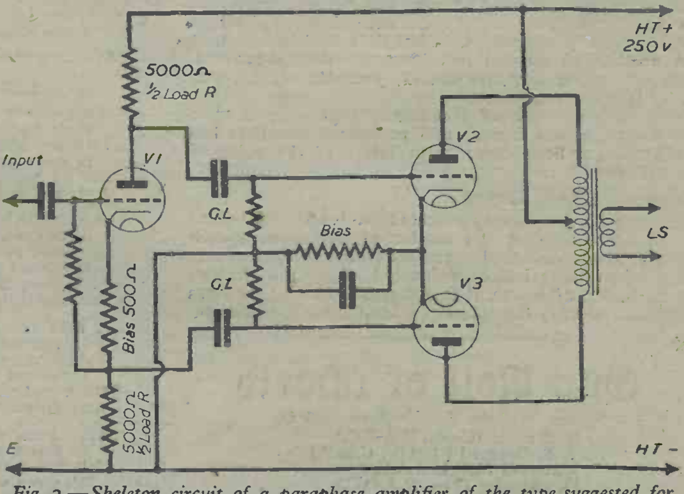


Fig. 2.—Skeleton circuit of a paraphase amplifier of the type suggested for fidelity reproduction. High-quality amplifiers were described in the January, February and March, 1944, issues of PRACTICAL WIRELESS. *A paraphase amplifier with negative feed-back was described in the last-mentioned issue.*

all-British programmes. One of the short-wave bands could also be allocated to the broadcasting of local service programmes. There could, for example, be a comparatively low-power short-wave transmitter in every populous area. With this arrangement, European short-wave frequencies in the allotted band could be on a "shared" basis if the power were strictly limited and if full consideration were taken of "skip-distance" effects when planning the frequency allocation.

Some such system will, in any case, be essential for television broadcasting, in that case using the ultra short-wave bands. And there can be little doubt that television will play a large part in our post-war radio entertainment.

Amplitude and Frequency Modulation

In connection with the "local" short-wave services full consideration should be given to the advantages offered by frequency modulation, not only because of its freedom from man-made static, but also because of the better "quality" which is possible. It is of interest while considering F.M. that it is reported that the N.B.C. of America has already applied for permission to set up a frequency-modulated transmitter, to be free from

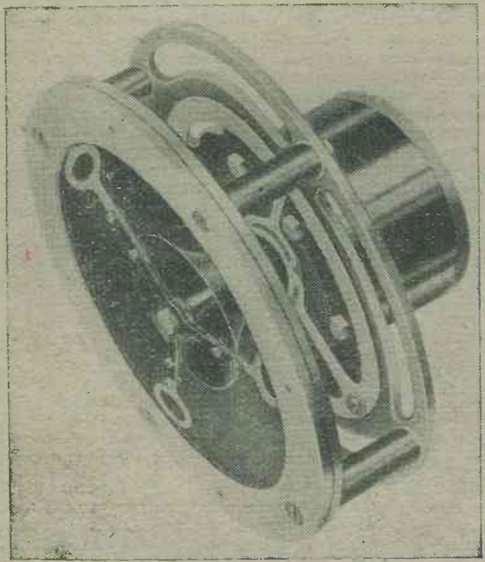


Fig. 3.—An example of modern high-fidelity speaker design; the Goodman infinite baffle type.

the advertising which has so far characterised American broadcasts, after the war.

A different type of detector unit is required for the reception of F.M., but many thousands, perhaps millions, of new receivers will have to be made after the war and there is no reason why these (or some of them) should not be made with facilities for F.M. in addition to A.M. reception. This would mean that a switching system would be required so that the usual diode or leaky-grid detector could be replaced by a discriminator stage and limiter when desired. Alternatively, a plug-in unit could be devised to modify an existing receiver for use on F.M.

Receiver Requirements

After that brief review of requirements at the transmitting "end" we can turn to the receiver. On medium waves a superhet would be a virtual essential to ensure freedom from interference between high-power transmissions on 20 kc/s separation. The intermediate-frequency would have to be carefully designed for an acceptance of about 16 kc/s. And at least this band-width would be required on short waves for F.M. reception. This would involve a certain amount of "down-grading" of the I.F. transformers with a consequent reduction in gain. The loss of gain might be overcome by the greater efficiency of our valves, or by the use of an additional stage; even the latter need not cause any consternation if valve prices were reduced to a level similar to those ruling in the United States, and there would be advantages resulting from the reduced risk of instability and the corresponding simplification of design.

An H.F. stage would probably be required prior to the frequency-changer, but that has always been advocated for high-sensitivity receivers. There would probably be a band-pass filter between the H.F. and mixer stages in order to obtain a reasonably square peak between 16 and 20 kc/s wide. To ensure that the broadcast transmissions were suitable for reception on the simpler types of receiver, not designed with a special eye to fidelity, it would be necessary for the volume range at the transmitter to be contracted as in the past; that is, for the percentage volume level, minimum to maximum between soft and loud passages, to be somewhat less in the modulation applied to the transmitter than in the original production.

Contrast Expansion

Our fidelity receiver would therefore probably require a volume-expander or contrast-expander stage between the detector and low-frequency amplifier. The volume-expander is not new and was used pre-war particularly in amplifiers for use with gramophone records. Its purpose is to give greater amplification to loud than to soft passages, and so to increase the "loudness" ratio of the reproduction. One method is to use a super-control pentode as expander and control its bias by means of a diode fed, along with the pentode, from the detector output. As the output rises the pentode bias is reduced and its gain thereby increased.

Volume expansion is of little value, however, unless it is followed by an amplifier capable of giving an ample output; say not less than 5 watts undistorted for the average drawing room. If the amplifier were inadequate it would mean that the quieter passages would be inaudible. Our "quality" receiver would therefore require to have at least a 5-watt output stage. This could most satisfactorily be provided by the use of a phase-splitter and a push-pull paraphase amplifier. A paraphase amplifier is suggested because it gives all the advantages of normal push-pull (cancellation of even harmonics and greater valve-for-valve output) without the need for inter-valve transformers.

In addition, the use of negative feed-back (perhaps optional by the operation of a switch) would be regarded as an essential. This is because, as previously explained in these pages, negative feed-back improves reproduction to a useful extent and also because it compensates for varying output loads. The latter advantage is especially marked when operating more than one loud speaker, and when the number of speakers in use at any one time may vary from one to two, three or more.

The Speaker

Excellent loud speakers are already in use, and manufacturers can readily provide a speaker which will do full justice to the best amplifier. For our post-war de-luxe receiver we should probably want a double speaker, or one having a "tweeter" or high-note reproducer, in addition to the cone which will deal with all the middle and lower frequencies. It is probably true that it has not yet been possible to design a speaker of the cone type which is as good as the best long-horn type, but the latter is rather limited in its use because of its size, weight and cost. But we need have no fear of the capabilities of the cone-type moving coil if it is mounted on a properly-designed large baffle and suitably positioned in the room. Perhaps some enterprising builder will one day build speakers into the walls of the principal rooms of the house, but we shall want high-fidelity reproduction long before that is commonplace!

Notes on Meter Maintenance

By D. MENDWELL

THE maintenance and repair of electrical measuring instruments of the types used in radio engineering presents no more difficulties than does the maintenance and repair of receiving apparatus in general, though the "watchmaker's touch" must be acquired before one can with confidence handle the various small parts when cleaning, adjusting, repairing or reassembling them. Constant practice, of course assures this and, with care, even an initial job can be successfully undertaken without damage to an instrument or the risk of reassembling it wrongly. Those meters in most general use will be dealt with in what is considered to be numerically the order of utility in which employed.

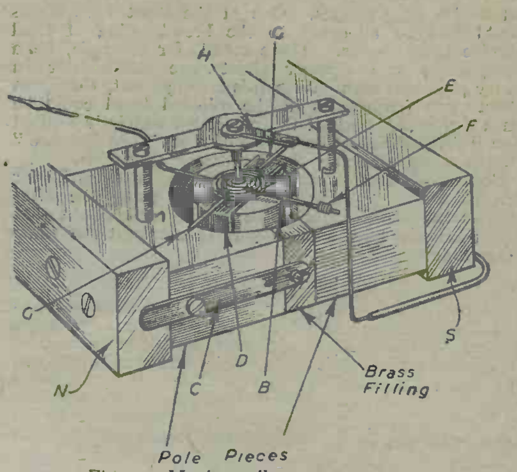


Fig. 1.—Moving coil meter movement.

Moving-coil Voltmeters

These have a reasonably low current consumption and a somewhat dependable accuracy of pointer registration providing maintenance is methodical and undertaken at predetermined intervals—if in everyday use, every six weeks or so. A breakdown sketch of a standard type of assembly is shown in Fig. 1, "N" and "S" being the poles of a horseshoe magnet of cobalt steel, light in weight and of such size to fit the meter case. At "B" is seen the "flux intensifier," which is incorporated into the assembly for the purposes of keeping the magnetic field radial and the reduction of reluctance effects in the gap between the poles. Dependable moving-coil instruments are fitted with an iron magnetic shunt as depicted at "C," and, this being adjustable, some variation of field strength is possible to act as a control of calibration and full-scale deflection (abbreviated to FSD by meter mechanics and instrument technicians).

At "D" can be noted the moving coil, which, with current flowing through it, is surrounded with magnetic lines of force to form another field from its magnetic poles. This field interacts with that of the permanent magnet, setting up magnetic "distortion" and thereby creating the force that is required to turn the coil at that angle of deflection that is proportional to the current and thus keep the movement uniform across the scale. Function, however, is additionally controlled by the phosphor-bronze or cadmium-copper springs seen at "E," these "feeding" the current to the moving coil. One spring is inserted into the assembly clockwise, the other anti-clockwise, in order to nullify changes in temperature. Bearings, on dependable meters, are jewel-pivoted, while the pointer, seen at "F," is balanced by aid of a small weight. An additional balancing weight, shown at "G," is fitted across the lower end of the pointer or indicator.

Computing Range Resistors

A very simple method of computing the values of series resistors for a D.C. voltmeter of this type is to divide the full-scale current, in milliamperes, into 1,000 so as to arrive at the ohms-per-volt (o.p.v.). For example, assume the FSD to be 5 milliamperes, but that required to be 200 volts. Therefore, $1{,}000 \div 5 = 200$, that is, 200 o.p.v. This multiplied by the required FSD is $200 \times 200 = 40{,}000$, the value of the series resistance necessary in ohms to increase the FSD to the 200 volts required. These series resistors are, in general, wire-wound, enabling some measure of calibration to be achieved by increasing or decreasing the number of the wound turns of wire. Final checking is done by comparison with readings from a standard meter, the circuit arrangement being illustrated by Fig. 2. The resistance value of the potentiometer can be 500 ohms for a 20-volt input and 50,000 ohms for a 200-volt input, the meters under check being assumed to have FSD ranges within these limits.

Cleaning and Adjustments

The most common trouble encountered with moving-coil assemblies is sticking movements, the cause, in the majority of instances, being due to dirty pivots and iron filings in the gap preventing free coil action. The remedy is to remove the coil from the gap entirely, being careful while doing so not to damage the hair springs or the pointer. The pivots are then cleaned by dipping the end of a matchstick into a small quantity of jeweller's rouge and then gently twisting this to and fro. Bearings are similarly cleaned, the matchstick being pointed for the purpose. Iron filings in the gap of the magnet are best removed by passing a cloth through the gap proper and drawing them to the outsides of the magnet, from which they can be removed by aid of a small pair of tweezers.

When reassembling, care must be observed not to distort the springs and to see that none of the convolutions are sticking together. Should this happen, the

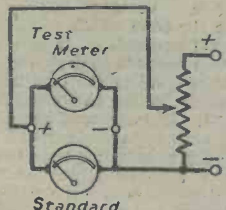


Fig. 2.—Checking against a standard meter.

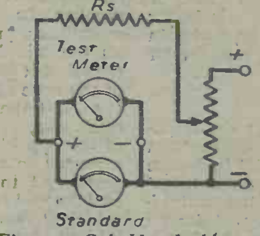


Fig. 3.—Suitable checking rig, R3 must have limiting value.

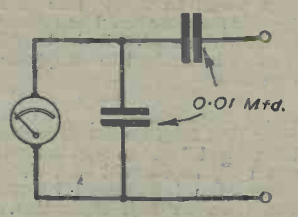


Fig. 4.—Method of doubling the range of an electrostatic voltmeter.

turning torque would be increased to such an extent that the initial calibration would be decidedly not true to scale. It is advisable, too, to make a note when unsoldering these springs in order to make sure that they are replaced exactly in their original positions.

As has been mentioned, pointers are balanced and they should thus be true to scale regardless of the angle or tilt of the meter. Should a pointer move "down" when a meter is moved over in the hand, then the balance weight has become light and a spot of shellac must be applied to it in order to even things up. Conversely, should the pointer move "up," a touch of paint applied to the tip of it will usually effect balance. As the coil is wound on an aluminium former, current is present in it, the former, as it turns in the gap, due to this current being opposite in action to the applied current, thereby introducing a degree of damping to give the movement the necessary dead-beat effect. That is, eddy currents are induced in the aluminium former that are conducive to a reaction effect between their field and the field of the permanent magnet, this acting as a brake or "damper" on the moving coil and controlling excessive pointer swing or jerky action. Therefore damping is a function of the overall operation. It may be met with in three forms, air, magnetic, and liquid, usually air or magnetic as described.

Ammeters and Milliammeters

Similar assemblies are used as current meters and are, with the possible exception of low-range micro-ammeters, fitted with a shunt resistance. Ranges are increased by adding additional values of shunt, a useful equation being $R_x = R_m \ (n-1)$, where R_x = the value of the shunt resistance wanted, R_m = the internal resistance of the movement, and $n-1$ = final FSD range required. For example, the internal resistance of an 0 : 1 milliammeter is 27 ohms and a FSD is wanted of 10 milliamperes, the range thus having to be increased by 10. But $n-1=9$, and 9 divided into 27 comes to 3, which is the value of the shunt resistor required in order to secure a FSD of 10 milliamperes. Sensitivity of the voltmeter movement was given in ohms per volt, but sensitivity of current meters is rated from the number of sub-multiples of an ampere as micro- or milliamperes of current that must traverse the coil to attain FSD. Fig. 3 illustrates a suitable checking rig in which the resistor Rs must have a limiting value controlling the FSD of the movement under test. Cleaning, maintenance and repairs are, of course, undertaken similar to the methods previously described, the shunt resistor being adjusted as to value to secure accurate calibration. Current meters that are but slightly off-scale are often fitted with magnetic shunts to enable dead-on pointer readings to be accurate as to scale.

Thermo-ammeters

Current thermocouples are chiefly used for the measurement of high-frequency current, say from 100 M/A. to high values found in big transmitters, though as an average 0-1 amp. scales or up to 15 amps. are more generally met with. Basically, the movement is a moving-coil one with the coil self-supporting, to which is added a millivoltmeter and a thermocouple. This latter consists of two wires of dissimilar metals, spot-welded to a heater wire, possibly of platinum with a "couple" of platinum and iridium. When current flows through the heater the temperature of the wire increases to the extent that doubling the current produces four times the heat, and as the thermocouple is in contact with the heater wire, a voltage is developed across the "cold" ends that is proportional to the amount of heat at the "hot" end. Therefore, as this heat is proportional to the amount of current passing through the heater wire (to the square of the A.C. or H.F. current) and a movement is connected to the cold end of the "couple," there is available an *indirect* arrangement of components suitable for the measurement of high-frequency currents.

As the scale is a square-law one it has the disadvantage of being somewhat cramped at its zero end. Unfortunately, too, the zero setting is sometimes indefinite, necessitating adjustment at frequent intervals. The coming use of thermoelectric devices will, it is anticipated, replace the thermo-ammeter entirely. There are, however, still a number in use that require servicing, a procedure that is accomplished, again, similarly to that described for moving-coil instruments in general. Calibration is effected by aid of the magnetic shunt (if fitted), this being adjusted to get the pointer dead on-scale. Should no shunt be fitted and the pointer reading high, unsolder the heater wire of the "couple" and slightly shorten it. Conversely, if the pointer reads low, slightly lengthen the wire—there being usually sufficient length beneath the solder to permit it being done.

This type of instrument must not be overloaded, for as little as 10 per cent. excess current can burn out the heater wire. In high-class movements, registering less than 150 milliamperes, the "couple" is vacuum-sealed. Thermo-type meters, like milliammeters, incorporate a small resistance in series with the coil proper for the purpose of reducing the nett effect of resistance increase in the coil due to temperature rise. This resistance is known as a "swamp resistor" and it must *not* be adjusted as to value or interfered with in any way.

Electrostatic Voltmeters

This type of instrument is assembled on the principle of the electrometer, being calibrated in effective values with a possible minimum reading of around 20 volts, though the amount of current consumed at low frequencies is sufficiently small to be considered negligible. Its application is to determine the difference in potential between two points. Coils and magnets are excluded from the assembly which, in general form, resembles a condenser with fixed and moving vanes, i.e., a variable one. With the majority of instrument met with, the FSD averages around 450 volts, though it can be designed to measure very high voltage values. The pointer is, of course, connected to the moving vane component, function being due to stationary electric charges and not to *moving electric* charges as the previously discussed meter movements.

Maintenance work should be undertaken with some care, especially with the plates or vanes, which should not be bent when cleaning. The small hair-spring used to return the pointer to zero needs gentle handling as well, otherwise calibration may be badly upset. Fig. 4 depicts a method of doubling the range of such an instrument as the capacity of the assembly, a few micromicrofarads only can be regarded as of negligible value, though the two 0.01 mfd. should be closely matched and of such working voltages that they are not less than the meter FSD.

Moving-iron Meters of the Repulsion Type

Construction consists of a coil of wire into which, as a sort of core, an iron vane is inserted, the pointer being attached to another, moving, iron vane. Function is due to mutual repulsion of these two vanes when magnetised by a common electromagnetic field, that is, current traversing the coil imparts a like polarity to both vanes, causing repulsion. If linear scale divisions are wanted, one or possibly both of the iron vanes may be specially shaped to delay or advance its action to or from the magnet pole pieces; the usual hair-spring returns the pointer to zero when the circuit is broken. This type of instrument may be used to measure either alternating or direct current, though requiring considerable more power than a moving-coil meter to operate. Adaption lends it for employment as either an A.C. or D.C. ammeter. Cleaning and adjustment is not difficult due to the robustness of construction, though removing this or any other movement from its case should be done very carefully.

Electrodynamo Meters

These, largely, are an adaptation of the moving-coil meter minus a permanent magnet to assist in the production of the turning force or torque. Instead, an electromagnet is used in the form of a coil. Thus it contains two coils, one movable and the other stationary, so that repulsion and attraction surrounding conductors (parallel) is the motive force. Application can be as a volt-, current-, or watt-meter, and as calibration in this country conforms to B.S.S. conditions, the universal dynamometer applies itself as a standard for comparison checks with other meters. The scale pointer is attached to a small rod or pivot fixed to the moving coil, while various springs and adjusting points may be seen in an assembly. In some forms of design, two moving and two static-wound coils may be met with which are rather complex in assembly. Amp maintenance, bearing in mind the instructions for the moving-coil type of meter, calls for some patience and perseverance when adjusting, cleaning or reassembling.

Maintenance in General

All meter glasses should be fixed into their frames with a suitable cement and frames or flanges given a light coat of white petrolatum to prevent dust entering the movements. Top springs of the majority of movements are adjustable, being soldered to an arm that is controlled by an external screw-head with an eccentric shaft on the reverse side engaging the arm or arms and thus permitting zero adjustment of the pointer on the scale. (See "H" in Fig. 1.)

When extending or altering the ranges of voltmeters, a solid carbon type of resistor, somewhat lower in value than that actually required, may be used, an example being a 40,000 ohm one where a 50,000 ohm one is wanted. Then file or scrape the carbon until calibration is true to scale. Wire-wound resistors are, of course, generally employed for the purpose, but the carbon suggestion makes a good emergency repair, and experience has shown it to last for some time.

Centre-zero instruments of all types are basically similar to "end-zero" types, but their hair-springs are moved round through a quarter of a circle, thus end-zero movements may be modified to centre-zero movements by altering the position of the springs. Some forms of the valve-voltmeter use centre-zero scales and indicators for the purposes of measuring positive and negative potentials, positive reading to the right of centre-zero and negative to its left.

As ordinary resistance wire may vary with temperature, it is seldom employed for making shunts for current types of meter, it being replaced by one of the patent resistance wires having a low temperature coefficient, *manganin*, or a wire of German-silver alloy, for examples.

Never clean the glass of a meter when in circuit, as this may form an electro-static charge capable of attracting the pointer and setting it off-scale as to indication. Breathing on the glass will rectify this condition should it occur. Remember that some meters use but one spring, but that where two are inserted into an assembly they are coiled in opposite directions and must be thus re-inserted after being removed. Spring diameters vary from .01 to approximately .0055 of an inch; learn to handle them gently with a suitable pair of tweezers.

The pivots of high-grade meters rotate in jewel bearings, usually of sapphire, though diamonds, rubies, or agates may be seen, all more or less hollowed in the tiny centres to hold the pivot point.

Never operate any type of meter close to a powerful external alternating field of flux, especially those containing permanent magnets, the risk is demagnetisation and errors in pointer readings.

Electrostatic voltmeters used for the measurement of very high voltages may have the movement entirely immersed in oil, so that undue rough usage may puncture the oil chamber and upset entirely the normal operating action, this because the oil is the liquid damping medium employed. When this happens the instrument must be taken apart, the puncture sealed and, of course, the oil chamber refitted. This rough treatment may also cause trouble in air chambers where air damping is employed, and in some instances the damping vane in the chamber (of dynamometers usually) will need straightening before the meter will function correctly, for attached to this vane is the scale indicator or pointer.

Finally, never apply current or voltage to any type of meter of such value that it coincides with the FSD range of the meter, 15 per cent. below this value is a safe figure to allow as a maximum, i.e., with a meter of 100 volts FSD, let 85 volts be the maximum in circuit. Excess potentials may burn out hair-springs and coils, absolutely not replaceable these days, the only remedy, should this happen, is to purchase an entirely new movement—if it can be procured.

(Courtesy of The Institute of Practical Radio Engineers.)

W.R.N.S. are now serving aircraft, wireless and assisting generally at a Fleet Air Arm Training Station, and "Wrens" are releasing a large number of aircraft and radio mechanics for service in the fighting theatres of war. A feature of the work is to allow them to fly in machines they have serviced to give them a complete knowledge of things that may go wrong when airborne.

A "Wren" wireless telegraphist signalling by morse to airborne craft on a training flight.

Instability in Superhets: Causes —and Some Cures

By R. LINLEY

THIS article sets out to explain some of the many forms of instability and associated troubles that may be experienced by the amateur when he attempts to design a superhet, and also how to achieve maximum efficiency in each stage.

Some time ago I decided to build a mains-driven superhet, and as it was my first superhet, and I could not follow a published circuit diagram owing to the parts not being obtainable, I decided to use as simple a circuit as possible, namely, F.C. followed by one I.F. stage and lastly a D.D. tetrode for second detector. A.V.C. and beam-power output giving 4.85 watts output.

This article is an account of the development of this circuit, and also of the troubles which have been found on some of the sets I have serviced.

Of course, it is assumed that all the components in the set are perfect, and that the trouble is due to design or layout, not forgetting that instability is responsible not only for howls, squeals, "motor-boating," etc., but also for a good deal of poor sensitivity and low stage gain.

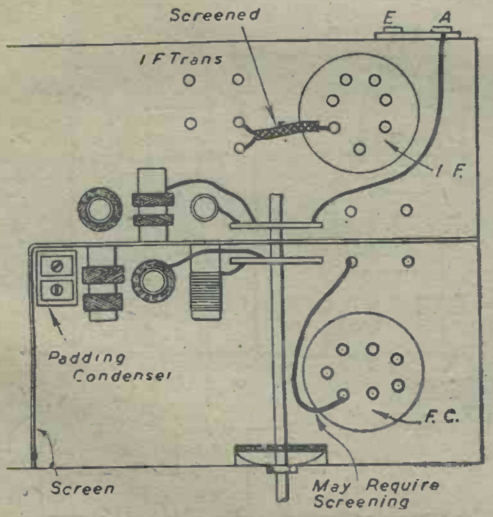


Fig. 1.—Lay-out of frequency changer stage, with small sub-chassis coils.

Layout and Screening

The first thing to be decided is the layout and screening.

Interaction can take place between the oscillator and mixer sections of the frequency changer, and if the layout allows this to take place it will defeat the object of the screening within the valve. This is particularly important if the set is an all-waver, the unwanted coupling can take place at the wave-change switch. The layout in Fig. 1 avoids this trouble. This shows the small sub-chassis type of coil, but the same general principles apply with other types of coil. Also, interaction was found to take place at frequencies approaching the intermediate frequency (465 Kc/s) between the aerial lead to the W.C. switch and the anode lead of the I.F. valve. This lead was screened as shown (Fig. 1). By screening the I.F. anode lead the losses are lower than screening the aerial lead, which may be carrying minute voltages of far higher frequencies than the I.F. A small grid stopper (10 ohms) was necessary in the grid circuit of the oscillator to ensure stable operation, particularly on the short-waves. If this is required, solder right on the grid pin of the valve-holder. Oscillator instability can be due to wrong value grid leak, there being nothing to be gained by using values other than those recommended by the makers of the valve.

While on the subject of the valve makers' recommendations it should be remembered that the total resistance in the grid circuit of the F.C. and I.F. stage, including the A.V.C. filter resistor and A.V.C. diode load should not exceed a certain figure. In general, with the 4-volt British series this may be taken as 2 meg. with H.F. valves, although there are exceptions.

Earth Leads

The earth leads can be the cause of puzzling forms of instability more so in a high gain receiver. It is best to use either a stout bus-bar of, say, 18-gauge copper wire or heavier gauge if possible, or to take all the earth returns from each stage to its own earthing tag bolted to the metal chassis by the same bolt that holds the valve-holder for that stage.

H.T. decoupling was not found very important for the F.C. and I.F. stages, provided there was no pre-F.C. high frequency stage, and that only the usual one I.F. valve was used. All that was found necessary in many cases was the condenser C3 in the circuit diagram. Place this right near where the lead from the I.F. transformer in the anode circuit of the frequency changer goes to H.T.+; the leads from this condenser must be short, as its task is to present a low R.F. impedance to any stray H.F. currents in the high tension circuit.

Tunable Hum

With some superhets a form of tunable modulation hum, or perhaps a sound that may be a cross between "motor-boating" and a sort of flutter may be noticed on a few transmissions. This is more likely to occur on the short-waves, and is caused by low-frequency voltages in the H.T. power line due to poor voltage regulation, modulating the oscillator anode voltage.

This is most in evidence when the volume-control is turned full on and a fairly powerful short-wave station is being received. The only cure is to filter out these unwanted L.F. and hum voltages. Fig. 2 shows a few ways of doing this.

This applies to any type of frequency changer. It should be noted that for simplicity, wave-change switching, padding condensers, etc., have been omitted from Fig. 2. In Fig. 2A the optimum value of R1 has first to be found, as explained later. If this comes to 30,000 ohms or less, then Fig. 2C will have to be used, but assuming R1 is 50,000 ohms or more, then it can be split in two as shown, making R1 not less than 30,000 ohms and R2 20,000 ohms or more depending upon the original value. C1 can be an electrolytic condenser of 4 or 8 mfd.

Fig. 2B is very simple, for if R2 is anything from 10,000 ohms upwards then C1 will be effective. If R2 is from 10,000 to 20,000 ohms C1 may have to be as high as 16 mfd., although 8 mfd. can be tried. If R2 is 20,000 ohms upwards 4 or 8 mfd. should do the trick. C2 is .01–.1 mfd.

Fig. 2C is a little more complicated, for in this case the optimum value of R1 was low, say 25,000 ohms, and in this case could not be split into two resistors for although the optimum voltage would be maintained on the oscillator anode, if decoupled as in Fig. 2A, the resistor acting as anode load would be too low in value to offer sufficient impedance to the R.F. voltages and so would heavily damp the circuit, and the decoupling portion would be too low in value to act efficiently.

So R1 is wired as usual without decoupling and adjusted to optimum value. Then a milliammeter is inserted between R1 and the positive high tension line connecting a condenser of .01 to .1 mfd. across the meter terminals to avoid instability.

Take a note of the current reading at the most critical frequency. (The oscillator anode current varies to some extent with frequency). Now measure the voltage drop across the speaker field and using ohms law find the value of resistor to drop this voltage at the oscillator anode current. For example, say, oscillator anode current 2 m.a. voltage drop across speaker field 50 volt, then

$$\text{resistance ohms} = \frac{\text{volts}}{\text{milliamps.}} \times 1{,}000 \ \frac{50}{2} \times 1{,}000 = 25{,}000 \text{ ohms.}$$

R3 can now be 15,000 ohms and R2 10,000 ohms (in Fig. 2C). C1 and C2 may each be 4 mfd., though in extreme cases one or both may have to be increased to 8 mfd.

Alignment

As is well known, instability can take place simply because the circuits are out of alignment, so this should be attended to first. It is well worth making up a simple oscillator for this purpose. A simple one-valve battery affair will do, as one can do without a L.F. modulation circuit provided that one uses a voltmeter across the bias resistor for alignment purposes. I always use this method where I can, although I have the fine Service Oscillator described in Practical Wireless last year.

Another cause of instability this time in the I.F. amplifier is too tight a coupling in the first I.F. transformer. If it is not desired to alter this component a resistor may be shunted across the primary; use as high a value as possible consistent with stable operation.

It is very important that the I.F. valve be fully screened either by a valve can or by the metalizing on the valve. If this is making poor contact, scrape it all off carefully and use a valve can, do not use a metalized valve and a can as the heat will be too great for the valve.

Common Coupling

Unstable operation can occur due to common coupling in the A.V.C. circuit, although in a simple circuit such as we are discussing this is not so likely to be noticed except perhaps at frequencies near the intermediate frequency. If this is the now usual 465 kc/s, then perhaps the trouble may be found to occur, say, beyond 450 metres up to the end of the scale (550 metres) on the medium waves and from 800 metres up to, say, 1,000 metres on the long-wave band. All that is required to decouple this circuit is a resistor of, say, 10,000-100,000 ohms and a condenser of .005 to .1 mfd. connected as shown (Fig. 3), but more about the A.V.C. circuit later. Any trouble on the L.F. side can be dealt with in the same manner as for a straight set.

Fig. 4 shows my circuit. This is given not because I consider it to be an ideal one, but to illustrate the choice of some of the components. To start at the aerial side of the circuits, the I.F. filter shown dotted is sometimes used if Morse on or near the I.F. breaks through, but if the acceptor circuit as shown is used it will greatly lower the impedance of the aerial circuit at the intermediate frequency, and so another possible cause of unstable operation at frequencies approaching the I.F. is eliminated.

The A.V.C. on the frequency changer is not taken from the lower end of the aerial coil grid winding as usual, but goes direct to the grid and the coil is coupled by a small condenser C2 of 50 ppf. The losses are very slightly less, more so on the short-waves, but my real

As previously explained, C3 (.05-.1 mfd.) was all the H.T. decoupling required.

reason for using this method was to obtain extra selectivity as the coils I used had rather low "Q."

Oscillator Circuit

The oscillator circuit is by far the most critical one if one wishes to obtain good results. If the stage

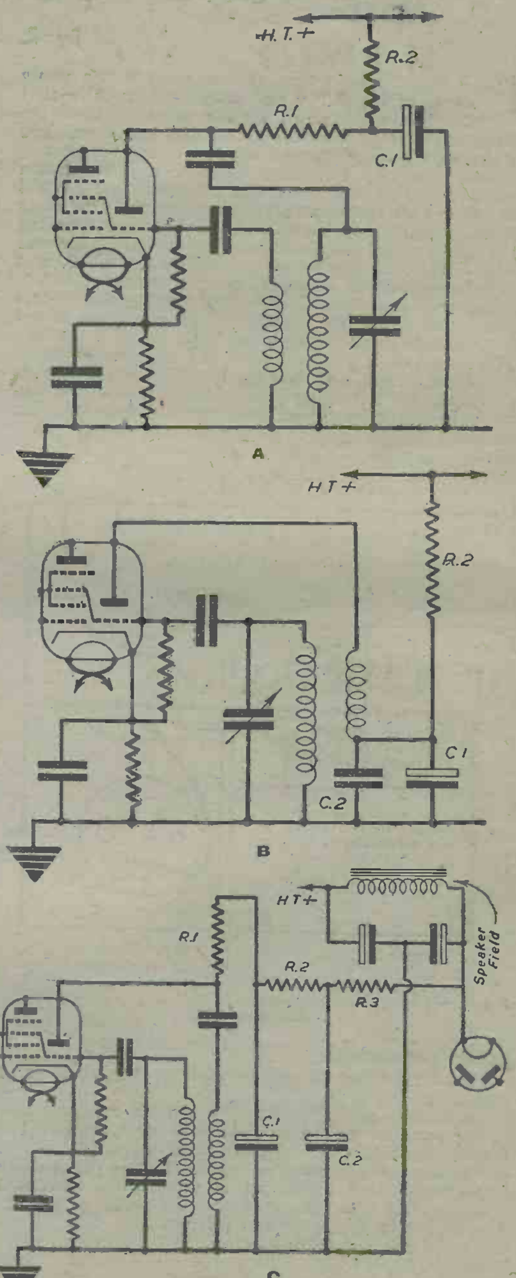


Fig. 2.—Three methods of eliminating L.F. hum.

(*Continued on page 79*)

oscillates too violently or, on the other hand, not sufficiently hard enough, then the sensitivity of the whole receiver can fall off alarmingly. A study of the valve maker's curves proves this. Now, the correct way of adjusting the oscillator stage is to insert a micro-ammeter at X, Fig. 6, in the oscillator grid circuit, and

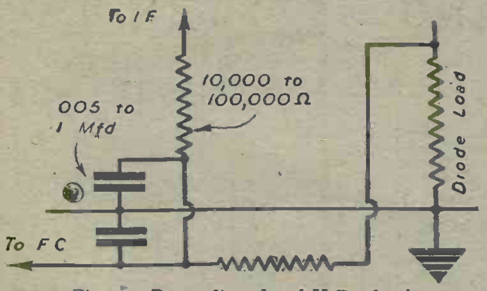


Fig. 3.—Decoupling the A.V.C. circuit.

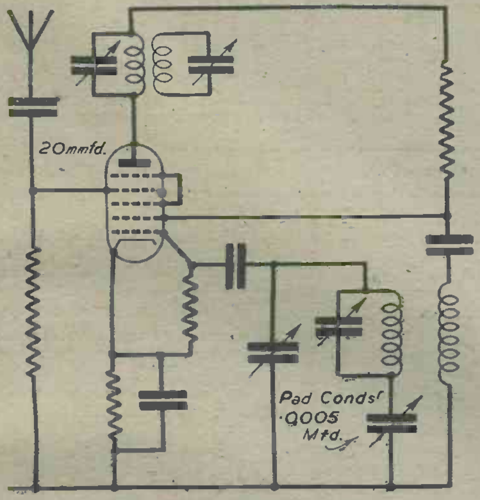


Fig. 4.—Circuit used for testing oscillator coils. A triode hexode can be used.

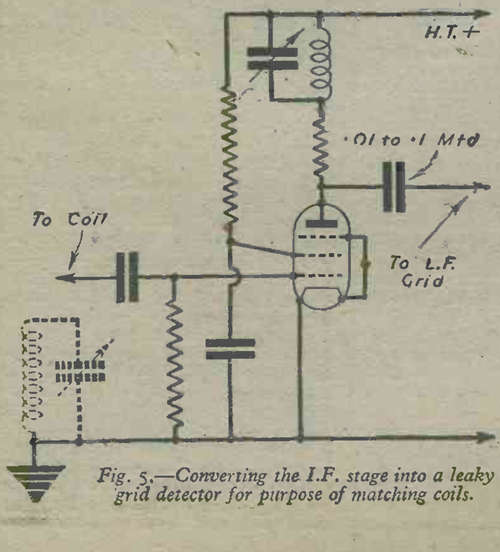


Fig. 5.—Converting the I.F. stage into a leaky grid detector for purpose of matching coils.

adjust the feed-back circuit until a grid current that conforms closely with the valve maker's recommendations flows, but how many amateurs are lucky enough to possess a good micro-ammeter of 0-500 micro-amps? Now, assuming that the H.T.+ voltage is 250, the makers of the Osram X41 say that the resistance in the anode circuit should be 50,000 to 100,000 ohms, so make R1 in Fig. 4 30,000 ohms and insert in series with it a variable resistor of 100,000 ohms in this case. Now, preferably using a signal from a test oscillator applied to the aerial terminals, or using a signal from the aerial, tune the set to a frequency where best results are required, in an all-wave set this would be the short-wave band, if the range is 16-50 metres, then tune to around 25 metres and adjust the variable resistor for best results using a voltmeter across the bias resistor or a milliammeter in the anode circuit of the I.F. valve. Then replace R1 with a resistor of the value found. If this value does not fall near to the value the makers suggest, then either the reaction coupling of the oscillating coils is too tight or too loose. If too tight, a sort of motor-boating or squeal may be found to occur at the H.F. end of the band. A series resistor in the reaction coil lead will cure the trouble. Experiment for best value (100-2,000 ohms).

If, on the other hand, the coupling is too loose for the oscillation to reach the peak heterodyne voltage for maximum conversion gain, then it is possible that the coils were designed for another type of frequency changer whose oscillator section had a higher slope.

If adjustment of the value of C8 has no effect, then the oscillator grid condenser can be omitted (C7). This will not mean that the grid leak is shorted providing that there is a padding condenser at the lower end of the oscillator grid coil for each range. The circuit may now have to be treated as for too tight a coupling as above.

R1 should now be adjusted in value again and its optimum value should fall closely within the valve maker's figures.

R5 (10 ohms) acts as a stabilizer and prevents parasitic oscillations of higher frequencies taking place.

R8 (20–50 thousand ohms), together with C10 (.0001 mfd.) and C 91 (.0002 mfd.) act as a R.F. filter and stabilise the diode detector. If R8 is too high, then the volume will fall off while if C10 and C11 are increased in value the treble response will be attenuated. The volume control acts as diode load as this gives better fidelity than when the volume control is placed in the grid circuit of the following L.F. stage.

The bias condenser for the output stage, or for any L.F. stage is chosen by the formula. Reactance Ohms $\frac{1{,}000{,}000}{6.28 \times c/s \times \mu F}$ choosing a value so that its reactance at the lowest frequency (say 50 c.p.s.) is about a quarter of the value of the bias resistor in ohms.

Tone Control Circuit.

The tone control circuit may be of interest. There is not sufficient L.F. gain in hand with the D.D.Pen. type of output stage for the usual negative feedback circuit so I have chosen component values that retain the advantages of feedback on the higher audio frequencies and yet do not reduce audio gain too much.

It could be called a bass boost negative feedback circuit although the effect is not at all boomy and is a great improvement on the usual top-cut type of circuit (R. 16, R12, C16, C17). The decoupling of the screen of the output tetrode removed the last trace of hum and does not cause the slightest drop of volume, R14 (5,000 ohms), C15 (.5 to .1 mfd.).

The A.V.C. diode coupling condenser C14 was reduced to 20 or 30 ppf. to great advantage. There was very little loss of A.V.C. voltage, but the damping on the I.F. transformer is very greatly reduced and the transient response appears to be very greatly improved, instruments of the percussion group standing out more clearly. R15 is the A.V.C. diode load and R17 and C6 act as a filter.

If C6 is at the lower end of the coil in the usual manner

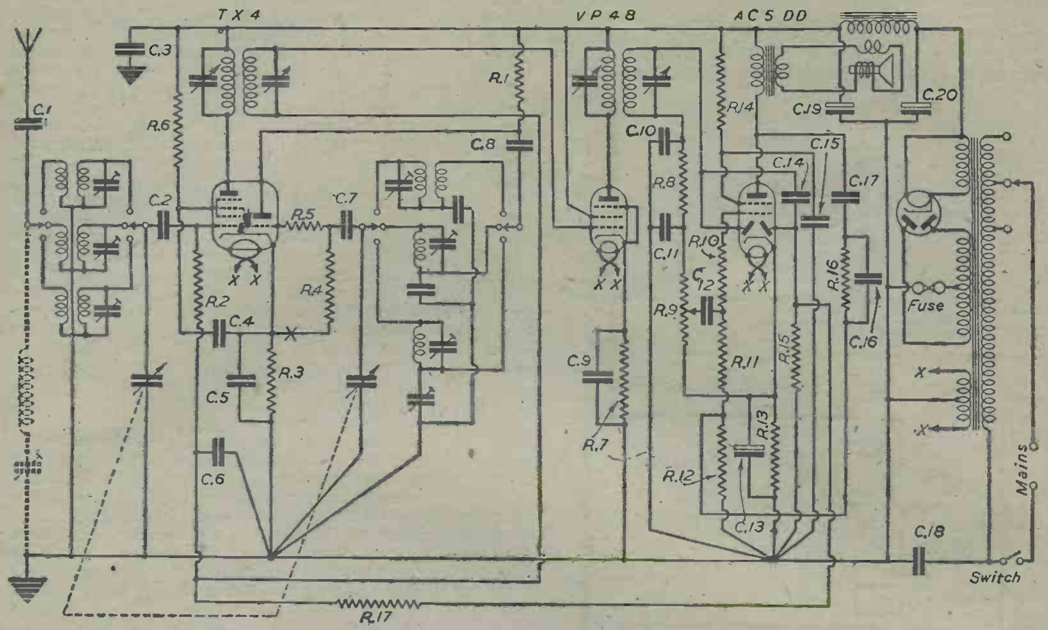


Fig. 6.—The author's superhet circuit. **Condensers** (*values marked * determined by experiment*) : C1, .0001-.001 ; C2, 50 *ppf* ; C3, .05-.1 ; C4, .1 ; C5, .1 ; C6, .1 ; C7, .0001- ; C8, .01* ; C9, .1 ; C10, .0001 ; C11, .0002 ; C12, .02 ; C13, 50 *mfd.* ; C14, 30 *ppf* ; C15, .5-1 *mfd.* ; C16, 1.0003 ; C17, .005 ; C18, .005-.1 ; C19, 8-16 *mfd.* ; C20, 8 *mfd.* **Resistors** (*values marked * determined by experiment*) : R1, 50,000 *ohms** ; R2, .5 *megohms* ; R3, 150 *ohms* ; R4, 25,000 *ohms* ; R5, 10 *ohms* ; R6, 50,000 *ohms* ; R7, 200 *ohms* ; R8, 20,000-50,000 *ohms* ; R9, ½ *megohm vol. cont.* ; R10, 10,000-50,000 *ohms* ; R11, .5 *megohms* ; R12, 20,000 *ohms* ; R13, 200 *ohms* ; R14, 5,000 *ohms* ; R15, 1 *megohm* ; R16, 100,000 *ohms* ; R17, .5 *megohms.*

then its value should not be reduced below .05 mfd. as it is virtually in series with the tuning condenser and would effect ganging. Also the time constant of the A.V.C. circuit should not be too high or bass response will be affected. I find a time constant of 1/20 second best myself, i.e. (in mfd.×R in megohms=1/20 such as R17 ½ megohm and C6 .1 mfd.) at the same time if R17 is lower than about ½ megohm it will damp the circuit somewhat.

It should not be assumed from the foregoing that the superhet is a very difficult circuit to experiment with, but some forms of instability and poor sensitivity may prove difficult to trace if one is familiar only with the straight type of circuit.

In many cases all that the circuit may require is a little hotting up.

Making and Matching Superhet Coils

Coils for the average superhet circuit can be made at home if a little patience is used in accurately matching them, but it is very desirable that a calibrated " service oscillator " is at hand although it is possible to match them on a signal picked up by the aerial. All data below is for 465 kc/s I.F.

I would suggest that for a start coils of the small unscreened type be made using formers of 1in. diameter and about 2½ins. long.

If a three-gang condenser (untracked) is going to be used then the aerial and H.F. (or band-pass) coils will have to be matched together first. I would add that the easiest way to do this is to turn the I.F. stage into a leaky grid detector circuit for the time being. To do this put a resistor of 100,000 ohms in the anode circuit of the H.F. pentode and a resistor of 250,000 ohms (¼ meg.) in the lead to the screen by-passed to earth by a condenser of around .1 mfd. Short the cathode direct to earth. Use a grid leak of 1 meg. and a small grid condenser of 20–50 mmfd., so that the damping on the coil will be very low. Solder the grid lead and grid condenser direct on the grid, whether this is the top cap or a pin in the base, and see that the lead to the coils and condenser are as short as possible. Use an A.C. reading voltmeter and blocking condenser joined to the anode of the output valve as an output meter, or judge the change of volume by ear. For the medium waves aerial coil 100 turns of 30 or 32 g. enamelled copper wire can be used for the secondary and about ¼–⅓ of this number for the primary using finer wire. Match as usual for a straight set by removing a turn or portion of a turn, and do not be satisfied until one can go all round the dial without increase of signal strength being noticed in any position by altering the trimmers on the coil(s) after they have been adjusted at the lower end of the waveband.

When this is done, or if there is only one tuned circuit at signal frequency the trimmer(s) should be set half-way, and using the same tuning condenser and scale that will be used with the finished receiver, mark the scale in wavelengths, say, every 50 metres on the medium-wave band. This is where the signal generator is required.

Now re-wire the I.F. stage in the usual manner, and wire the frequency changer so that the aerial or signal grid is aperiodic, use a grid resistor of 100,000 ohms and an aerial condenser as small as possible about 20 ppfd. or a 2in. length of flex from the grid side of the grid resistor twisted round the aerial lead or the lead to the signal generator.

The oscillator coil can, for a start, consist of 80 turns for the grid winding, and the reaction winding the same number of turns pile round about ¼in. below the grid winding. Wire up the coil, taking care that the reaction winding is connected in correct phrase, and note the position of the wavelengths on the dial adjusting the padding condenser (.0005 mfd.) and the parallel trimmer.

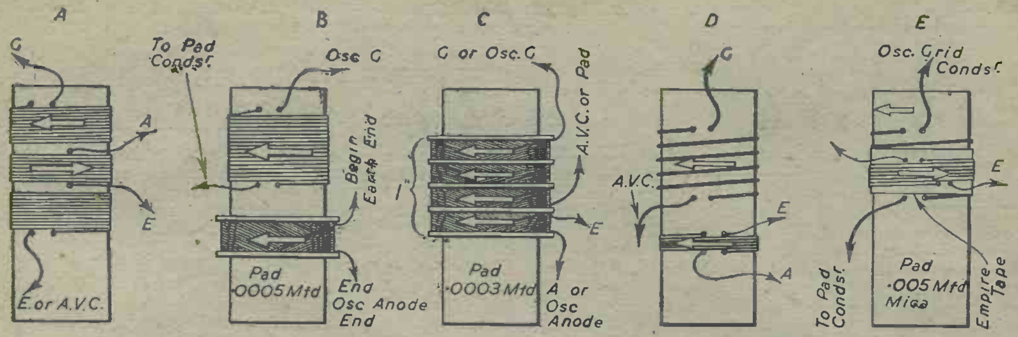


Fig. 7.—Coil details (see table). A, medium-wave aerial coil; B, medium-wave oscillator coil; C, long-wave aerial and oscillator coil; D, s.w. aerial coil; E, oscillator as aerial coil.

The number of turns on the grid winding of the oscillator coil may have to be modified until the wavelengths coincide with those you have marked on the scale for the aerial coil (and H.F. coil if used).

All the medium-wave coils can be wired permanently in position, and they will be found to match correctly when aligned in the usual manner.

The time taken in matching the oscillator coil to the markings on the scale will be well repaid, and, as the coils will be matched in position in the set, all the wiring and stray capacities will be taken into account.

The long-wave coils if required will have to be matched in the same manner.

If a short-wave range is used matching will be found much simpler, although a service oscillator of some sort will be found a great time-saver.

For the usual 16–50 metres approx. range when tuned by .0005 mfd. use a 1in. former the same size as for the other coils. For the aerial grid winding 5 turns of 18 g. tinned or enamelled copper wire is used spaced one diameter of the wire. Place the aerial coupling winding ¼in. below using 3 turns of 22 to 30 g. enamelled copper wire side by side. For the oscillator coil grid winding use 4¾ turns 18 g. tinned or enamelled copper wire spaced one diameter of the wire as before. The reaction winding may have to be wound over the oscillator grid winding, it depends on the frequency changer valve. Use 4½ turns of 20–24 g. enamelled copper wire. If the oscillator is driven too hard a sort of motor-boating or squegger effect may take place at the H.F. end of the band, in this case a small portion of the reaction winding will have to be removed as determined by experiment. Use trimmers of 30 ppfd. (maximum) for both aerial and oscillator coils, and a fixed mica condenser of .005mfd. for the oscillator padding condenser.

Tune in a signal around 20 metres or signal from the test oscillator and set the trimmers for maximum output using the lowest capacity peak for the oscillator trimmer, for the rest of the matching process leave the oscillator trimmer alone. Now tune to around 40 metres (if signal comes in at two places the one that requires the least tuning condenser capacity is the correct one), and adjust the aerial trimmer. If the trimmer capacity has to be increased to obtain a peak signal then the aerial coil inductance is too low, so gently move the turns a little closer together and then go back to 20 metres and adjust the trimmer for peak output.

But if on going up to 40 metres the aerial trimmer has to be decreased in capacity the aerial coil inductance is too high, so increase the spacing of the aerial grid turns slightly and go back to 20 metres and again adjust the aerial trimmer.

After going back and forward about half a dozen times the coils will match fairly well all over the band.

Of course, adjustments to the inductance of the coil in this manner must be carried out very delicately.

All coils when matched should have a thin coating of shellac to prevent turns moving.

The table shows some coil details. An improvement can be made to the aerial coils by using Litz wire for the grid winding. I.F. transformers are described in the book "Coils, Chokes and Transformers."

COIL TABLE (See Fig. 7)

Aerial and H.F. Transformers			Oscillator Coils		
	Grid Winding	Primary		Grid Winding	Reaction Winding
M.W.	100 turns 30-32g. enam.	30 turns 36-40g. enam.	pad .0005	80 turns 30-36g. enam.	30 turns 36-40g. enam.
L.W.	400 turns pile-wound 36g. enam. 3 slots	100 turns 36-40g. enam. 1 slot	pad .0003	250 turns pile-wound 3 slots 36g. enam.	150 turns 1 slot 36-40g. enam.
S.W.	16-50 metres 5 turns 18g. t.c.w. or enam. spaced one diameter wire	3 turns 22-30g. enam.	pad .005 fixed mica	4¾ turns 18g. enam. or tinned copper wire spaced one diameter wire	4½ turns 20-24g. enam.

Oscillator coils will have to be modified as explained in text.

"Cincpac"

"CINCPAC," a dramatic feature programme, broadcast on November 28th, was prepared with the co-operation of the U.S. Navy. It was one of a sporadic series produced by the B.B.C. in the U.S.A., and intended to present wartime America to British listeners. Other programmes have shown the Marines, the Seabees, the Navy and others at work in the Pacific.

The word "Cincpac" means nothing to most of us in Britain; to the American Navy it means Commander-in-Chief, Pacific, or, in other words, Admiral Chester W. Nimitz himself, the man responsible for so many things that take place in the Pacific Ocean, from commissioning a P.T. boat to giving a task force its sailing orders.

The show told the story behind Cincpac, how it was able to supply the Fifth Fleet away from base and enabled task forces to provide continuous air cover over Saipan for more than 40 days away from base. The capture of Saipan and the destruction of the Japanese left on the island were vividly dramatised.

The programme presented a picture of America, from its East Texas oilfields to its farms, and of the Navy in battle and at work, showing how Cincpac unites these two into an enormous and powerful war machine.

"Cincpac" was written by Merrill Denison, with music composed and conducted by Victor Bay. The programme was produced by an Englishman, Roy Lockwood, of the B.B.C. in America.

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

IN the latest H.M.V. releases, there are four records in the D.B. 12in. series which call for special mention. Two of them are devoted to the world-famed violinist Yehudi Menuhin, and two to the N.B.C. Symphony Orchestra. These names alone should be sufficient to warrant the recordings making a wide appeal, but when they are linked with Handel's "Sonata No. 4 in D," and Rimsky Korsakov's "Russian Easter Overture, Op. 36" respectively, there is little doubt that they will eagerly be sought after by the lovers of these two great masters. Yehudi Menuhin, accompanied by Marcel Gazelle on the piano, can be heard giving a perfect rendering of Handel's Sonata on *H.M.V. DB* 6175-76. The work is in four movements, Affettuoso, Allegro, Larghetto and, finally, Allegro. The first and third movements are slow and sombre, and although the second and fourth are naturally of a quicker tempo and lighter texture, I finished listening to the recording with a feeling that I have enjoyed Yehudi Menuhin much more when he has been playing other compositions which gave him even greater scope for his undoubted mastery of his instrument and superb technique. Lovers of Handel's music, will, however, enjoy a flawless interpretation of this work by a great artist ably supported by Marcel Gazelle.

The second recording, namely, the N.B.C. Symphony Orchestra playing Rimsky Korsakov's "Russian Easter Overture, Op. 36" is on *H.M.V. DB*6173-74, and the recording forms, in my opinion, one of the outstanding performances by that orchestra, which, in this instance, is conducted by Leopold Stokowski.

The composition calls for the best from all the performers concerned, and when I say that the performance is wonderful, I mean that no one was found lacking in skill and complete understanding of this great work. It is far too comprehensive for me to attempt to analyse it, therefore I strongly recommend it for your hearing.

There is a delightful record by Heddle Nash—Tenor—this month, its number being *H.M.V. C*3409. He sings, accompanied by the Liverpool Philharmonic Orchestra, conducted by Dr. Malcolm Sargent, "In Memory I Lie Beneath The Palms and Dream of Love," from Act 1 of "The Pearl Fishers" by Bizet, and "Spirit So Fair" from Act IV of "La Favorita," by Donizetti. I recommend this record for the vocal section of your library.

Coming to the 10in. series, I open these with another vocal, but in this instance, somewhat lighter. The record is *H.M.V. BD*1090 on which Ann Stephens has recorded those two jolly little pieces "Teddy Bear's Picnic" and Gourley's "Dicky Bird Hop," a number ideal for driving away the blues.

On the dance side, I recommend "Till Stars Forget To Shine" and "Too-Ra-Loo-Ra-Loo-Ral, That's An Irish Lullaby," a fox trot and waltz respectively by Joe Loss and his Orchestra on *H.M.V. BD* 5862.

"Time On My Hands," fox trot, and "Chloe" are two good numbers by Eric Winstone and his Band on *H.M.V. BD*5863, while those fans of Tommy Dorsey and his Orchestra will thoroughly enjoy the two pieces they play on *H.M.V. BD*5864, namely, "I Never Knew" and "Blue Skies" both fox trots.

Columbia

TO those who enjoy perfect pianoforte performances, I say "Make a note of *Columbia DX*1167-68 and 69." These are the numbers of three 12in. records on which Dennis Matthews (pianoforte) and the Liverpool Philharmonic Orchestra, conducted by George Weldon, have recorded Mozart's "Concerto In A Major" *K*488. The work is in three movements: Allegro, Adagio and Allegro assai, and it occupies the six sides of the three records. The performance by Dennis Matthews, and the Orchestra, is as delightful as it is perfect.

In the 10in. series, I recommend *Columbia DB*2155 which is a recording by Albert Sandler and his Palm Court Orchestra, playing "Geisha Selection" Part 1 and 2. This brings back warm memories of that delightful musical play, as the selection includes most of the well-known numbers. A fine record. Kathleen Ferrier—Contralto—gives an exceptionally good rendering of "O Praise The Lord" and "I Will Lay Me Down In Peace," on *Columbia DB*2152, Gerald Moore being at the piano. A most pleasing voice combined with perfect control and expression.

Bing Crosby enthusiasts will welcome *Columbia DB*2153 on which he has recorded "Let's Spend A Night At Home" and "Some Day We Will Meet Again," which Bing sings in his usual pleasing manner.

Another vocal is that by Monte Rey on *Columbia FB*3047. He sings "I'm So In Love" and "Let Me Love You Tonight."

Victor Silvester and his Ballroom Orchestra have recorded on *Columbia FB*3063, "Too Much In Love" —quickstep—and "Someone Is Thinking Of You" a waltz. A nice record for dancing in strict tempo.

Felix Mendelssohn and his Hawaiian Serenaders offer "Serendade to a Pagan Moon" and "Blue Bahamas" which they present in good style.

Parlophone

RICHARD TAUBER has made a fine record this month. He sings, with orchestra, "I'll See You Again" and that old favourite "Maire, My Girl" on *Parlophone RO*20533. His voice seems richer, and the expression and technique he puts into these songs reveals his great versatility.

Geraldo and his Orchestra offer two good fox trots on *Parlophone F*2043, they are "The First Few Days" and "Milkman, Keep Those Bottles Quiet." "Tin Pan Alley Medley No. 65" is on *Parlophone F*2042, and it is played, as usual, by Ivor Moreton and Dave Kaye. A nice selection of popular numbers.

Harry Parry and his Radio Sextet, have recorded for No. 49 and 50 of The 1944 Super Rhythm-style Series, "Parry Party" and "Gone with the Wind," *Parlophone R*2950.

Regal

I HAVE only one Regal this month, but it is an exceptionally good one in its particular class, by which I mean organ recordings. Its number is *Regal MR*3742, and it consists of "Finlandia," that fine work by Sibelius, played by Reginald Dixon at the organ. I recommend this.

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).

St. Pancras Radio Society

SIR,—May we once more encroach on your kindness by asking you to be good enough to make mention in your columns the fact that the society's classes have re-commenced, and new members are welcome to join at once.

All inquiries should be addressed to the Hon. Secretary, Mr. S. Barnett, 6, Anson Road, N.W.2.

We should like to take this opportunity to thank you for past and present favours.—S. BARNETT.

The "Home Service" Engineer

SIR,—I wish to write this letter in defence of the many radio hams who have done their fellow radio listeners a good turn by *servicing* their radio receivers, very often at the cost of the replacement parts only. Now, month after month there are letters in P.W., mostly from the radio trade, demanding that only people with a shop shall be allowed to service radio sets for other people, as most people who offer to service sets, unless they have a shop, are rogues, and know nothing about the trade. Now I should like to point out that having a radio shop that sells complete radio sets, does not make the owner a radio engineer, and although most radio dealers are honest men, I have met many that are not. I see lately that the radio trade is more or less demanding that only those licensed by the trade should be allowed to service listener's receivers. I should like to point out that very many radio traders employed servicemen in peace time, but as a large number of these are in the Forces, many people are very grateful to anybody who is able to service their receivers for them. I quite agree that there are a number of rogues who are making a good thing out of the shortage of skilled servicemen, but you will find them in nearly every trade. In pre-war days there were over 2,000 members of the R.S.G.B., a great many of them licensed radio hams, and all with a fairly good knowledge of radio. Many of these are in the Forces, but many remain at home on some important work to help their country, and often give up some of their leisure time in helping other people who do not happen to share their radio knowledge, and it is in defence of these, that I say to the radio trade: Make sure that all your own members are honest and competent before you talk of licensing radio servicing, and condemning outsiders as rogues.—DOUG. STEWARD (2HAB) (Hemel Hempstead).

Experiences with a Supergen

SIR,—On Saturday, October 28th, I made the single valve regenerative receiver described in PRACTICAL WIRELESS dated May, 1943. It is my first short-wave set, and it works well. I am using Mazda HL2 for the valve and home-made coils.

The following is my log from Sunday, October 29th, to Thursday, November 2nd. CBS New York, 19.6 metres, call sign WCBX. CBS New York, 16.8 metres, call sign WCBN. General Electric Station, Schenectady, 19.7 metres, call sign WGEA. Berlin, Germany, 31 metre band. The voice of the Italian Social Republic, 35 and 45 metres. Germany, 47.6 metres. The B.B.C. North American Service (I would like to know the call sign and wavelength of this station). Radio Brazzaville, 24 metres, call sign FZI. Schenectady, 25.3 metres. call sign WGEX. Boston, 25.45 metres, call sign WRUL. CBS New York on the 16, 19, 25 metre band, call signs WRNA, WRNI, WRNX. General Forces programme, American Station in Europe. B.B.C. African Service, The British Mediterranean station (wavelength and call sign unknown for last two). The American controlled Algiers radio, 31 metre band; and WKIG, Western, Mass., wavelength unknown. Hoping this information may be of interest to other readers.—F. ARMSTRONG (Cheshire).

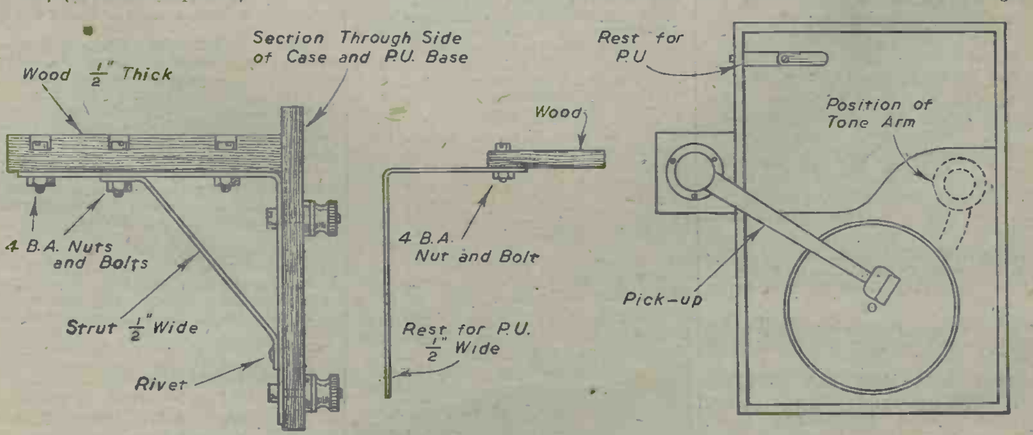
Pick-up for Portable Gramophone

SIR,—With reference to the method of fitting a pick-up to a portable gramophone, given by Northern Reader, I have recently fitted one to a Columbia Portable. The method I adopted was to fit a portable base for the P.U. outside the case and attached to one side with two 4BA screws and milled edged nuts, which makes it easy to attach. It can be removed complete with P.U. and does not interfere with the gramophone in any way. I also fitted a rest for the P.U. when changing the records; this can probably remain a permanent fitting inside the case.

The position and height of the base is determined by the length and height of the P.U.—E. W. BULL (Southsea).

An Open Letter to the B.B.C.

SIR,—With reference to the many complaints already received by you, on the distorted reception of B.B.C. Transmissions on the Home and Forces wavelength



Method of fitting pick-up to portable gramophone. E. W. Bull (Southsea).

(Allied Forces excepted) in the south of England, I would refer you to PRACTICAL WIRELESS, the issues as given below: December, 1943, page 40; March, 1944, page 173; April, 1944, page 216; August, 1944, page 393.

I feel quite sure copies of this publication were supplied to you in respect of the complaints. From a perusal of the excuses offered from time to time for bad reception in this area, they are as follows:—

(a) Assistance to enemy.

(b) Mush areas.

(c) If good reception in south of England, bad reception elsewhere.

With regard to (a) and (b). Surely this can no longer hold good in view of the existing military situation. Radio Paris gives a good signal, so is not worried with (a) and (b).

With regard to (c). The remarks of your Mr. Burton are most interesting in his reply to Mr. Field in the issue of PRACTICAL WIRELESS of March, 1944, wherein he states this bad transmission can be cured, but only at the expense of other listeners.

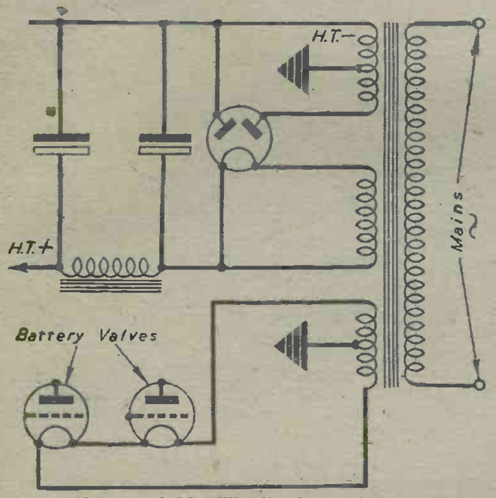
In view of the fact that the south of England have suffered the awful noises coming from your Studios for the past two years, how about giving the "others" a chance to enjoy it; as we have had our fill.

The old story of screens and vertical aerials makes no difference; *all* frequencies are hopeless after darkness has set in.

The Allied Forces wavelength is perfect, so why cannot the general public who foot the bill be considered. —L. H. BUCKLEY (Poole).

Converting Battery Set to Mains Operation

SIR,—I had a battery receiver which I wanted converted to mains. So instead of going to the shop and buying two A.C. valves, I disconnected the filament wires from the valves on the set and wired them in series and



Circuit of Mr. Wood's Conversion.

connected them to the heater winding of the transformer as the winding was 4 volts and the valves were 2 volts each, and in series, the voltage was perfect. You will see what I mean by my circuit above. The set works quite well.—J. M. T. WOOD (Enfield).

Has Esperanto any Advantages?

SIR,—I am an old reader of "P.W.," which has been my only contact with radio affairs since 1939. Like other readers, I am looking forward to the days when we can continue our activities with DX as in pre-1940 days.

No doubt before the war many amateurs who were lucky enough to possess their own DX had contacts with their brothers in other lands, who could understand our language. No doubt also many amateurs missed many contacts and a great deal of useful information and pleasure just because they didn't know French or Norwegian and the other fellow didn't know English.

I am an Esperantist and I would like to point out to other radio enthusiasts through the medium of "P.W." the advantages of Esperanto for the amateur transmitter. This international language, Esperanto, has a technical vocabulary which includes all words used in radio, even the modern terms used in television. Esperanto can be learnt in a fraction of the time required for languages such as French, German and Spanish, etc. I might mention that the Japanese scientists have been quick to realise the advantages of Esperanto for technical and scientific purposes.—J. C. D. SMITH (Burnley).

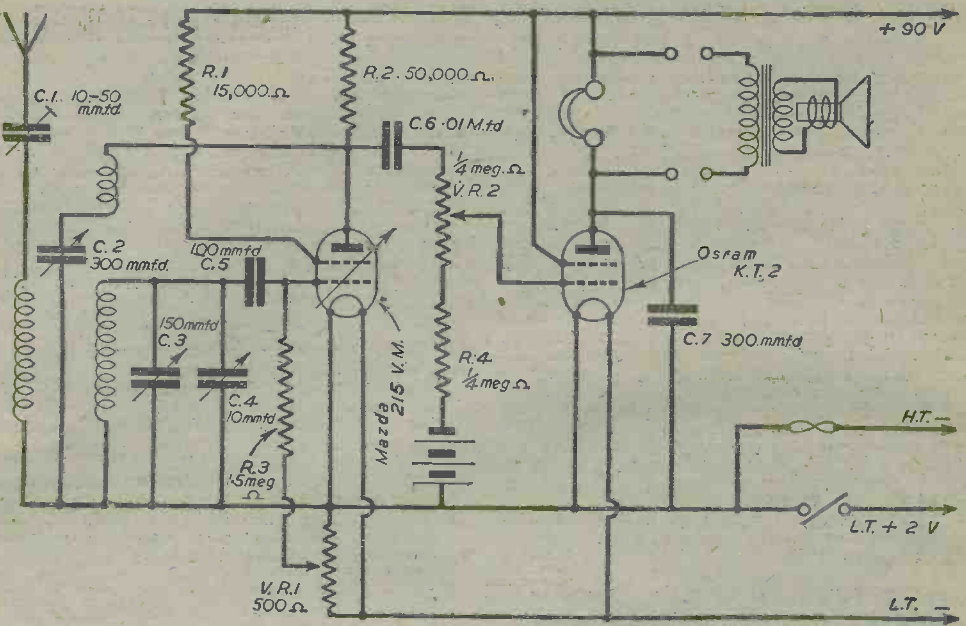
Midget Design

SIR,—An example of confused inferences is shown in your November issue by Mr. W. H. Williams (Llandudno), who criticises the design of the Midget A.C./D.C. receiver of Mr. Marshall (September issue) entirely without foundation. To his various assertions the answers are:

1. Commercial A.C./D.C. *Midgets* with throw-out aerials do not make provision for an earth connection; indeed, they usually forbid the use of same.
2. The sign ⏚ when applied to *A.C./D.C. Midget* circuit diagrams is construed as indicating chassis and *not* true earth unless so indicated by the letter "E."
3. The filament circuit drawn by Mr. Marshall does *not* show a short to earth when switched on, as there is *no* true earth connected but technically the earthy end of the 606 filament should be shown direct to chassis, with chassis and one side of the mains made and broken by one pole of the double-pole O/F switch.
4. The H.T.— ends of reservoir and smoothing condensers decidedly go to chassis, as chassis is H.T.—.
5. The cathode of V2 is in direct contact with chassis (H.T.—) where it should be.
6. The screen of V2 has on it a positive potential via the output valve's biasing resistance and therefore is positive with respect to its cathode, which is at chassis H.T.— potential.

The assertion (I quote): "Of course, the simple insertion of a condenser of high working peak voltage cures all the faults indicated" (end of quotation) is, to put it mildly, somewhat misinformed and irrelevant.—R. SKELTON (London).

SIR,—I give my experiences with a small S.W. receiver. My set started as the "Economy 3 DX," but the H.F. stage proved unsatisfactory (the V.M. tet. I used was over 10 years old). I cut it out and rebuilt the set as a two-valver (as circuit). All components except the six-pin coils and the output tetrode were scrap—the tuning condenser was a .0003 minus half of its plates, the bandspread was a .00015 diff. reaction condenser with one lot of fixed plates removed and now has one fixed, one moving plate (about 10 mmf.). From July 31st I have logged about 25 U.S. stations and about 30 others, all north of the Equator except Shonan and Botavia on the 19 m.b. I have QSL'd WMB1 and received a letter and a 12-page schedule of programmes for all New York stations up to September 30th, but as the letter arrived on October 2nd this was not a great deal of good! I also received a veri. from WBO8 and have sent reports to various other stations, including PRL8 (Radio Nacional Rio de Janiero) and WNGL (Puerto Rico). I have picked up war correspondents calling from Rome on about 15.30 m/c. (19.5 m.); (I picked up Donald Coe's report of the Caruso trial, which was very interesting), and wondered if this station was 2RO6, which is scheduled on 15.300 m/c. Another point—I wonder if British propaganda comes up to the "thrillers" put over on "Radio Metropole" (25.88 m., 11.6 m/c.).—R. T. AMBLIN (Bath).



Mr. Amblin's Circuit.

Automatic Speed Control

SIR,—Myself and my friends here read with great interest the letter of Mr. L. Warner, regarding A.S.C. We should like to point out, however, that the use of wave-guides, etc., does not actually speed up the transmission, but merely delays part of it and then lets the whole thing out at once, thus giving the impression that the transmission is faster. Whereas this device might be of great help to your reader, who wishes to hear the "News at dictation speed" at the normal speed, I'm afraid that it still doesn't help us down here in our search for a circuit to speed up the transmission, so that we can hear the football results on Friday evening! Can any of your readers help us, please?—A. H. GREEN (Stony Stratford).

[*We are astonished that readers are taking A.S.C. seriously.*—ED.]

Radio Shonan, Etc.

SIR,—With regard to M. Goldberger's inquiry, Radio Shonan is at Singapore. I have only heard the station once, about a year ago, when it was announced as "Radio Shonan—formerly Singapore." I heard news in English until 22.30 B.S.T.

The station referred to by W. H. Borland has also been heard on medium waves on about 220 m. It appears to be part of a B.B.C. service since transmissions are often followed by the drum-V sign and "Ici Londres." The following announcement heard recently and addressed to Romo may be of interest:

"In future we shall be using a frequency of 7,205 Kc/s except for the period between 19.00 and 20.00 G.M.T., when we shall be on 6,050 Kc/s."

Some of your readers may be able to give some information about "The British Mediterranean Station, the Voice of the United Nations," in the 49 m. band.

Stations heard recently which I have not seen mentioned are ZNR, Aden, Arabia, on 24.76 m., and PRL8, Rio de Janeiro, Brazil, on 25.6 m. ZNR is usually R7, and PRL8, which broadcasts in English from 20.30 to 21.15 B.S.T., varies from R2 to R7.

Wishing your excellent paper every success, I remain, Yours faithfully.—G. HINBEST (Rainham).

Post-war Programmes

SIR,—I think it is about time some of us got down to the business of discussing what type of broadcasting and programmes we would like in the post-war days.

So far the B.B.C. has stated that the Regional Broadcasting will be resumed. Another idea set up by them is to have a row of buttons. By pressing button A we will hear some programmes of culture content—a Sibelius symphony, a Haydn quartet, a Sheridan play, the Brains Trust, etc. Button B gives us Variety, Music Hall, Dance Bands, Boxing and Racing. There are things to be said in favour of these ideas, and others against, and that is what I want to get at. We radio amateurs who have listened to stations and programmes from all round the world, should have a good idea of what we want to hear. I would like to see a discussion group started on post-war broadcasting, either through the medium of PRACTICAL WIRELESS or by letters to each other, and sending in reports to be published in PRACTICAL WIRELESS.

If we get a group started there are a great many things we could discuss. So I invite other radio amateurs to write to me as soon as possible, and see what we can arrange.—GEORGE A. LOCKIE (Kelso).

Service Engineers

SIR,—PRACTICAL WIRELESS is always good—sometimes better than at others. November issue is very good, and I am pleased indeed at the interest PRACTICAL WIRELESS is taking in service engineers.

I'm not a service engineer, though it is my intention to become one. Experimenting with, and designing sets (not too complex) has been my hobby for some twelve years, the last five of them spent in the Army, during which time I have managed to get a good grounding in servicing Service sets.

But when one reads letters like those from our friends F. J. Grant and P. D. Vickers, it makes one wonder if this radio business is really worth while.

Perhaps the answer is in November's "Comments of the Month." It certainly made pleasant reading to me, and I should think to a lot of people like me.—W. CAMERON (Newmarket).

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RADIO SOCIETY OF GREAT BRITAIN invites all keen experimenters to apply for membership. Current issue "R.S.G.B. Bulletin" and details, 1/- below.

AMATEUR RADIO HANDBOOK (300 pages), paper cover, 4/-; cloth, 6/6. Radio Handbook Supplement (140 pages), paper cover, 2/9; cloth, 5/-.—R.S.G.B., 28-30, Little Russell Street, London, W.C.1.

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Radio tuning units, add to any amplifier 4 or 6.3 volt valves (state which), 1 R.F./Det., complete kit, £3; 2 R.F./Det. with A.V.C., £4 7s. 6d. Any above, assembled, £1 extra. **COILS!**—M.W. aerial or H.F., 2in. x 1in., 5/- pair; super quality litz wave-wound, 7/6 pair; dual wave with reaction, 10/6 pair; suitable H.F. chokes, 1/6; reduction dozen coils, circuits on request. Small .0005 2-gangs, 12/6; double trimmers to suit, 1/6. Cash or C.O.D. S.A.E. with enquiries please.—BM/ZDDF, London, W.C.1.

B.A. thread screws and nuts, one gross assorted useful sizes, 2/6; ditto, brass washers, 1/6 gross. Fibre washers, 1/6 gross; assorted solder tags, 2/- gross; assorted small eyelets and rivets, 1/3 gross. Rubber-covered stranded copper wire, 1d. yard; heavier quality, 1½d. yard; very heavy quality, 2½d. yard; ideal for earths, aerials; etc. Tinned copper connecting wire, 20ft. coil, 6d.; ditto, rubber covered, 10ft. coil, 6d. Finest quality resin-cored solder, ½lb., 2/-. Wood's metal stick, 2½in. by ¼in., 1/-. Cotton covered copper instrument wire, ¼lb. reels, 18, 20, 22, 24 gauges, 1/6; 26 gauge, 1/9; 30 gauge, 2/-; 42 gauge double silk covered, 2 oz. reel, 2/-; 32 silk covered, 2 oz., 1/9; 36 ditto, 1/9. Sensitive permanent detectors, Tellurium-zincite combination, complete on base, guaranteed efficient, 2/6; reliable crystal with silver cat's whisker, 6d. Reconditioned Headphones, complete, 4,000 ohms, 12/6. All postage extra.—Post Radio Supplies, 33, Bourne Gardens, London, E.4.

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PUSH BUTTON UNITS. Complete with 12 buttons and escutcheon, 8/6. 8 button unit with knobs and mains switch, rated 125v. at .3 amp. and 250v. at 1 amp., 5/6.

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DROPPING RESISTANCES. Best quality, 750 ohms, .3a., 7/6. 1,000 ohms, .2a., 7/6 p.f.

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The index letters which precede the Blueprint Number indicates the periodical in which the description appears: Thus P.W. refers to PRACTICAL WIRELESS, A.W. to *Amateur Wireless*, W.M. to *Wireless Magazine*.

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PRACTICAL WIRELESS, January, 1945

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