The Wireless World

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Telling the Public

A Change of Attitude

IF we were asked what we regarded as the outstanding feature of this year's Radio Show, we would say that it is to be found in a revolutionary change of attitude on the part of the radio manufacturer, and especially of his publicity department, towards the buying public. In our view this change is more revolutionary even than the improvements in this year's instruments, good as these are.

For years manufacturers have been telling the public what a good thing it is to have a wireless set in the home and each manufacturer has done his best to point out to the public how much better or how much cheaper his sets are than those of his rivals.

Influence of Saturation

Now that the point of saturation is beginning to be reached in the distribution of sets to individual homes, and when most of the sets so distributed are still fairly serviceable, the manufacturer has at last been brought face to face with the fact that this type of propaganda will no longer sell a set to those who already have one, and may even tend to encourage users to continue with their old sets because no effort is made in such publicity to make them aware that the new types have so much more to offer. The change which has come about this year is remarkable. Wherever you go in the Exhibition, and wherever you meet with radio advertising, emphasis is laid on the technical progress which wireless and television have made and the features of the sets are described without any of the former reticence in the use of technical expressions. The public is told just what the sets have been designed to do and what are the principal improvements introduced. At last we seem to have passed that phase in the history of the wireless industry when every set had to be sold as a musical box and makers were afraid to make any reference to what was inside.

The disappearance of the Radio Theatre at Olympia no doubt came about because it was at last brought home to the organisers that such a display was only useful so long as an appeal was being made to those who had never had a wireless set and would like to know what entertainment broadcasting could provide.

The approach of saturation and the knowledge that nearly every prospective buyer of a set is already a user of some set has brought about this revolutionary change in the manufacturer's attitude towards the public. It is now appreciated that the public is experienced in wireless, is by now capable of summing up the deficiencies of the old sets and will be responsive only to the appeal of new technical improvements such as the manufacturers are able to offer this year. These new features are at last being explained intelligently to a discriminating and experienced public.

The Element of Surprise

We hope that the manufacturer will not lose sight of the importance of this approach to the public, and we believe also, now that the market for wireless sets has stabilised, that it would be useful from all points of view and would certainly increase public interest if new models and new devices were reserved as far as possible to be launched as surprises at show-time rather than released all the year round, often leaving little element of surprise for the annual exhibition, and so creating the impression that progress is far less marked from year to year than is really the case.

Diversity Reception

USE OF INTERCONNECTED RECEIVERS FOR

By R. H. TANNER, B.Sc., A.C.G.I.

THOUGH the elaborate "spaced aerial" reception methods employed by the B.B.C. for long-distance relays are quite out of the question for domestic purposes, it should be comparatively easy to apply the simpler two-channel anti-fading system described in this article.

THE normal method of securing diversity reception by the use of aerials spaced from one another by distances large compared with the received wavelength is hardly suitable for home use; few people have a garden of adequate dimensions even if short waves alone are considered. However, a similar improvement in reception can often be effected by the use of a frequency diversity system, whenever it is possible to receive two transmitters radiating the same programme, even though both may be fading severely. In this way, the Empire programme can be received with pleasanter results in remote parts of the world. In addition, many foreign programmes on all wavebands are radiated by two or more transmitters and thus lend themselves to this method of reception.

The general principles of diversity reception were dealt with in a recent article in *The Wireless World* (January 13th, 1938) by H. W. Griffiths, and it is sufficient to say that in the simplest case the AVC systems of two receivers are coupled together and the audio outputs mixed to give a composite and, it is hoped, fading-free programme.

The essential parts of the circuit of a present-day superhet receiver are depicted in Fig. 1, and few sets of this type will be found to differ greatly from this, although the number of stages employed in the various sections of the circuit will depend on the complexity and sensitivity of the individual receiver. For diversity reception, two such receivers are necessary, and it is preferable though not essential that both should be of the same make and type, as they will then have similar AVC characteristics and similar AF sections.

The interconnections of the AVC systems may be made in one or two ways, depending on the arrangement of the decoupling, but in most cases the best method is to connect the two corresponding points marked "A" by the simple filter shown in Fig. 2. This filter is included to prevent the mixing of the two intermediate frequencies which would otherwise give rise to most objectionable whistles. During tuning operations, or when the two sets are being used separately, the connection is broken by the switch S1.

The mixture of the two audio-frequency outputs is not such a simple problem and may be solved in many quite different ways. The decision as to the best method to use in any individual case will depend to a certain extent on the amount of diversity reception likely to be carried out. In cases where this is small, two possibilities present themselves. The first and simplest is to use two loud speakers placed side by side, one fed from each set. For instance, the two sets may be left in their own cabinets, with only one lead between them connecting the AVC systems. If this lead is provided with a plug-and-socket connector, which may replace S1, the sets may readily be separated and their individual usefulness is completely unimpaired. With the loud speakers mounted on two separate baffles no means of altering the relative phases need be provided, but if they are mounted together on one baffle, provision must be made for reversing the speech coil connections to ensure that the two outputs will add up and not tend to cancel one another out. In this connection, it should be mentioned that difficulties may be experienced if the land lines connecting the two transmitters to the programme source differ greatly in length, as they may, for example, in the case of two American stations. The additional phase delay thus introduced into one circuit causes the two programmes to sound

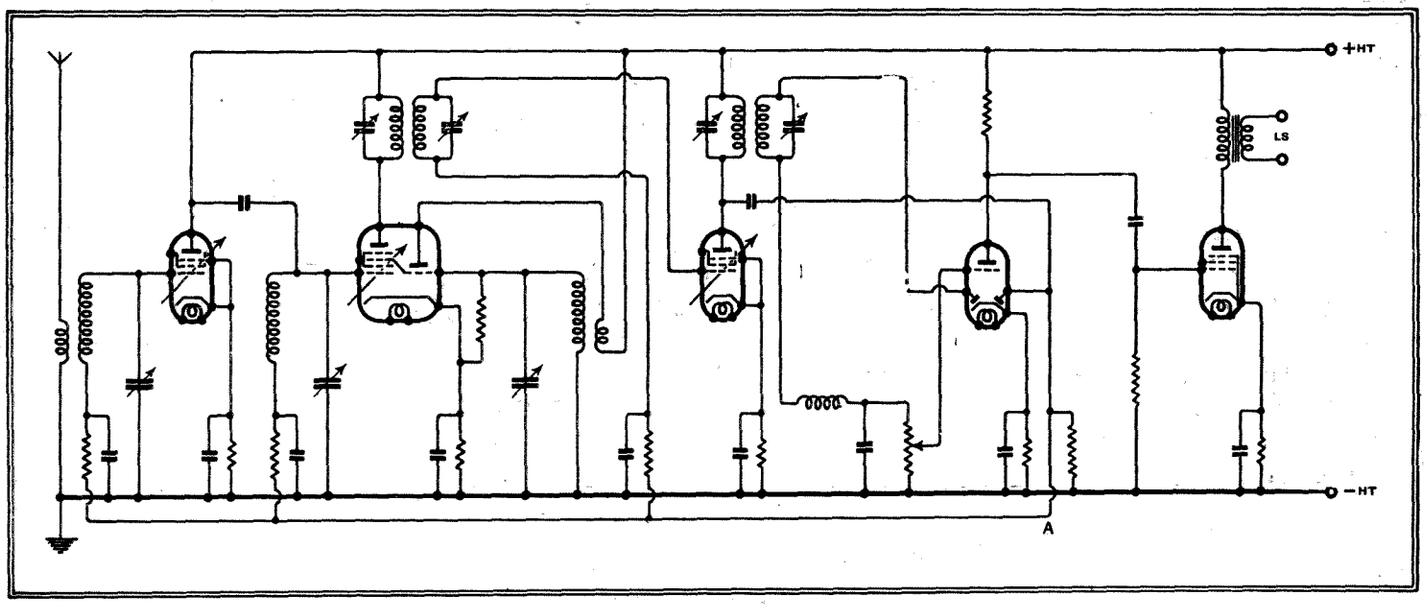


Fig. 1.—Circuit of a typical modern receiver suitable for diversity reception. Decoupling, screen supplies and wave-change switching have all been omitted for simplicity.

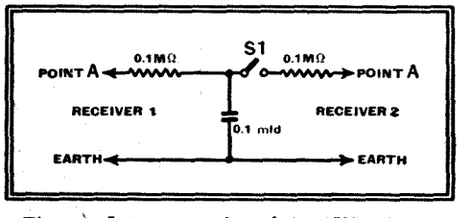


Fig. 2.—Interconnection of the AVC systems of two receivers through a simple filter circuit.

at Home

COUNTERACTING FADING

slightly out of step, with somewhat unpleasant effects. No echo, however, could be detected when listening to London and Welsh Regionals together.

The second possibility is to use the circuit shown in Fig. 3, where only one speaker is used and mixing takes place in the speech coil circuit. Two separate output transformers must be used and a reversing switch provided. The two sets are again kept quite distinct, and when not in use together may be arranged to supply two programmes to different parts of the house.

When it is intended that diversity reception shall be the set's chief function, a rather more elaborate alteration may be made with advantage. The mixing is arranged to take place in the grid circuit of the output valves, which in this case must be similar, as they are arranged in push-pull. The circuit is shown in Fig. 4 with the alterations indicated by dotted lines. The rebuilt set has the advantage

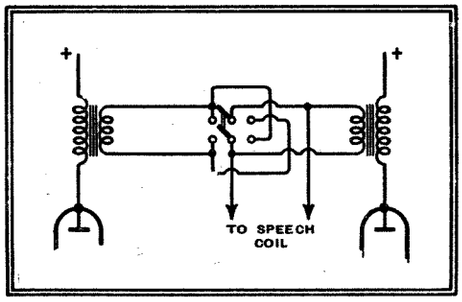


Fig. 3.—Feeding a single loud speaker from two independent receivers, connections to the output valve anodes are shown.

of greater output without distortion even when only one station is being received. In the case of mains-operated equipment, two high-tension supplies are now available and advantage of this may be taken by feeding the output valves independently of the remainder of the set. This will generally prove to be an equitable arrangement, as the current drain on the two sources should be approximately equal. Alternatively, when using two identical receivers, the HT supplies may be paralleled. Three additional switches have been included in the diagram, the first of which, S1, has already been dealt with. The second, S2, is used to disconnect the HT supply from one of the receiver sections when using the rest of the set in a normal manner. The third, in conjunction with a centre-tapped choke, allows the relative phases of the two programmes to be reversed. For convenience these last two may readily be combined and controlled by one knob with three positions. The centre-tapped choke feeding the output valves may be merely the secondary winding of a standard push-pull transformer, the primary of which is left unconnected. As it is not required to carry DC, it may well be of the miniature nickel alloy type. The only other change necessary which has not yet been mentioned is the provision of a suitable push-pull output transformer matching the valves to the speaker.

So far nothing has been said on the important question of aerials. The best

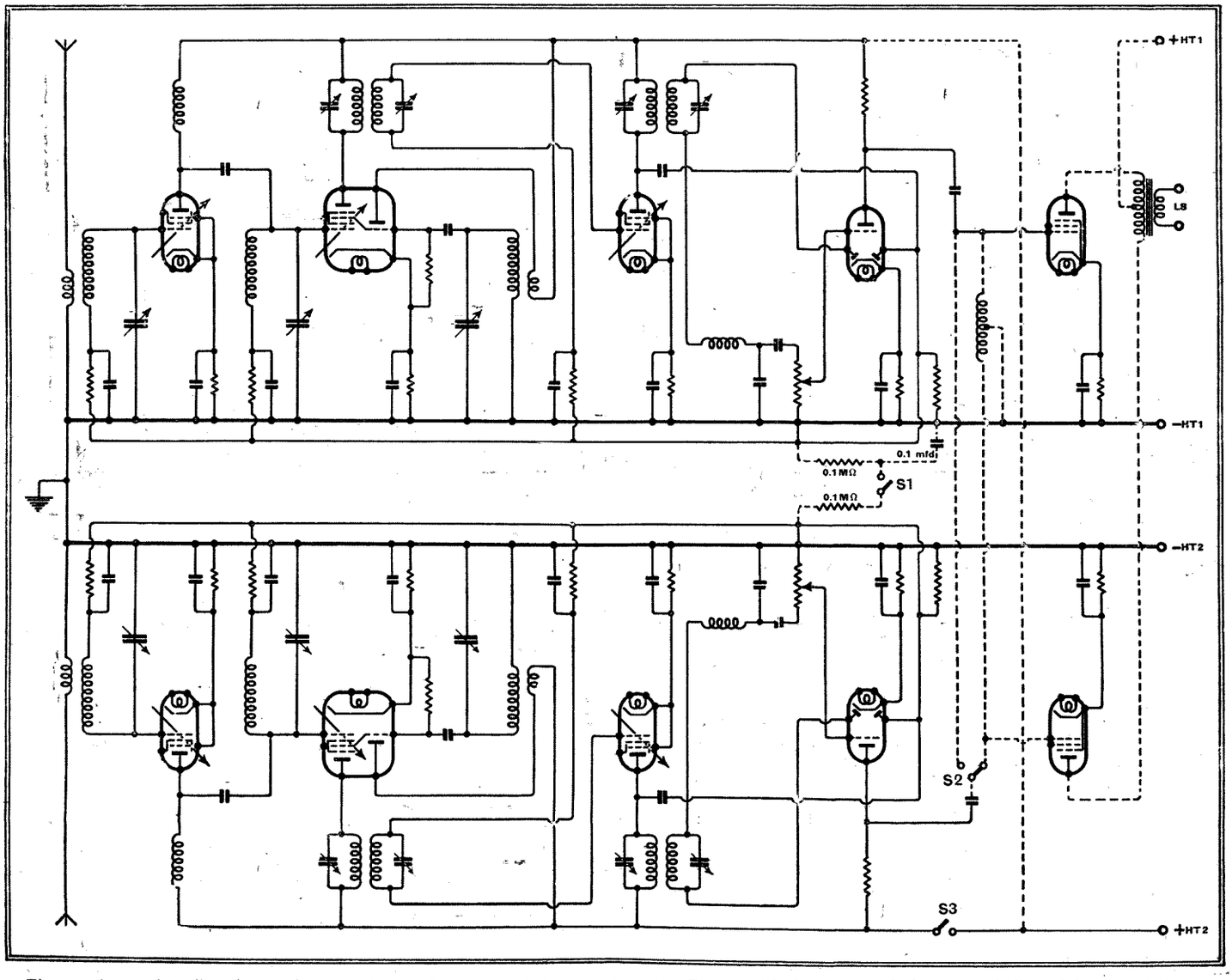


Fig. 4.—A complete diversity receiver, consisting of two sets of the type shown in Fig. 1, with the suggested alterations indicated by dotted l

Diversity Reception at Home—

arrangement, especially for short-wave work, is to erect two so that the electrical coupling between them is small. In this way the interaction between the two input circuits is reduced to a minimum. One interesting idea for short-wave reception involves the use of one horizontal and one vertical aerial, and with this arrangement it is possible that the diversity effect will be present even with the two sets tuned to the same station, owing to the fact that the horizontally and vertically polarised waves will not normally fade together. In parenthesis, it may be repeated that for true "spatial" diversity reception the aerials should be spaced apart at several wavelengths distance, although the receiver requirements are the same for both systems.

It is sometimes perfectly feasible to use the aerial for both receivers without undue ill effects, assuming, of course, that no experiments with spatial diversity reception are intended. It is, therefore, always worth while carrying out the simple test of tuning-in a station on one set, with the AVC systems isolated, and then removing the aerial from the other receiver, noting the resultant increase in signal strength. If this appears excessive, it is worth while trying the experiment again with a resistance of from 10,000 to 50,000 ohms in each aerial lead before deciding that it is necessary to erect a second antenna.

This article is not intended to be an exhaustive study, but is directed rather towards suggesting subjects for further experiments. Sets differ too greatly in details of design and in performance for any hard and fast rules to be laid down. The system has been successfully tried out, so far as reception conditions in London would allow.

Theory into Practice

II.—RECEIVER WIRING AND ITS INSULATION

By R. H. WALLACE

ALTHOUGH a theoretical circuit diagram conveys much information in a small space, it does not tell quite the whole story. This article and the one that preceded it deal with the problems encountered in translating a theoretical design into a practical receiver.

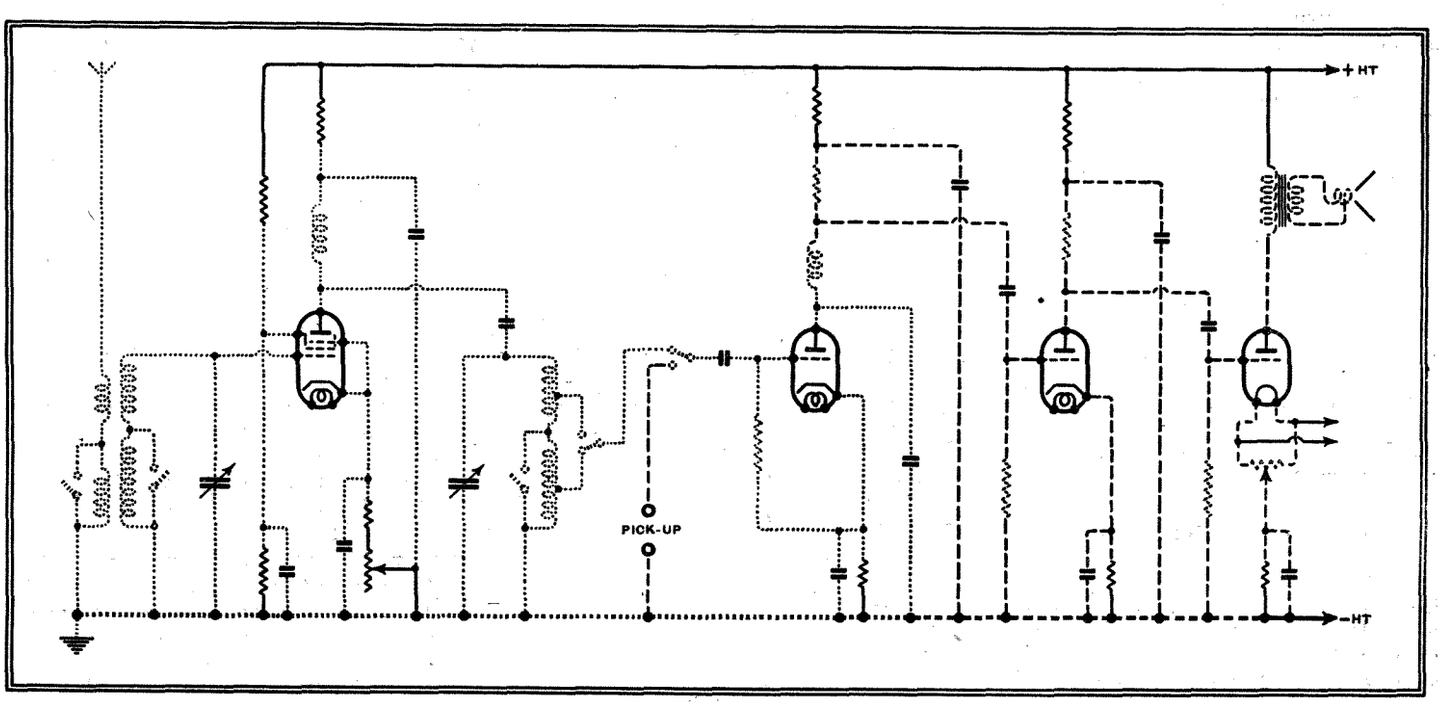
IN the circuit diagram of a receiver all the wiring is represented alike by neat black lines, the only indication of its nature generally given by the designer being as to whether it is to be screened or not. Unfortunately, the faith thus placed in the discretion of the builder is not always fully justified, and many excellent designs are impaired by the wiring of the various parts of the circuit not being properly adapted to their special requirements.

Obviously the type of connecting wire suited to the aerial circuit will not necessarily be right for the power supply circuit. But there are more subtle distinctions than this, and it is the purpose of this article to treat briefly of the type of insulation and wire best adapted to the different parts of the circuit and its correct disposition.

The natural place to begin seems to be at the aerial terminal, and here we are dealing only with currents at radio frequencies and of small magnitude, which need to be nurtured carefully so that as little as possible is lost. The size of conductor in this part of the circuit, except where the highest frequencies are concerned, is based mainly on the mechanical rigidity required, and should not be less than 18 SWG., while 16 SWG. is to be preferred as it is about twice as strong. For the short and ultra-short wavelengths the latter size should be considered a minimum, as the stability needed to ensure constancy of the stray capacities and inductances is not otherwise obtained; similar remarks apply to the oscillator wiring of a superhet if correct ganging is to be obtained.

It is usually considered that bare wire is preferable to tinned wire at the highest frequencies on account of the "skin effect," but since bare wire is readily corroded should the set be out of use, it is the opinion of the writer that it is better to use silver-plated wire if possible, since it is not only a better conductor than copper but less liable to corrosion; the use of lacquer coatings will, of course, raise the losses.

In the RF circuits the best insulator of all is air, and it should be used wherever possible. There are many cases where unsupported wire would be liable to make contact with other wiring, or the chassis,



Skeleton diagram of a "straight" receiver, showing nature of the currents flowing in the various sections of the wiring. Full lines indicate wires "dead" to both RF and AF, while those wires which carry AF are shown in broken lines. Dotted lines indicate radio-frequency wiring. It is assumed that all the decoupling condensers are completely effective.

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and the use of uncovered wire can be made possible here by the suitable positioning of one or two pillars of ceramic or other insulator, according to the wavelength involved. Next in efficiency to air come the special "low-loss" insulators now to be had. Unfortunately, few of these are flexible enough to be used directly as a wire covering, except in the form of small beads threaded thereon, and their cost militates against their extended use. The only common field of employment of this material as an insulator for wire is in the better class of screened lead where the beads are used as spacers; this class of lead is much better than a fine wire threaded through sleeving, both in respect to losses and constancy of capacity. In special cases, for short, straight runs it is possible to use bare wire inside a metal tube, with only a few spacing washers of ceramic or varnished paper at intervals, thus making practically a concentric feeder.

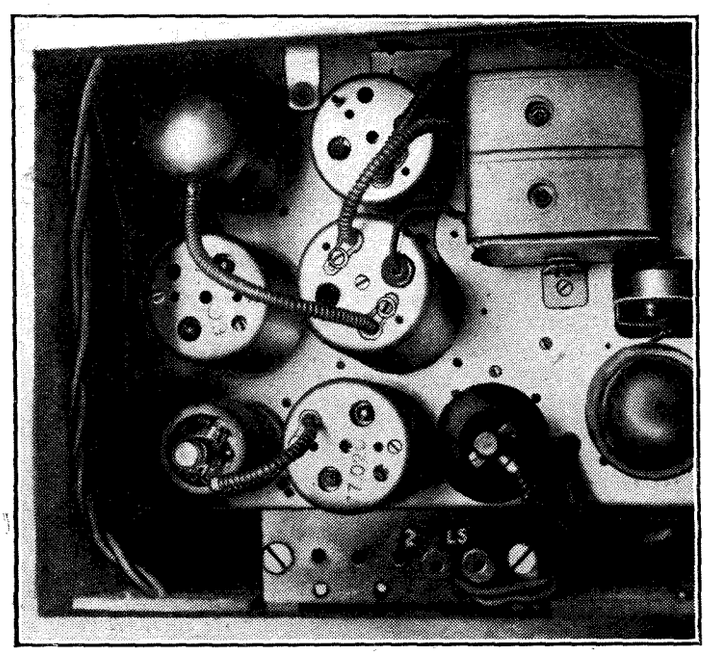
The above remarks apply with greater force the higher the frequencies in use; at no frequency will the use of the best materials be otherwise than an advantage, but the benefit derived from their employment may be negligible at lower frequencies, appreciable at medium, and quite essential for satisfactory results at the highest.

In a similar manner the effects of stray inductive and capacity coupling vary with the wavelength. Most people are aware of the precautions to be adopted, but not all are sufficiently discriminating in their perception of which leads are at RF potential. A case in point is the lead to earth from a decoupling condenser. The fact that one end of a wire is connected to the chassis is taken by some to mean that it cannot be carrying RF currents; actually in this case it has to pass currents balancing those flowing in the other lead, and so can cause interaction with other wiring if near to it. At the higher frequencies even the chassis cannot be considered as "dead" in the RF sense, and it is necessary to connect the earth lead of the set directly to the part of the chassis where the connection from the ganged condenser is made, as this gives the shortest earth paths with most designs. In such cases also it is wise to use copper strip or braid for the wiring from condenser and inductances to ensure that these are as low in resistance as possible. On the same grounds the use of a common earth lead from several components to the chassis is to be deprecated, and each section of a ganged condenser should be separately earthed to the chassis.

Uncontrollable Regeneration

The foremost objection to excessive stray capacity to earth is that it restricts unduly the tuning range of the set, but if the dielectric involved is poor the losses will be greatly increased, so much so as to prevent satisfactory operation in some cases. Both of these evils are lesser ones than that of interaction between the different portions of the circuit, and it is the function of screening to prevent this taking place to an excessive extent. The amount of screening needed is dependent on the amplification involved; where this is low the amount of screening needed is small, but with high-gain RF amplifiers complete isolation of the various circuits is essential; this is where the use of differing frequencies in the various stages, as with the superhet, enables large amplifications, such as would hardly be possible with a straight set, to be obtained.

It is the essence of good design to reduce all stray regeneration to a minimum, as it is easy to introduce a controlled amount later if needed, while the effect of stray couplings is not easy to calculate and may vary a great deal between one set and another made to the same specification.



Use of screened leads in a high-gain superhet. Also note that the volume-control potentiometer is mounted on a bracket in such a way as to bring it close to the valve with which it is associated.

The small fields due to the currents in the leads of the RF section are not likely to cause much trouble from inductive pick-up, and in any case the screening used to prevent capacity effects will be almost as effective in combating the former at these frequencies. The manner of wiring may, however, add considerably to the inductance of the tuned circuit at very short wavelengths where the self-inductance of a few inches of wire may be significant, and a careful arrangement of the connections is well repaid. The great thing is to avoid the formation of loops in the wiring, and this adds to the effect; it will be found preferable in most cases to keep the "go" and "return" wires close together, and put up with the attendant increase of stray capacity, rather than separate them and increase the inductance.

At the highest frequencies regeneration is not likely to be much trouble, and indeed is often difficult to provoke; of more importance is the reduction of losses to the lowest possible amount. At the other end of the spectrum the stage gain is high and the interaction between the anode and grid circuits, caused by stray couplings among the wiring, would be enough to cause instability even if every component were separately screened. Nevertheless, it is not possible to screen much of the wiring individually without heavy losses, even with the best insulation, and one has to rely rather on careful placing and the use of screening boxes to make a stable amplifier. In the writer's opinion the use of more than 6 inches of ordinary screened sleeving or 9 inches of special screened lead per stage should be unnecessary with a good design. Exception must be made in the case of reaction wiring where the losses are relatively unimportant.

Special reference must be made to the most difficult stage of all, from the point of view of design, namely, the detector. The difficulties with this arise from the fact that it has to be treated both from the standpoint of RF and AF currents. The wiring must be considered as a part of the two sections of the set and must be low-loss on the grid side and well screened on the anode side. The diode should receive similar care.

The subsequent stages of the receiver should be quite free from RF impulses and the length and disposition of the wiring is of less moment, while its insulation against the increasingly higher voltages becomes much more necessary. Capacity interaction will be less, but owing to the greater currents flowing inductive pick-up is more likely to take place. Careful layout of the set will solve most of the problems of this part of the design, while screened wire may be used more liberally, though the use of an excessive amount will reduce the high-note response. The grid circuits naturally call for the greatest care both in insulation and in their relation to other parts.

The voltages on the wiring of the AF amplifier are the steady ones due to the anode supply of the valves plus the signal voltages; the latter may rise to very high peak values. In deciding on the insulation required it is wise to allow for twice the steady voltage in anode wiring, while that of the grid should be at least as good; in the case of large output stages the grid peak volts may rise to as much as 200.

Theory into Practice—

Pick-up wiring, being an extension of the grid wiring, needs complete screening, and if the high-note response does suffer it is generally easy to arrange for the output of the pick-up to be compensated accordingly, while the hum induced by the absence of the protection would normally be intolerable. Care should also be taken that these leads do not run near the gramophone motor coils, or the heavy field will penetrate the screen. Microphone leads are even more susceptible to this trouble, as subsequent amplification is usually higher and the screening material must be carefully chosen for low resistance if it is to be fully efficient; a heavy braid is probably the most suitable.

Perishable Insulation

In connection with the use of rubber insulation it should be remembered that almost all natural rubber suffers considerably from ageing, which causes it gradually to harden, and this is the more rapid the higher the ambient temperature. If flexibility is important in a lead it is wise to replace it every five years or so. Natural rubber is also affected by oil, and in radiograms care is needed to ensure that the oil from the motor cannot drip into the set, while the motor leads themselves are better covered with varnished sleeving, which resists this attack.

All the wiring beyond the decoupling resistances may be considered as "dead" in the RF and AF sense, so long as the associated condensers are of sufficient capacity, and these wires may be of any reasonable length. This, however, must not be taken as an indication that they may be treated carelessly at such points as those where they pass through a screen or chassis, or rub against an earthed component, and extra insulation should be provided at such points.

With the higher voltages used in television apparatus special care must be taken and no bare wire or terminal should be nearer than $\frac{3}{4}$in. from any earthed point for voltages of up to 10,000 volts, while for the projection-type cathode-ray tubes where the potential is as high as 25,000 volts the least distance should be $1\frac{1}{2}$ inches. Even with these precautions it is safer to use some insulation such as heavy varnished sleeving, in case the wires become displaced; sharp points and angles in the wires should be avoided as these tend to concentrate the stress and cause failure. The insulation of the time-base circuits ought to be rated for 1,000 volts to be on the safe side.

In the case of the filament and heater wiring the voltage drop permissible and the carrying capacity of the wire are of more importance than the insulation, except in a universal set where all the wiring should be insulated to a high value throughout. For leads of, or over, 18 inches the potential drop is the deciding factor, while below this length the safe current in the wire is the limiting consideration. With average valves and transformers, and especially in the case of the rectifier, it is unwise to permit a drop of more than 0.05 volts in these leads and the accompanying table has been prepared with this value as a basis.

Heater leads, since they carry heavy currents, have large external fields; twisted flex, screened if possible, makes the best connections. The wires should be kept short and as far away from the other leads as possible, especially the grid circuits.

Wiring design is essentially a commonsense matter once the conditions obtaining in the different parts of the receiver are realised, and careful attention to these details will result in a set that will not only work well when new, but will continue to do so for years even under adverse circumstances. Reliability is the true test of a really good design.

RECOMMENDED SIZES OF HEATER CONNECTIONS.

Length of Twin Wire.	Current in Amperes.				
	1 amp.	2 amps.	4 amps.	6 amps.	10 amps.
Up to 18in.* Rubber-covered Flex Wire.	14/0.0076 or 7/0.012	23/0.0076 or 11/0.012	40/0.0076 or 16/0.012	70/0.0076 or 28/0.012	110/0.0076 or 34/0.012
Up to 36in. Rubber-covered Flex Wire.	23/0.0076 or 11/0.012	40/0.0076 or 16/0.012	70/0.0076 or 28/0.012	110/0.0076 or 34/0.012	162/0.0076 or † 65/0.012
Up to 9in.* Single Wire Rubber-covered or Sleeved.	One 0.036 (20 SWG.)	One 0.036 (20 SWG.)	One 0.036 (20 SWG.)	One 0.048 (18 SWG.)	One 0.064 (16 SWG.)

* Drop of 0.07 volt.

† This is maximum current advisable and shorter lengths should be no less. 0.0076 is 36 SWG. and 0.012 approximately 30 SWG.

TELEVISION PROGRAMMES

THURSDAY, SEPTEMBER 1st.

12, C. H. Middleton "In the Garden."* **12.15,** Come and be Televised.* **12.45-1,** Inter-school Spelling Bee.* **2.30,** O.B. from the Regent's Park Zoo. **3,** Jack Hylton and his Band. **3.30-4,** 169th edition of Picture Page.* **4.30,** Zoo O.B. **5,** Film, Cicely Courtneidge in "Aunt Sally." **6.30,** "Cabaret Cruise."* **7,** Forecast of Fashion.* **7.15-7.30,** Film. **8.30,** 170th edition of Picture Page.* **9,** "Libel," play by Edward Wooll. **10.30,** News.

FRIDAY, SEPTEMBER 2nd.

12, C. H. Middleton "In the Garden."* **12.15-1,** Come and be Televised.* **2.30,** Intimate Cabaret. **2.45,** Zoo O.B. **3.15,** Catch-as-Catch-Can Wrestling. **3.30-4,** "Queue for Song."* **4.30,** Zoo O.B. **5,** Film, Jack Hulbert in "Jack Ahoy." **6.30,** "Cabaret Cruise."* **7,** Forecast of Fashion.* **7.15-7.30,** Films. **8.30,** "Queue for Song."* **9,** Cabaret. **9.20,** News Film. **9.30,** Cartoon Film. **9.35,** "A Hyacinth Halvey" one-act comedy. **10.10,** Interval Music. **10.25,** News.

SATURDAY, SEPTEMBER 3rd.

12, C. H. Middleton "In the Garden."* **12.15-1,** Come and be Televised.* **2.30,** Jack Hylton and his Band.* **3,** The History of Fire-fighting. **3.30-4,** "Cabaret Cruise."* **4.30,** Demonstration by members of Women's League of Health and Beauty. **4.45,** Judo Demonstration.* **5,** Film, "Aunt Sally." **6.30,** "Queue for Song."* **7,** Forecast of Fashion.* **7.15-7.30,** Films. **8.30,** "Cabaret Cruise."* **9,** Two short plays. **9.20,** Films. **9.40,** Variety Starlight. **10,** Interval Music. **10.25,** News.

SUNDAY, SEPTEMBER 4th.

8.50, News. **9.5-10.20,** "Winter Sunshine," a comedy by G. A. Thomas and Archibald Batty.

MONDAY, SEPTEMBER 5th.

3, "Hyacinth Halvey" (as on Friday at 9.35 p.m.). **3.35,** Gaumont-British News. **3.45-4.15,** O.B. from Northolt Park of the Race for the British Empire Cup.

9, Film, "The Student of Prague." Cast includes Anton Walbrook, and Dorothea Wiek. **10,** Interval Music. **10.25,** News.

TUESDAY, SEPTEMBER 6th.

3-4.15, "The Importance of Being Earnest," a trivial comedy for serious people by Oscar Wilde.

9, Louis Golding shows some of the cherubs he has collected in his wanderings. **9.10,** Cartoon Film. **9.15,** "Gianni Schicci," one-act opera (Puccini). **10.15,** Musical Item. **10.25,** News.

WEDNESDAY, SEPTEMBER 7th.

3, Contrasts. **3.10,** Gaumont-British News. **3.20-4,** A review of songs from the "Mizzen Cross Trees," "Powder and Pipeclay" and "Rogues' Gallery."

9, Starlight. **9.10,** Cartoon Film. **9.15,** Talk on Sport. **9.30,** British Movietonews. **9.40,** Variety. **10,** Interval Music. **10.25,** News.

* Items from the studio at Radiolympia.

News from the Clubs

Thames Valley Amateur Radio and Television Society

Headquarters: The Albany Hotel, Station Approach, Twickenham.

Hon. Sec.: Mr. L. Cooper, 3, Summer Avenue, East Molesey.

The following programme has been arranged:—

September 12th.—Restart of the Morse Instruction Group.

September 14th.—Lecture by a representative of the Automatic Coil Winder and Electrical Equipment Co., entitled "Electrical Measurements and Instruments."

September 17th.—Visit to the B.B.C. Listening Post at Tatsfield.

September 25th.—20-metre Field Day.

October 12th.—Annual general meeting.

November 9th.—Talk and demonstration by the 5-metre group.

December 3rd.—Provisional date for the annual dinner.

December 14th.—Lecture entitled "Transmitters or Television."

West Herts Amateur Radio Society

Hon. Sec.: Mr. A. W. Birt, 6, Hempstead Road, Kings Langley.

The August meeting was held at the Hon. Secretary's station, G3NR, and during the evening G3NL was worked on 7 Mc/s. G3NR then demonstrated his 28 and 56 Mc/s apparatus and also a QRP CO, input 0.84 watt, with which he recently worked G8IT and received a 569 report. G3MI is active on 14 Mc/s, CW and phone. Two other members are awaiting their full transmitting licences.

Eastbourne and District Radio Society

Headquarters: The Science Room, Cavendish Senior School, Eastbourne.

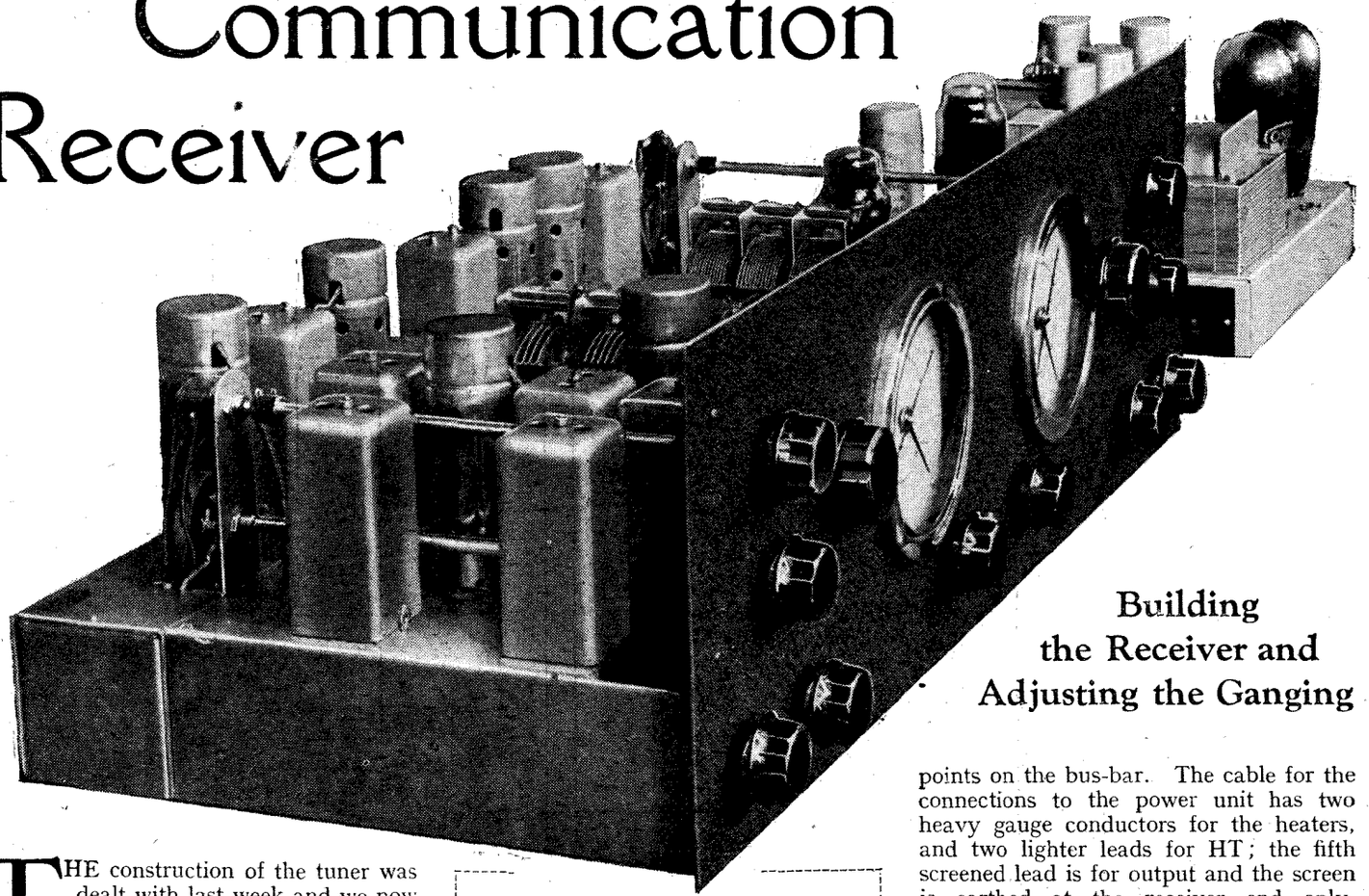
Hon. Sec.: Mr. T. G. R. Dowsett, 48, Grove Road, Eastbourne.

The August 8th meeting was devoted to five-metre work.

The Wireless World

How a Receiver is Designed.—XXIV.

Communication Receiver



Building the Receiver and Adjusting the Ganging

FOLLOWING upon the details of the tuner which appeared in last week's "Wireless World," this article describes the construction of the receiver. The process of adjusting the IF amplifier is treated as well as the details of ganging.

THE construction of the tuner was dealt with last week and we now turn to the IF amplifier and early AF equipment. The circuit diagrams, both of this section of the apparatus and of the power unit, appeared in *The Wireless World* for August 18th, but we shall defer consideration of the construction of the power unit until next week.

Everything in the receiver is quite straightforward and no difficulty should be encountered. Components are not cramped together and there is plenty of space to work in. As usual the greatest care is needed in the switch wiring, but there is no reason why anyone should make a mistake if the diagrams which accompany this article are carefully followed.

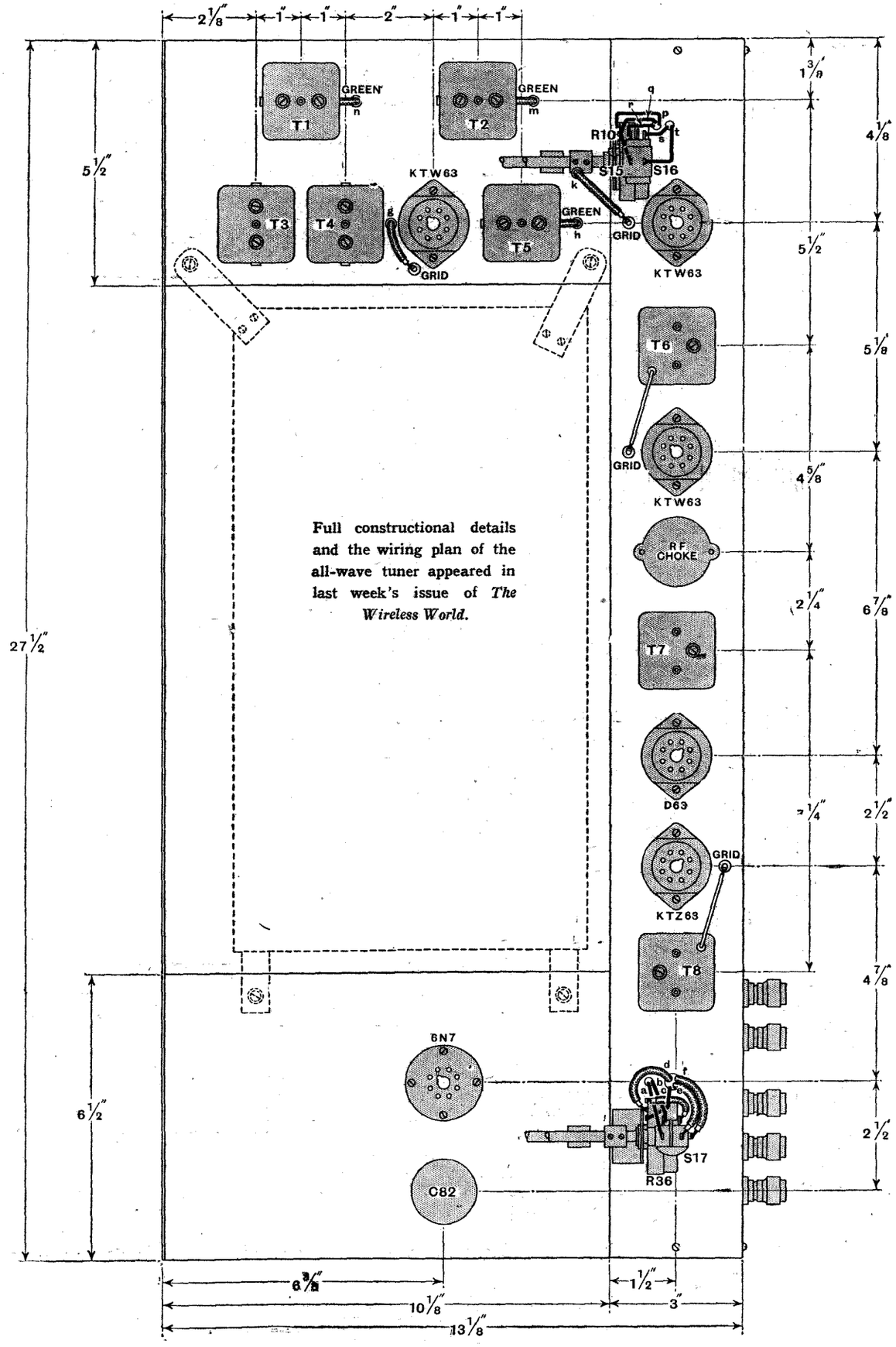
The chassis is divided into compartments to give the necessary screening and a single hole is provided in each partition to take the inter-unit leads. With very few exceptions these are the HT, screen, AVC, cathode, and heater wires, and they are run as bus-bars straight round the set, the various connections being taken off at appropriate points en route. The use of different coloured sleeving is convenient for the ready identification of the various leads, but is not, of course, essential. Care must naturally be taken to make sure that no short-circuits occur between the leads of the bus-bars at the points of connection, where the wires cannot well be sleeved. To avoid the possibility of such short-circuits it is a good plan to cover the joints with rubber tape which is readily obtainable from cycle shops. Again, this is not an essential, but a precaution, for with a little care it is easy to stagger the connections along the bus-bar so that there is no likelihood of trouble with the joints left bare. When all has been done the neatest job is obtained by binding the leads of the bus-bar together with thread, and this also increases the mechanical strength.

Connections to the tuner cannot be made when it is in place in the receiver chassis. The leads should, therefore, be cut extra long and connected to it before it is mounted. It can then be placed in position and the leads cut to their correct length and joined to their appropriate points on the bus-bar. The cable for the connections to the power unit has two heavy gauge conductors for the heaters, and two lighter leads for HT; the fifth screened lead is for output and the screen is earthed at the receiver end only. Although there are only five leads, a seven-pin plug is used to avoid confusion with earlier equipment, using 4-volt valves.

Now, before turning to the adjustment of the apparatus, there is something which must be said about valves. The types chosen have been selected primarily for performance, secondly for general availability, and thirdly for economy. The RF valve is a Mullard EF8; the frequency-changer is the Osram X65, the IF valves KTW63, detector D63, BF oscillator and phase-splitter KTZ63, output stage PX4, rectifier U52; the tone-control stage and the push-pull AF stage have American 6N7 valves.

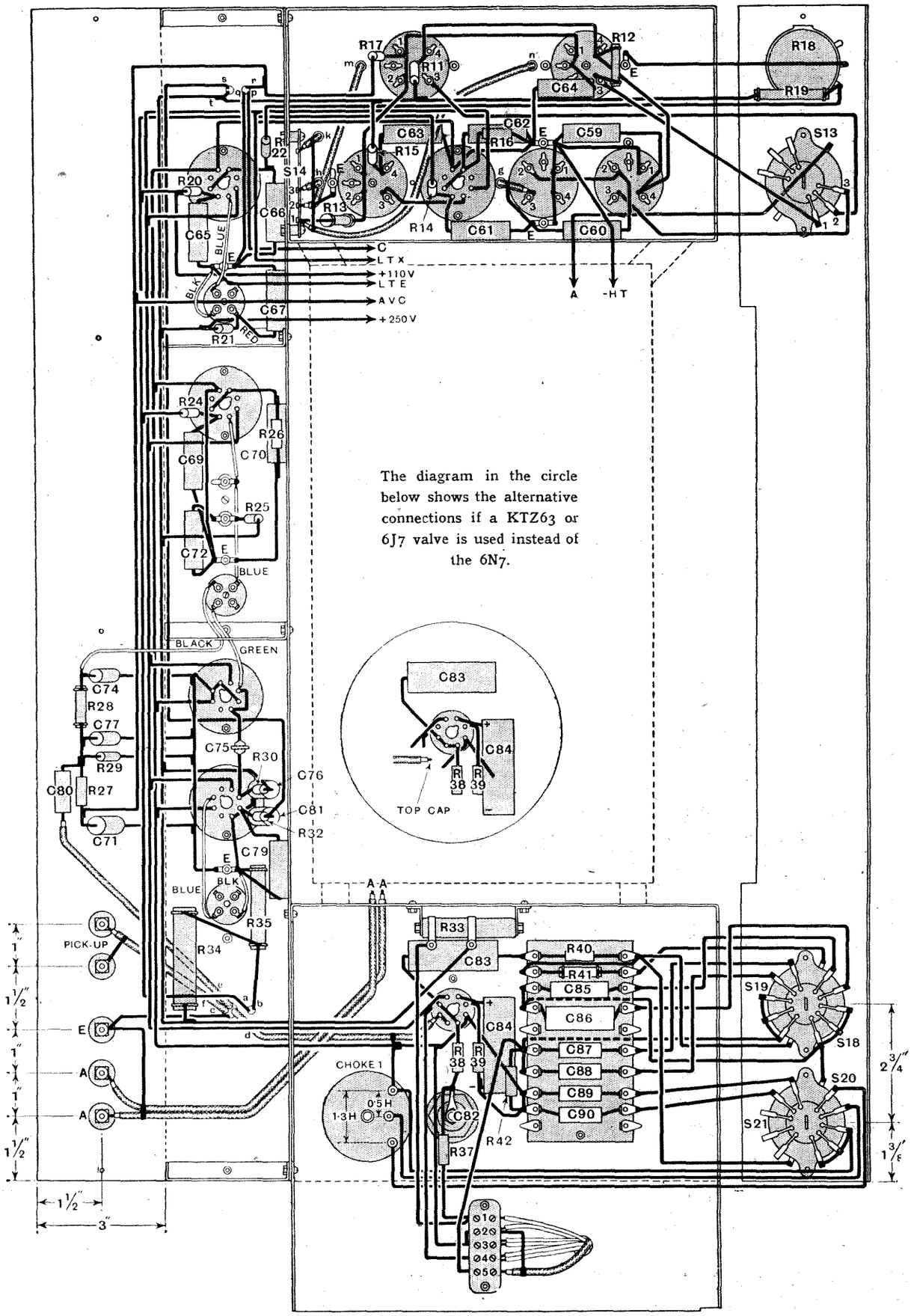
For one reason or another constructors may wish to use other valves, and there is no objection to this if the correct substitutions and the appropriate alterations are made. Although with the exception of the EF8 all the valves used are of American type, the valves actually employed in the development were British counterparts except for the 6N7 stages for which there are no British equivalents. With the exception of the RF and output stages, American valves or American types of other British makes can be used everywhere without alteration. For the X65, the 6J8G can be used and the counterparts of the KTW63 and KTZ63 are respectively

LAYOUT AND WIRING CONNECTIONS OF "THE WIRELESS



Full constructional details and the wiring plan of the all-wave tuner appeared in last week's issue of *The Wireless World*.

WORLD" COMMUNICATION RECEIVER CHASSIS (Less Tuner Unit)



The diagram in the circle below shows the alternative connections if a KTZ63 or 6J7 valve is used instead of the 6N7.

The Wireless World **Communication Receiver**—the 6K7G and 6J7G; the detector (D63) can be type 6H6G and the rectifier 5U4G.

The EF8 appears in the Tungsram range, but there is no American equivalent. Its use is recommended wherever possible, but if an American valve *must* be used, the correct type is 6K7G. The performance will not be affected except as regards signal-noise ratio, which may be somewhat poorer, since the EF8 is claimed to introduce exceptionally little noise. The base must, of course, be changed to an octal-type for the 6K7G, but the only circuit alteration needed is to the screen-grid wiring. Instead of being joined to the HT line and using the decoupling components of the anode circuit, the screen must be joined through an extra 500-ohm resistance to the 110 volts line and an extra 0.1 μF condenser joined between screen and chassis. There is no exact equivalent of the PX4 valves in the American range, and if it is desired to use American types, the 2A3 must be adopted and American 4-pin sockets provided. With these valves the bias resistance R59 must be changed to 375 ohms, and another resistance of 375 ohms must be inserted in the lead to the centre-tap of the output transformer primary. The mains transformer must have a filament winding of 2.5 volts 5 amperes instead of the 4-volt 2-amp winding, and the HT secondary must be rated for a current of 180 mA, instead of 160 mA. These changes are necessary because the 2A3 has a different filament rating from the PX4, and it also takes a heavier anode current at a lower anode voltage. The anode-to-anode load for the 2A3 valves should be 5,000 ohms instead of the 8,000 for the PX4 type.

There remains the question of the 6N7 type, for which there is no close equivalent. There are two reasons why a constructor might wish to avoid this type; he may want to use only British-made valves, or if he lives in an inaccessible part he may want to reduce the number of different types of valves used so that he need keep fewer spare valves by him. By a simple change in wiring it is possible to use the KTZ63 or 6J7G for the 6N7 in the receiver. The changes in wiring are shown in one of the drawings, and nothing else need be altered. This alteration will result in a slight reduction in AF gain; this is only likely to be of any importance on gramophone and then only when a low-sensitivity pick-up is used.

In the power unit the two sections of the 6N7 are used separately, and it must accordingly be replaced by two KTZ63 or 6J7G valves. This unit will be dealt with in a further article, and drawings showing the details of both arrangements will be given.

These notes cover the likely variations in valves which it may be desired to make and they are permissible changes which will affect the performance only slightly or not at all. Other alterations, such as the use of 4-volt types, are not recommended owing to the absence of near equivalents for important positions such as the RF, FC and IF stages.

LIST OF PARTS

TUNER

1 Set of 24 coils, L1-L24 Sound Sales SCR1-24
1 Variable condenser, 3-gang, 0.0005 mfd., **C53, C54, C55** Polar C1703
1 Variable condenser, 3-gang, 60 mmfds., **C56, C57, C58** Polar C1705
2 Dials, geared slow motion Peto-Scott
1 Valve holder, 8-pin, octal type Clix V4
1 Valve holder, 8 contact Bulgin VH24
24 Trimmers, 30 mmfds., **C1-C23, C38** Eddystone 1023
1 Trimmer, 160 mmfds., **C24** Bulgin CP2
1 Double trimmer, 150-550 mmfds., **C41, C42** Polar 55
2 Double trimmers, 250-650 mmfds., **C28, C31, C34, C37** Polar 66
1 Valve screen, small octal type B.T.S.
1 Grid clip, octal type Bulgin P96
1 plug top valve connector Belling-Lee 1175

Fixed condensers:

3 0.0005 mfd., mica, **C30, C36, C40** T.C.C. "M"
5 0.0003 mfd., mica, **C26, C29, C32, C35, C39** T.C.C. "M"
1 0.0001 mfd., mica, **C51** T.C.C. "M"
1 0.0025 mfd., mica, **C33** T.C.C. "M"
1 0.002 mfd., mica, **C27** T.C.C. "M"
1 0.005 mfd., mica, **C52** T.C.C. "M"
2 0.01 mfd., mica, **C43, C47** T.C.C. "M"
6 0.1 mfd., tubular, **C44, C45, C46, C48, C49, C50** T.C.C. 341

Resistances:

1 300 ohms, ½ watt, **R2** Erie
1 350 ohms, ½ watt, **R5** Erie
1 500 ohms, ½ watt, **R3** Erie
1 1,500 ohms, ½ watt, **R7** Erie
1 10,000 ohms, ½ watt, **R9** Erie
2 50,000 ohms, ½ watt, **R1, R4** Erie
1 100,000 ohms, ½ watt, **R6** Erie
1 30,000 ohms, 1 watt, **R8** Erie

Chassis, fitted with switches and knobs, complete with screws, etc. B.T.S.

Miscellaneous: Peto-Scott
2 Lengths systoflex, 1 oz. each Nos. 18 and 22 tinned copper wire, etc.

Valves:

1 X65 Osram
1 EF8 Mullard

RECEIVER

5 IF transformers, 465 kc/s, **T1, T2, T3, T4, T5** Varley BP124
1 Inter-IF coupler, 465 kc/s, **T6** B.T.S. WW/IFA
1 IF-Det. coupler, 465 kc/s **T7** B.T.S. WW/IFB
1 Coil assembly, T8 B.T.S. WW/BFO
2 DP switches, 5-way, with knobs and locators, **S18-S19, S20-S21** B.T.S. C125
1 3-way locator plate with 9½in. drive bar, 2 switch banks, 2-pole 3-way and knob, S13, S14 B.T.S. B123
2 Potentiometers, wire wound, 10,000 ohms, **R10, R18** Reliance TW
1 Potentiometer, tapered 2 megohms, **R36** Reliance SG
1 Switch, rotary type, DPDT, **S17** Bulgin S114
1 Switch, rotary type, DPST, **S15, S16** Bulgin S115
4 Shaft couplers Bulgin 2005
2 10½in. lengths and 2 11in. lengths ¼in. rod Bulgin
1 Resistance group board, 10-way Bulgin C32
6 Valve holders, 8-pin, octal type Clix V4
5 Valve screens, small octal type B.T.S.
4 Grip clips, octal type Bulgin P96
1 Correction choke, 1.3 H., **CH1** B.T.S. WW3
1 Connector, 5-way Bryce 5C4
1 Plug, 7-pin Bulgin P37
5 Knobs (black), ¼in. B.T.S.

Fixed condensers:

1 0.0003 mfd., tubular, **C74** T.C.C. 451
1 0.0005 mfd., tubular, **C77** T.C.C. 451
2 0.005 mfd., tubular, **C88, C90** T.C.C. 451
1 0.002 mfd., tubular, **C87** T.C.C. 451
1 0.01 mfd., tubular, **C80** T.C.C 451
1 0.015 mfd., tubular, **C89** T.C.C. 451
2 0.05 mfd., tubular, **C60, C85** T.C.C. 341
15 0.1 mfd., tubular, **C59, C61, C62, C63, C64, C65, C66, C67, C69, C70, C71, C72, C76, C79, C81,** T.C.C. 341
1 0.2 mfd., tubular, **C86** T.C.C. 341
1 0.5 mfd., tubular, **C83** T.C.C. 341
1 50 mfds., 12 volts, electrolytic, **C84** Dubilier 3016
1 8 mfds., 500 volts, electrolytic, **C82** Dubilier 0281
1 1 mmfd., ceramic, **C75** T.C.C.

4 Panel bushes, ¼in. bore Bulgin 1048

Resistances:

2 300 ohms, ½ watt, **R22, R26** Erie
7 500 ohms, ½ watt, **R11, R14, R15, R20, R21, R24, R25** Erie
1 1,500 ohms, ½ watt, **R39** Erie
1 4,000 ohms, ½ watt, **R16** Erie
1 7,500 ohms, ½ watt, **R41** Erie
1 10,000 ohms, ½ watt, **R28** Erie
1 20,000 ohms, ½ watt, **R30** Erie
6 50,000 ohms, ½ watt, **R17, R29, R32, R37, R38, R40.** Erie
2 100,000 ohms, ½ watt, **R12, R13** Erie
1 250,000 ohms, ½ watt, **R42** Erie
1 500,000 ohms. ½ watt, **R27** Erie
1 100,000 ohms, 1 watt, **R19** Erie
1 10,000 ohms, 2 watts, **R35** Erie
1 9,000 ohms, 3 watts, **R34** Erie
1 1,500 ohms, 20 watts, **R33** Bulgin PR6

5 Terminals, ebonite shrouded, A(2), E(1), PU (2) Belling-Lee "B"
1 RF Choke Bulgin HF10
3 Lengths screened sleeving Goltone
Chassis and Panel, complete with screws, etc. B.T.S.

Miscellaneous: Peto-Scott
6 lengths systoflex: 2 ozs. each Nos. 18 and 22 tinned copper wire, etc.

Valves:

1 KTZ63, 3 KTW63, 1 D63 Osram
1 6N7 Premier Supply Stores

(The list of parts for the Power Unit will be included next week.)

Trimming the Receiver

For the adjustment of this receiver a calibrated modulated test oscillator must be considered essential, and it must operate on fundamentals down to 20 metres, and preferably lower, so that even on the highest frequency range it is not necessary to use a higher harmonic than the fourth. The correct adjustment of the receiver without such an oscillator is extremely difficult and will not be described, for it is probably impossible to all but the most experienced and they will already know how to do it!

All trimming and ganging adjustments are carried out with the BFO switched off and are made for maximum output. If the final adjustments are made with a small signal input from the oscillator the change in output is readily audible and a tuning indicator is unnecessary. If one is desired, however, an output meter may be connected across the speech coil of the speaker; alternatively, a voltmeter may be connected across R22 and adjustments made for minimum reading.

The first step is to line up the IF amplifier. Connect the earthy side of the oscillator to the chassis and the live wire to the grid of the first IF valve (not the valve in the selectivity chain between T4 and T5). Set the oscillator to 465 kc/s and adjust its output to a suitable level, and with the IF gain control near maximum, adjust the trimmers in T6 and T7 for maximum response. These trimmers are rather flat, that in T7 being especially so.

The Wireless World **Communication Receiver—**

Next adjust the selective circuits. Leaving the oscillator set at 465 kc/s, connect it to the X65 grid instead of the first IF valve; naturally, the normal grid clip of the X65 will be removed and that of the IF valve replaced. Set the selectivity switch to position 1 (fully anti-clockwise) and adjust the two trimmers on T1. This completes the IF adjustments for low selectivity; the settings of the trimmers on T1 will not be very critical, but will be more so than those on T6 and T7. Now set the selectivity switch to position 2 and adjust the two trimmers on T2—their settings will be fairly critical.

It is now the turn of T3, T4, and T5 with the switch in position 3. The settings of the trimmers on T5 are likely to be very sharp, but those on T3 and T4 will be less so. Care should be taken to adjust all these IF circuits as precisely as possible so that the correct resonance curve is obtained and the circuits are all peaked at the same frequency.

The input should now be adjusted to a low level and the modulation switched off, selectivity still being at "high." Switch on the beat-frequency oscillator and adjust the trimmer in T8 for a whistle of convenient pitch for CW reception. Then switch the oscillator off, replace the X65 grid clip, and connect the oscillator output to the aerial terminal in readiness for the ganging adjustments. For this modulation will, of course, be required.

As there are no less than thirty trimmers in the tuner, it might be thought that ganging is difficult. This is not so, however, for there are never more than four trimmers operative at one time. Fundamentally, ganging is no more difficult than in a broadcast set, but it takes longer because there are eight bands to do instead of only two.

It is probably best to tackle the medium waveband first (range 7), and the correct switch positions and wavelength range are given in the accompanying table. With the switches set correctly and *with the left-hand variable condenser at zero*, apply a signal of 1.365 Mc/s (220 metres), turn the right-hand condenser to zero, and tune in the signal on C7, C15, and C23, using these as the three tuning controls of an unganged receiver. Then increase the setting of the right-hand condenser by about a tenth of its possible angular movement (i.e., 10 deg. on a 100 deg. scale), adjust the oscillator carefully to this new frequency and readjust C7 and C15.

Next set the oscillator to about 570 kc/s and tune in the signal on the receiver. Then adjust the padding condenser C41 while rocking the tuning control backwards and forwards over a few degrees until the optimum combination of settings is found. Then return to the low-capacity setting of the condenser (at about 10°) and readjust C7 and C15. Now check the minimum and maximum wavelengths with the condenser at minimum and maximum. If these agree closely with those in the table all is well, but if they differ widely it is necessary to alter the trimmer settings appropriately if the proper overlap between the different bands is to be obtained. If, for instance, it is found that the maximum frequency is a little too low, then all the parallel trimmers must be unscrewed a little.

Short-Wave Ganging

When the medium waveband is done, tackle range 6 next in exactly the same way. Set the oscillator to 3.57 Mc/s and tune in the signal on the three trimmers C6, C14, and C22 with the gang condenser at minimum. Then increase the condenser setting to about 10°, tune the oscillator to the receiver, and carefully adjust C6 and C14. Now set the gang condenser at a similar distance from maximum—that is, about 85°-90° on a 100° dial. Tune the oscillator to the set and adjust the padding condenser C37 while rocking the tuning control backwards and forwards over a few degrees to find the optimum combination of settings. Then go back to the higher frequency and readjust C6 to C14. Lastly, check the maximum and minimum frequencies.

After this go on to band 5 and repeat the process at the higher oscillator frequencies appertaining to this band. The procedure is the same for all bands except that on ranges 1 and 4 there is no padding capacity to adjust, so that all ganging adjustments are carried out at low-capacity settings of the variable condenser. For bands 1, 2, and 3, of course, the six-way switch must be in position 6, and on bands 2 and 3 the padding condenser capacities are not very critical.

When the higher frequency limit of the test oscillator is reached it will be necessary to work on harmonics. At first the second harmonic will be used—that is, the test oscillator will be set to one-half the frequency desired (double the wavelength), but for the highest frequencies it may be necessary to use the third or even fourth harmonics. As the output of the oscillator falls off with an increase in harmonic it will be necessary to turn up its output control considerably. It is, however, impossible to be specific here, for everything, including the necessity or otherwise for using harmonics, depends upon the particular oscillator employed.

One other thing requires explanation. On the higher frequency ranges it may be possible to obtain two sharp settings of the parallel trimmer on the receiver oscillator circuit. Of these two the lower capacity one must always be adopted. If two are found, however, the input to the receiver, and, if necessary, the RF gain, must be reduced so that the signal is only just audible. If the two responses are still of equal strength, or very nearly so, then everything is in order and the lower trimmer capacity should be used. If the two responses become very markedly unequal so that one almost disappears, however, then choose the stronger. The other is an abnormal response which may be due to a variety of causes, such as receiver overloading if the input is excessive.

At very high frequencies and with the ganging correctly adjusted it will be found that if the test oscillator is giving sufficient output it can be tuned in on the receiver at two settings. The lower-capacity setting is the correct one and the one to be used in checking the tuning range and in calibrating the receiver. The other setting will be weaker and represents the image point. Owing to the action of AVC, the liability of the receiver to image interference cannot be judged by the relative audible response at these settings; AVC is trying to equalise the outputs.

It is worthy of note that if the receiver tuning is left fixed and the test oscillator frequency varied, the *lower* frequency of the oscillator is the correct one.

For all trimmer adjustments it is, of course, necessary to use an insulated screwdriver. By this is meant not an ordinary screwdriver with a long metal shank and an insulated handle, but a screwdriver which is all of insulating material save for the smallest possible tongue. If such a tool is not available, a useful one can be made from a foot length of ¼in. wooden dowelling by driving halfway into one end a piece of thin metal about ¼in. × ⅜in. The end of the rod should be whipped with twine to prevent its splitting.

Owing to the fact that the selectivity of the IF amplifier affects the degree of criticality of the oscillator trimmers, it is easiest to work at low selectivity on short waves. On the medium, and especially on the long, wavebands, however, where the signal-frequency circuits are having an appreciable effect on adjacent channel selectivity, it is wise to make ganging adjustments at high selectivity.

SWITCH POSITIONS AND WAVELENGTHS.

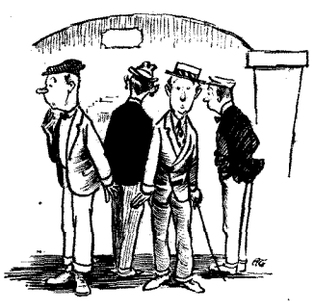
Range.	Left-hand Switch Position.†	Right-hand Switch Position.†	Tune on Condenser on*	Wavelength Range Metres.	Frequency Range Mc/s.
1	1	6	Left	5.15— 8.2	58.2—36.6
2	2	6	Left	8.05—12.6	37.4—23.8
3	3	6	Left	10.8—16.1	27.8—18.6
4	4	1	Right	15.9—47.6	18.9— 6.3
5	4	2	Right	39.8—109	7.55— 2.75
6	4	3	Right	84—238	3.57— 1.26
7	4	4	Right	220—600	1.365— 0.5
8	4	5	Right	945—2,160	0.318—0.139

* When the right-hand condenser is used for tuning, the left-hand condenser is to be set at minimum.
† Switch position 1 is with the control knob fully turned anti-clockwise.

Radio Impressions

By FREE GRID

WELL, I suppose that practically all of you who have any intention at all of visiting the Show have done so now. The rumour which I heard last week was perfectly correct and sets are actually being demonstrated on the stands at this year's Show. I am, of course, pleased to see this, but I cannot help feeling that there is a remarkable sameness about the programmes emanating from the various



"People of obviously low mentality."

sets on the stands. However, I musn't grumble as it is a great advance to have got a real demonstration at all. Those who have actually visited the Show will have noticed that the wireless museum, which was such a feature of last year's Exhibition, was absent. I was told privately that this exhibit was not repeated this year owing to the special request of certain manufacturers, as considerable embarrassment was caused last year owing to the public mistaking their stands for the museum due to the remarkable similarity of the exhibits.

The Purge

What pleases me most about this year's exhibition is that the variety show, the fat ladies, the coco-nut shies and other sideshows of former years have all been swept away and an attempt made to stage a real radio exhibition. As I have stated before in these columns, it is better to aim high and to fail than vulgarly to succeed. It was evident, however, that some of the sideshow patrons of former years had not heard of the "purge," as several people of obviously low mentality were to be seen wandering disconsolately round the exhibition like lost sheep.

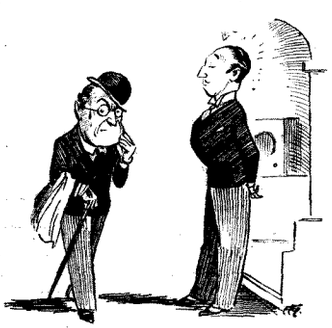
I soon found out that I had been correctly informed when I was told before the Show opened that this year the stands would be staffed by people who had been specially trained to answer questions, although I fear that I fell into the trap wherein I was intended to fall by my informant, who was a prominent manufacturer. I had, of course, assumed that it was technical questions they had been trained to answer, but I soon discovered my mistake.

With memories of previous years I approached a stand attendant and remarked sarcastically that I presumed that the technical men had, as usual, just gone to lunch. He quickly routed me, however, by greatly regretting that they had no technical men whatever, for although, said he, his firm had sent several urgent requests to the local labour exchange for technical experts to staff the stand, none had been forthcoming. All of them, it was explained, were engaged upon important work in connection with armaments.

Push-button Sets

The most astounding thing about the whole exhibition, however, was the new auto-tuning sets, several of which can be used in connection with "remote" push-button units. I suppose that most of you have heard about these sets, but I am willing to bet that none of you know the true story behind their development, which is one of the most astonishing things in the whole history of radio. Even I was not aware of the true facts before the Exhibition, and I only came into possession of them purely by chance just because I happened to give a homeward lift to a well-known manufacturer whom I found wandering about the streets slightly bewildered after listening to the speeches which had been made at a celebration luncheon held by the leading lights of the radio industry.

As a token of gratitude for my timely assistance he told me the true story behind the development of these sets, I, of course,



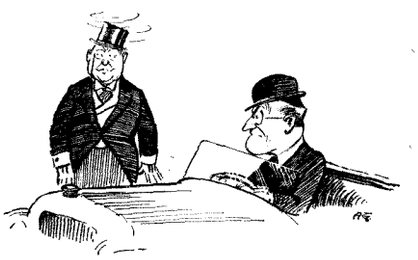
"He quickly routed me, however."

agreeing not to divulge his name as otherwise he would be drummed out of the industry. The story is scarcely credible, but, nevertheless, I have been able to check its accuracy with other sources of information which are available to me.

THE TRUTH ABOUT PUSH-BUTTON TUNING

You will recollect that I have often protested against the regrettable waste of time which takes place when a set breaks down and has to be sent back to the factory for a fault to be traced owing to the local wireless dealer being unable to deal with it as his name implies he should.

By means of the new system of remotely controlled push-button tuning, no set need ever leave its maker's factory. All that will happen when a listener buys a set will be that he will be supplied with a remote-control unit which will be coupled to it by means of an ordinary Post Office telephone line. By means of this staggering and



"Slightly bewildered after listening to the speeches."

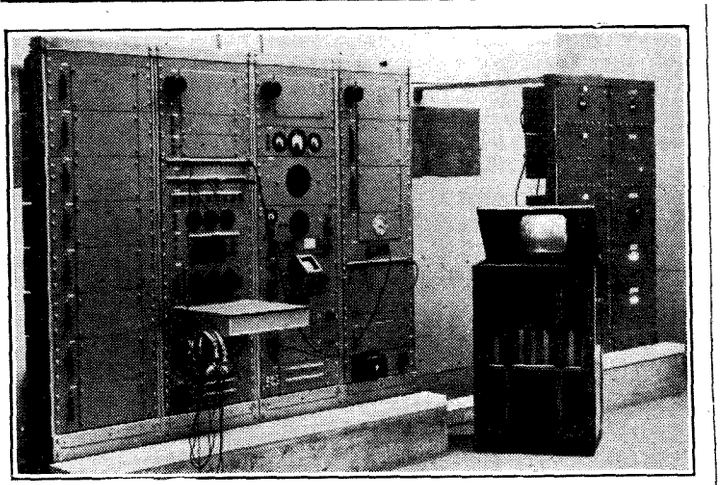
breath-taking scheme all faults which develop can be remedied immediately as the set will be already in the factory. A further great advantage is that sets will be vastly cheapened as all the costs of transport and similar overhead expenses will be simply wiped out.

Of course, an extension loud speaker will have to be used in the home, but this will be taken care of by means of a Post Office land line. Actually, there is no reason why the line used for connecting the remote tuning control should not be made to serve a dual purpose.

I don't think that I am exaggerating when I say that this is the greatest development that radio has yet seen or is likely to see for many a long day to come. Of course, the scheme will take time to put into operation, and you must not expect to see announcements about it yet, but when it is made public do not forget that it was I who was the first to reveal it to you.

There are, of course, still three days to go before the Show finally closes its doors, and much may happen before then. Needless to say, I shall be on the watch all the time, and if anything fresh turns up it will be duly reported to you next week.

NEWS OF THE WEEK



RADIOLYMPIA TRANSMITTERS. The B.B.C. equipment, situated in the gallery of the Grand Hall, which supplies the radio-frequency signals to the stands for the purpose of demonstrating broadcast and television receivers. The details of the complete scheme were given on page 127 of our issue of August 11th.

TELEVISION

A Concerted Drive by the B.B.C. and the R.M.A.

RADIOLYMPIA has certainly deserved the title, coined by the Radio Correspondent of *The Daily Mail*, of Teleolympia, for television has undoubtedly been *the* attraction.

The biggest drive from the Industry's point of view was undoubtedly the holding of the Television Convention for Retailers in the Television Broadcast Area. Some sixteen-hundred retailers gathered in the Addison Café, Olympia, on the second day of the Show to hear what the representatives of the Television Advisory Committee, the B.B.C. and the R.M.A., and a retailer, had to say on the future of television.

During the meeting it was reiterated that no change in the technical standard of the Alexandra Palace transmissions would be effected until after January, 1941. Sir Noel Ashbridge, B.B.C. Controller of Engineering, said that it was unlikely that any change, even in the number of lines per second, would be made after that date—that is, of course, unless some far-reaching and vital discovery is made.

A further impetus will be given to television when, as foreshadowed by Mr. C. G. Graves, Deputy Director-General of the B.B.C., during his broadcast last week, the programme hours are once again extended when the existing Theatre at Alexandra Palace is converted into a large television studio, the work on which will shortly be commenced.

Readers in the Midlands and the North, in which areas listeners are surprisingly "television-conscious," will have been heartened by Mr. Graves' statement that the B.B.C. is eagerly awaiting the result of experiments which the Post Office is to undertake in the matter of carrying television programmes to the provinces.

It is understood that the experiments referred to are concerned with the use of a number of ultra-short-wave repeater or relay stations instead of the very expensive coaxial cable.

A booklet, with the provocative title "And Now," telling pictorially in thirty-two pages all that television means to viewers has been published by the B.B.C. at 6d.

TELEVISION INTERFERENCE

The Post Office Widens Its Scope

POST OFFICE anti-interference engineers have hitherto officially concerned themselves only with investigating troubles affecting the medium and long broadcast wavebands. Increasing interest in television is now responsible for the free service available to the public being widened to cover the investigation of interference affecting the television, sound and vision, wavelengths.

According to the official statement, "every endeavour is made to help owners of receivers to obtain good reception." Those in need of help should fill in the "Electrical Interference Questionnaire" obtainable from all Head Post Offices and at the G.P.O. stand, No. 66, at Olympia.

CONCERT PITCH

Seeking an International Standard

A SPECIALLY appointed Commission of the British Standards Institution recently held a conference at Broadcasting House, London, on the standardisation of concert pitch. Three major questions were raised for discussion, and opinions from the public are invited by the Director, British Standards Institution, 28, Victoria Street, London, S.W.1. The questions are:—

1. Do you consider that definite steps should be taken to secure an international standard of concert pitch?
2. If so, at what temperature should the pitch be fixed, it being understood that the pianoforte, the orchestra and the organ would be exactly in tune at this temperature?
3. What rate of vibration (frequency) should be assigned to the note A of the treble clef at this selected temperature?

In this country concert pitch has remained constant at 439 complete vibrations a second since 1896. America accepts 440, which is virtually the same, but in France it has been unchanged at 435 vibrations a second since 1859.

Whatever the outcome of the present discussions, the pitch will inevitably vary with different conditions of temperature throughout the world.

MARCONI SUMMER SCHOOL

WITH a view to giving wireless lecturers at universities and technical colleges first-hand information on the latest application of communication theory to wireless practice, a Summer School is to be held at the Marconi College, Chelmsford, from September 7th to September 9th.

NIGHT O.B.S FOR TELEVISION

Further Attraction for Viewers

THE B.B.C. is alive to the fact that, although topical outside broadcasts by television sell receivers more quickly than almost anything that can be offered from the studios, a majority of viewers are unable to enjoy these in the middle of the day. It is a pity, for much of the best sporting material is only to be had during the hours of daylight. But a wealth of material is available after dark, and during the autumn and winter there is to be a big drive towards the ideal of an O.B. every evening.

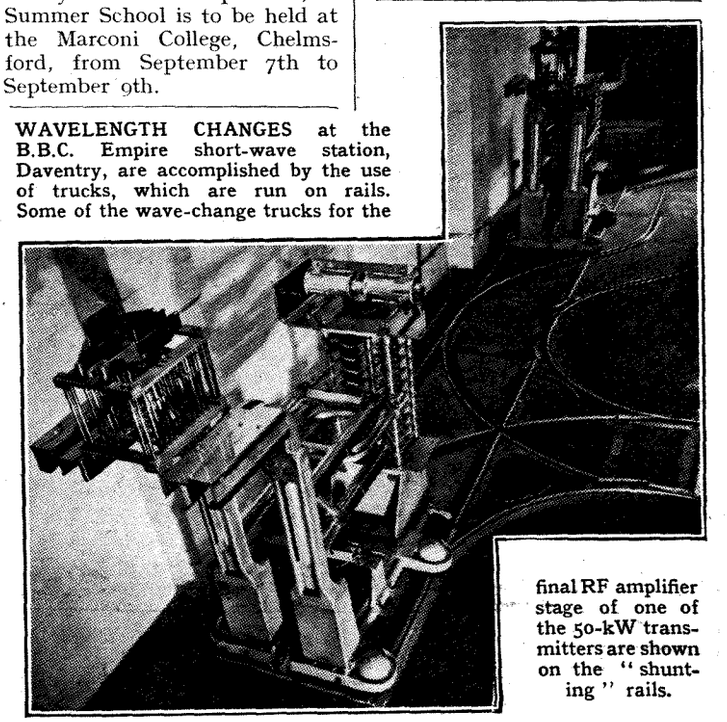
Among the attractions already promised will be ice hockey from arenas like Harringay and Wembley, with visits to Earls Court for boxing under the auspices of the National Sporting Club.

Before the units can embark on a regular series of nocturnal excursions, however, a separate lighting unit, with mobile transformers and other equipment, will have to be formed. The O.B. units will then only need an elephant or two to resemble a travelling circus.

RADIOLYMPIA NOVELTIES

"Side Shows" on the Stands

"I AM the gateway to the world of romance and happiness. . ." This can be heard through the earpieces of tele-



WAVELENGTH CHANGES at the B.B.C. Empire short-wave station, Daventry, are accomplished by the use of trucks, which are run on rails. Some of the wave-change trucks for the final RF amplifier stage of one of the 50-kW transmitters are shown on the "shunting" rails.

News of the Week—

phones on the H.M.V. stand at Radiolympia. It is part of a recorded sales talk, and when it is finished the visitor can lift the sound-head of a standard record player, and play the record through again. The salesman is almost superfluous.

All the way from South America comes "Exide," the *Electric Eel*. It is living in a tank on the Exide stand, and, although not yet fully grown, it has already established itself in the estimation of the electrical world by lighting a 220-volt neon lamp without any apparent effort. The battery is almost superfluous—why not all-eel sets?

The blinking eyes on the G.E.C. stand are worked by a time base and deflecting circuit, and on twiddling four simple controls the visitor can make the spot on the screens of the two cathode-ray tubes situated in the head of an unattractive dummy, roll, swivel and wink. This dispenses with the pretty young ladies, whose services have been so much in evidence at previous wireless shows.

NEW R.C.A. TRANSCEIVER

Ease of Operation a Feature

THE Radio Corporation of America has designed a new portable transmitter-receiver for field and commercial use. The complete set, which is built in a $\frac{1}{16}$in. welded aluminium case, and housed with batteries, microphone and earphones in a watertight container measuring 13½in. high by 9½in. wide by 5½in. deep, weighs 15½lb. It is fitted with a telescopic tubular aerial with a maximum length of 55in., which operates as a quarter-wave aerial with the metal case as a counterpoise. A strap is fitted to the case so that the unit may be worn against the operator's chest; the top of the case, opening away from the operator, can be used for taking notes.

The transceiver, which is designated AR-4291, covers the frequency range of 30-60 Mc/s (5-10 metres) in two bands by means of two interchangeable coils, the spare one of which is secured in position by a clip inside the container.

Two valves are incorporated which, when operating in the receiving position, are employed as a self-quenching super-regenerative detector and pentode output; when transmitting, the detector becomes a straight oscillator, Class A modulated by the pentode. A feature of this unit is that changing from the receiving to the transmitting position does not necessitate altering the operating frequency.

EDUCATIONAL OPPORTUNITIES

Radio and Electrical Engineering Courses

ACTIVITIES of the Northampton Polytechnic, St. John Street, London, E.C.1, for the 1938-1939 session, commencing on September 26th, are set forth in two publications just issued. The first is a prospectus of full-time courses, including Electrical Engineering (Communication) conducted by the Northampton Engineering College, while the second describes evening courses. Among the subjects likely to interest our readers are Radio Engineering (National Certificate Course) and Radio Communication.

The Borough Polytechnic, Borough Road, London, S.E.1, announces, as part of the 1938-1939 session, a course in Radio Engineering (including Television) for Ordinary and Higher National Certificates, City and Guilds examinations, etc. Part-time day and evening courses for radio service engineers are also announced.

From the Director of Education of the Manchester area (Deansgate, Manchester) we have received a pamphlet dealing with post-advanced lectures in electrical and mechanical engineering. A student's guide to engineering education in the Manchester district is published as a separate pamphlet.

Early application should be made for enrolment at these centres.

MONOCLE TELEVISION. It looks like an outsize in telephones and has attracted a big public on the H.M.V. stand at Radiolympia. Although it is being worked from a specially constructed electrostatic scanning receiver, it could, with minor adjustments, be used in conjunction with a standard television receiver as an extension to the cathode-ray tube. If it were made available to the public, it would provide a means of individual viewing, without disturbing other people who were occupying the same room.

FROM ALL QUARTERS

Battery Sets Still Popular

IT will doubtless surprise many readers to hear that, according to a statement made by the General Electric Company, battery sets still represent from a quarter to one-third of the total sale of receivers in England, despite the constant extension of electricity supply to the outlying districts of the United Kingdom.

Scophony in America

MR. S. SAGALL, Managing Director of Scophony, is, we understand, sailing for America at the end of September to introduce large-screen television receivers, employing the Scophony mechanical scanning principle, by the formation of a Scophony Corporation of America, backed by American financial and cinema interests.

Bombay Broadcasting House

THE installation department of All-India Radio is at present actively engaged in the construction of the new broadcasting headquarters in Bombay. There will be seven air-conditioned studios in all, located on the fourth floor of the building, and one of them will be the largest in the A.I.R. system permitting, as it will, accommodation for a studio audience.

Television Reception in Somerset

ALTHOUGH not constituting a long-distance record for the reception of B.B.C. television transmissions, it is of interest to record that Mr. G. J. Small, a dealer, of Station Road, Taunton, Somerset, has been receiving excellent pictures on a receiver, constructed entirely in his workshop, using a dipole aerial with reflector, mounted on a 60ft. mast. Spasmodic fading is, of course, experienced, but the general results are of good entertainment value.

Radio Link to the Shetlands

POST OFFICE engineers are to make radio tests in the spring, with the object of linking the Shetland Islands to the mainland by ultra-short wave wireless telephone. It is also intended to replace the present submarine telephone cable to the Orkneys by a similar system.

Broadcasting at 6.30 a.m.

MEMBERS of the B.B.C. staff wilted last week when they learned of the Spartan régime just introduced at Station WJZ, New York, which now offers programmes for early risers at 6.30 a.m. But there was peace again in Portland Place when it was discovered that these early programmes are electrically recorded in advance.

More Wireless Men Wanted

THE most serious deficit in R.A.F. recruiting is in the Wireless Operators' Section. Other sections which are still below the required strength are those for electricians and instrument repairers.

K.R.O.'s Recording Equipment

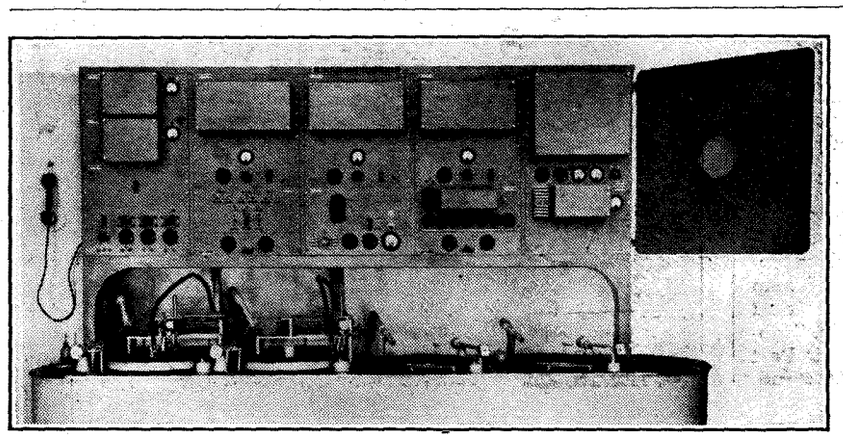
IN the article on the extension of K.R.O.'s Broadcasting House at Hilversum, it was stated that the recording gear was, with the control room apparatus, supplied by Philips. On this point we were misinformed, for all the electrical and mechanical apparatus in the recording room, including reproducing and recording amplifiers, as well as recording machines, was developed, manufactured and supplied by Numans-Laboratorium, of The Hague.

Zurich Television Conference

THE Physical Society of Zurich has organised an International Conference to discuss the problems involved in television. This will be held in the Federal Institute of Technology, Zurich, from September 19th to September 21st.

Higgs Console Receiver

IN our Olympia Show report, the number of valves in the Higgs Radio Console receiver, Type AW99C, was given in error as four; the figure should, of course, be nine. Dual speakers, fed from a push-pull output stage, are employed.



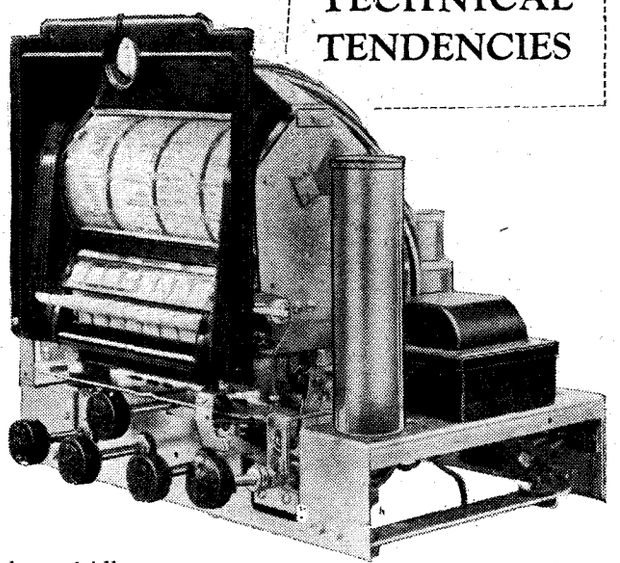
NUMANS' RECORDING AND REPRODUCING equipment installed in the extension to K.R.O.'s Broadcasting House, Hilversum. The recording machines are for 78 and 33⅓ r.p.m. and take discs up to 16 in. in diameter. Volume compression and expansion is incorporated in the recording amplifiers.

Olympia Show Review

Features of the New Receivers, Televisors and Accessories

TECHNICAL TENDENCIES

IN the following pages the Technical Staff of the "WIRELESS WORLD" review the outstanding technical developments of the season as revealed at the Olympia Show



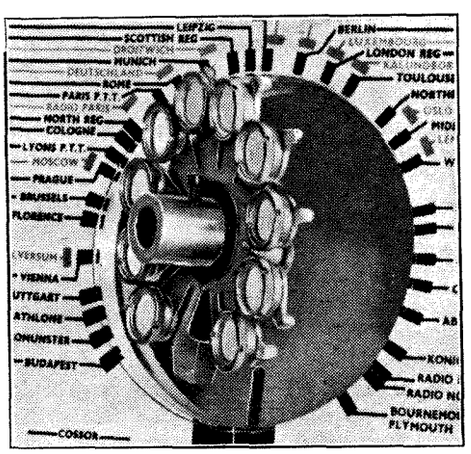
Pilot automatic tuning system with "piano key" action. Note large diameter drum tuning dial.

PRESS-BUTTON TUNING

The Feature of the Season's Receivers

AT first sight there seems to be an endless variety of press-button tuning devices, but on closer inspection they are found to fall into one of three classes: (1) Mechanical location of the main tuning condenser. (2) Electro-mechanical rotation of the main tuning condenser to the required position by a small motor. (3) Separate pre-tuned electrical circuits switched for each station.

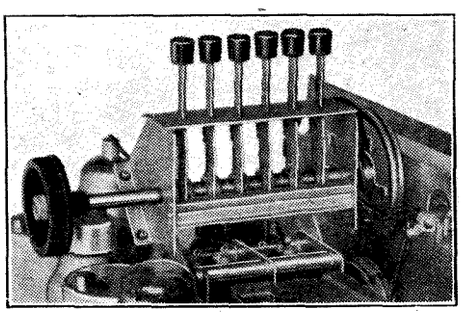
The first of these three methods is reduced to its simplest and most direct form in the Cossor "Teledial." A selector plate with ten flexible radial arms is geared to rotate the main condenser spindle. At the end of each arm is a die-cast spigot which is allowed a limited angular movement for the final adjustment of tuning. When the button associated with this spigot is depressed it mutes the loud speaker while the dial is being rotated, and a slot in the



Cossor "Teledial" with selector plate lifted from spindle to show locating slot in back plate.

back plate locates the spigot at the required setting of the main condenser. Removing the finger from the button automatically brings the set to life with the station tuned in. A similar scheme is used in the Ultra 400, but in this case the radial arms are rigid and they are located by a pair of hinged and spring-loaded "latch plates" facing in opposite directions.

The tuning condenser may also be rotated by press-buttons, and several methods of translating the motion have been evolved. In the Ultra 209 a series of cams is used, and in the Burndept Model 298 and Alba "Presto-Tune" receivers the condenser spindle is driven through pairs of racks and idle pinions so arranged that the condenser is moved directly to its new position irrespective of whether it is above or below the



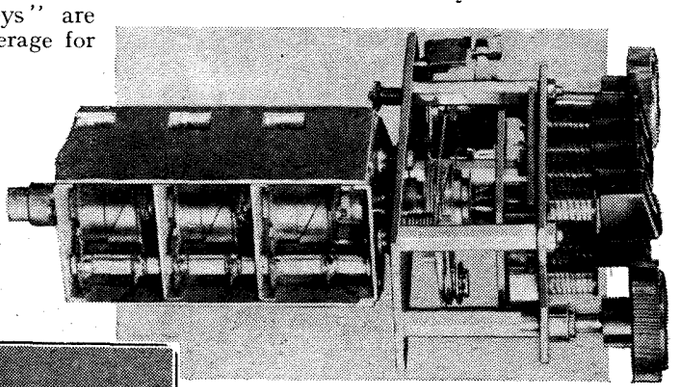
Rack and pinion selector gears are used in the Burndept mechanical push-button system.

previous setting. A firm pressure is required to operate the push buttons of most mechanical systems, and in the Pilot Model PT36 "piano keys" are used to increase the leverage for ease of operation. This model, incidentally, is fitted with an unconventional but very effective cylindrical dial.

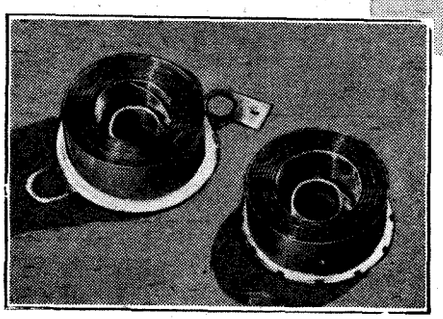
All problems of translating linear into rotational movement have been solved in the Philips "Direct Action" system by a tuning condenser of novel design. The plates are formed by brass spirals accurately spaced and centred, and the two halves slide one inside the other. The moving vanes, which are mounted on a sliding rod, are meshed to the right capacity by the direct action of the push buttons on a plate mounted on the end of the spindle. The amount by which each button projects may be adjusted from the front of the set by removing the bakelite cap and inserting a special screwdriver.

The motor-driven systems have this in common, that they require less effort on the part of the user to depress the button. The electrical switches are all of the same light touch, whereas the mechanical buttons may require different pressures depending on the previous position of the condenser and its associated cams.

A small electric motor with forward and reverse windings drives the tuning con-



Philips "Direct Action" mechanism (right) with linear motion of condenser vanes. (Below) The spiral condenser electrodes used in Philips "Direct Action" condensers are little more than 1in. in diameter.



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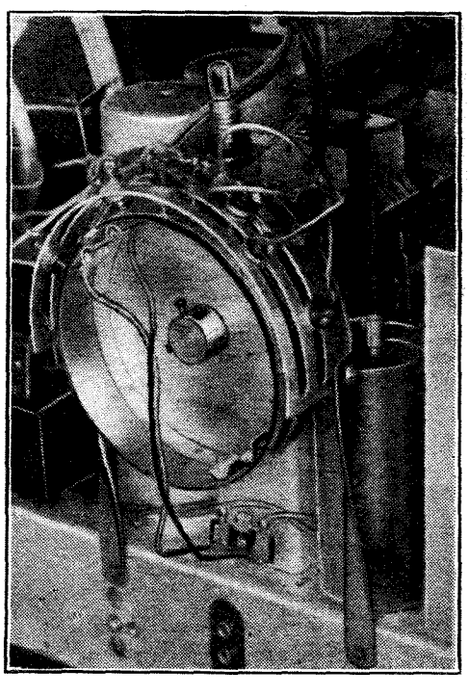
denser through gearing. The condenser spindle also carries a commutator to which wiping contact is made from each of the push-button circuits. When a station button is depressed, current reaches the motor via one of the wiping contacts on the commutator, and, the position of this contact having been previously adjusted to coincide with an insulated gap in the contact plate, the motor is switched off and the set tuned in at the point reached by the main condenser.

In the simplest versions of this system, one example of which was to be found in the Show, the motor does not reverse until

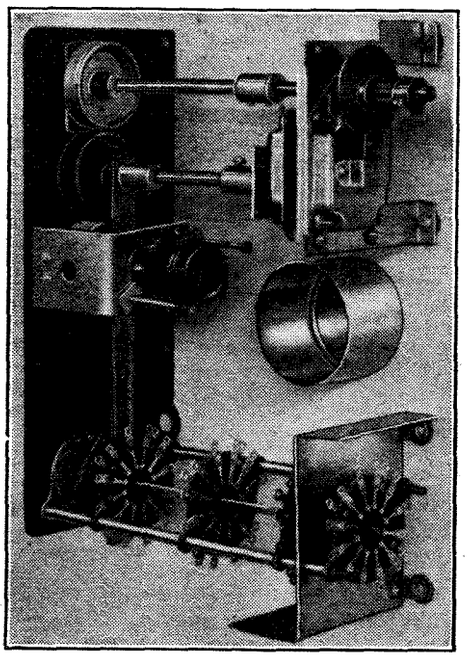


A drum-type commutator is used in the H.M.V. motor driven mechanism. Note the pilot lamp for use when resetting contacts.

it reaches the end of the scale, but in the majority of sets the contact plates on each side of the insulated gap are connected to give automatically a direction of rotation always towards the setting of the newly "dialled" station.

The commutator is generally a disc of insulating material with flat sector contacts, but it may also be a drum, as in the H.M.V. sets. In the Philips motor-drive system separate spiral drums are provided for each station. They are held by friction on a common spindle geared to the condenser to give three turns and an equivalent path on the spiral of nearly 12 inches. The small errors of location are thus reduced in their percentage of the total frequency range available. Another interesting feature of the Philips system is the use of a centrifugal clutch ensuring that the drive shall be instantly removed when the current is switched off without any overrun resulting from the inertia of the armature.

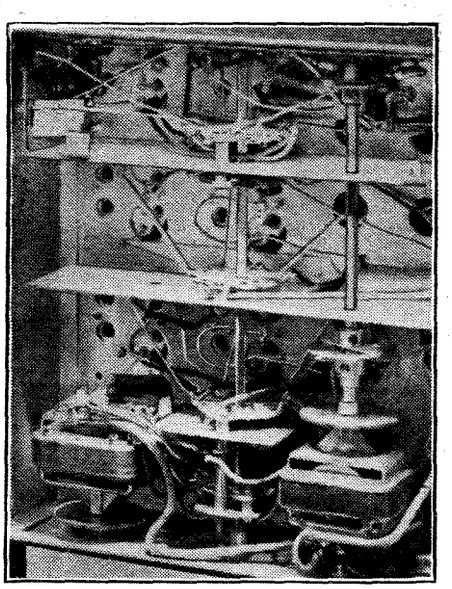
By careful attention to details of this sort the electro-mechanical tuning system can be made remarkably accurate, but some manufacturers prefer to make quite sure by including automatic frequency



The change-over from motor to manual tuning for short waves in the Murphy A52 is effected by friction wheels controlled by the waverange switch.

control—that is to say, the location of the final tuning point by electrical means in the circuit itself. McMichael, Ekco, H.M.V., and Murphy all have one or more sets incorporating this feature.

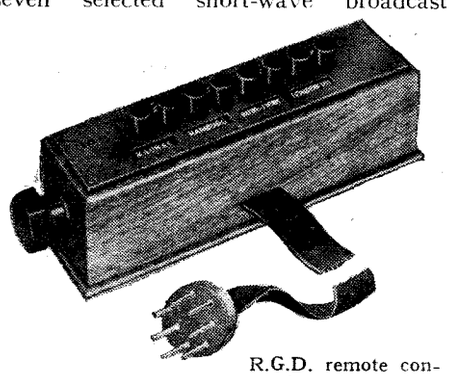
One of the incidental advantages of motor-driven tuning systems is that the motor may be used under manual control for moving from one part of the scale to another. In the Ekco sets separate press buttons for forward and reverse are arranged on the appropriate sides of the manual tuning knob. McMichael have taken advantage of the fact that the outer slow-motion ring in a concentric two-speed tuning knob is now no longer necessary with this system and have used it as a two-way switch to operate the motor.



Separate motors are employed in the R.G.D. sets for simultaneous waverange selection and tuning control.

The advantages of using a normal type of set with an auxiliary condenser drive are many, as we have already seen. There is one major difficulty—the conventional waverange switch must be turned before changing from a long- to a medium-wave station. Most manufacturers have decided against the extra cost of making this operation automatic, but a few have had the courage of their conviction that press-button tuning is hardly worth including if one must stop and think before pressing the button for a station.

Murphy Radio, Ltd., have removed the element of ambiguity by a shutter device coupled to the waverange switch. Station names appear in apertures at the side of each button, and when on medium waves only medium-wave station names are to be seen. Incidentally, there are no fewer than seven of these, and on long waves a fresh series of seven stations is made available. On the short-wave range a third set of contacts is arranged to give press-button transfer of tuning to any one of seven selected short-wave broadcast



R.G.D. remote control unit which includes volume control.

Regentone transmitter unit for push-button remote control through the house wiring.

bands. Automatic frequency control is cut out on short waves, and one of the valves so released is used to give double superheterodyne reception. Each of the seven SW broadcast bands is thus expanded to occupy the full range of the manual tuning control, which is a thread-operated "spade" inside the short-wave oscillator inductance.

A mechanical interlock is used in the G.E.C. press-button sets to render the medium-wave buttons inoperative when the waverange switch is in the "Long" position.

In certain Ekco motor-tuned sets one does not have to work the wave-range switch for changing-over be-

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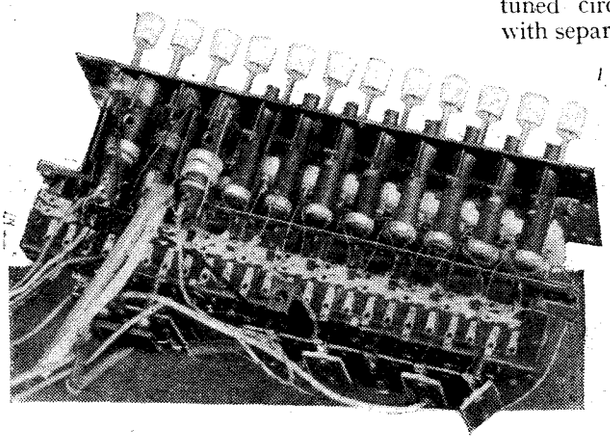
tween medium- and long-wave bands. The first few revolutions of the driving motor are transmitted to the waverange switch through dog clutches, and the position of the clutch is determined by a reed-armature relay. No



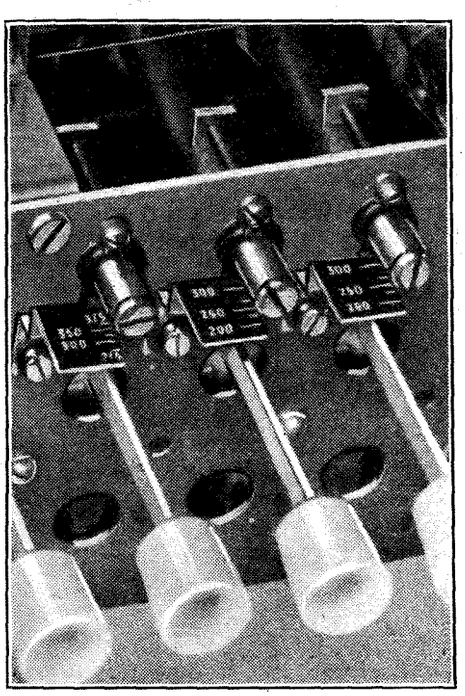
movement of the clutch takes place if two buttons on the same waveband are pressed in succession.

R.G.D. arrive at the same end by employing separate motors for tuning and waverange control. Double sets of contacts are fitted to each press button, and the two operations proceed simultaneously. The loud speaker is, of course, muted until both operations are completed. This system adapts itself well to remote control, and a neat, flat, rubber-covered cable which may be laid under the carpet carries all the necessary wires. In the latest models volume control by means of a variable negative feed-back will also be included in the remote-control unit.

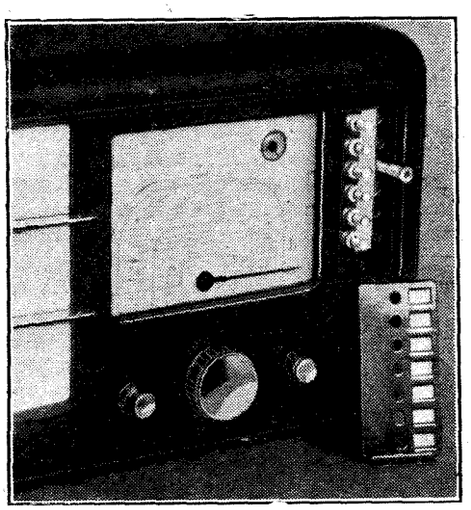
Remote control of stations in a prearranged sequence has been evolved by Regentone, who are showing a "synchronised impulse" transmitter which superimposes a signal (low frequency) on the mains to work a relay in the set. The main point of this scheme is that no intermediate wires are required, as the transmitter can be plugged into any power point in the house.

Finally, we come to the very large number of sets employing separate pre-set tuned circuits for each station. Those with separate pre-set condensers connected across the tuning inductances of a normal set mostly suffer from the old disadvantage of having to work the waverange switch, and although the temperature coefficient of semi-variable trimmers has been reduced to miraculously low figures as the result of recent research, the fixed silvered mica or ceramic will be always one jump ahead on account of its simplicity. Permeability tuning offers a solution to both these problems since the coil instead of the condenser is changed. The technique of frequency stability in dust-cored coil has been closely studied for some time in relation to IF circuits.

Permeability tuned circuits in the Bush Model PB55 receiver.

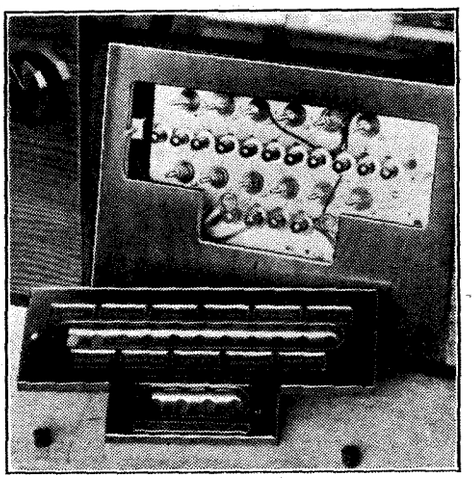


Calibrated scales to facilitate setting of iron cores in Bush PB55 receiver.



Adjustment of the pre-tuned circuits in the Ekco PB179 is made from the front of the set by a calibrated screwdriver.

Whatever the system used, ease of resetting is of first importance to the non-technical user. Where possible manufacturers have adopted a layout which enables this operation to be effected from the front of the set, and one of the best is to be found in the Ekco Model PB179, where the moulded cover plate over the push buttons is lifted out revealing all the core adjusting screws (the set is permeability tuned). Each adjusting screw, which is sunk to facilitate engagement of the special screwdriver, is provided with a miniature replica of the tuning scale showing the range of wavelengths covered by that particular press button. The sheet of station names from which identity discs of new stations are cut also indicates the number of turns which will be required



Control panel of Pye Model 806 which includes press buttons for tone control and volume expansion.

to bring that station close to tune on any of the ranges which include that wavelength.

The Bush sets also have calibration scales on their permeability trimmers, in which a red band on the trimmer spindle is read off against a metal scale engraved directly in wavelengths.

In Pye sets translucent moulded press buttons are used, and when depressed a part of the base of the button is exposed to a floodlit compartment causing the button to appear to glow. All resetting adjustments can be made from the front of the set, and even tone control, selectivity and volume expansion are press button operated on the Pye Model 806.

The manufacturers have, in fact, put in a tremendous amount of thought in order that the listening public need not think so much about the operation of their sets.

CIRCUIT DEVELOPMENTS

AFC as an Aid to Press-Button Tuning

THE most obvious trend in design this year is push-button tuning which is fully described elsewhere in this issue. Resulting from the adoption of push-button tuning, however, is the inclusion of automatic frequency control in many of the more highly priced receivers, especially those which have motor-driven tuning. AFC is an electrical arrangement which ensures correct tuning of the receiver and consequently greatly reduces the accuracy needed in the mechanical devices.

An AFC system is conveniently divided into two parts—the control system and the discriminator. The latter provides the voltage to work the control system and is the part which differs most in different sets. The control is exercised on the oscillator of the frequency-changer and an extra valve is connected in parallel with the tuned circuit and arranged so that it behaves as an inductance or capacity, the

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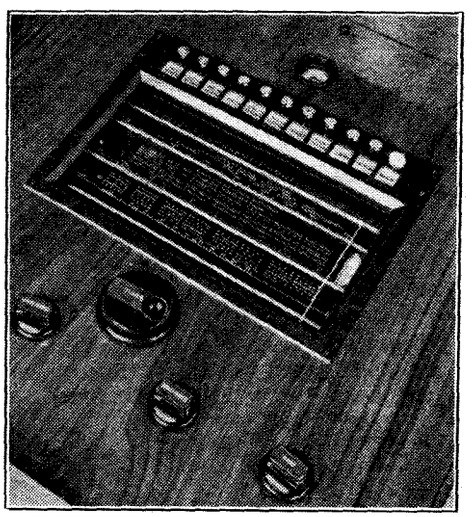
value of which depends on the mutual conductance of the valve.

The usual procedure is to connect anode and cathode of an RF pentode across the oscillator circuit and to feed the grid from a voltage divider also connected across the oscillator circuit. This voltage divider consists of a high resistance in series with a capacity or inductance of relatively low resistance. The volts applied to the anode of the RF pentode are in phase with the oscillator volts. The current flowing through the voltage divider is also very nearly in the same phase. The voltage applied to the valve grid, however, is about 90 deg. out of phase with the oscillator voltage, since it is developed across the re-



Control panel of the H.M.V. Model 664 radiogramophone. No fewer than three valves are used for the AFC system.

active element of the voltage divider. The current through the valve is in phase with the grid voltage, and 90 deg. out of phase with the oscillator voltage. The valve thus behaves as an inductance or capacity and, as the current depends on mutual conductance, the magnitude of the inductance or capacity does so also.

Varying the grid bias of the control valve thus controls the oscillator frequency. Normally, the valve is biased to the mid-point of its characteristic, and the application of a negative control voltage then changes the oscillator frequency in one direction and the application of a positive voltage changes it in the other.

The purpose of the discriminator is to develop a control voltage which will depend in magnitude upon how much the receiver is off tune and in sense upon the direction in which it is mistuned. It must also deliver no output when the receiver is correctly tuned.

There are two arrangements adopted. The simpler to understand is the one used by H.M.V. and in some of the Murphy sets. Two diode detectors are used, and their outputs connected in series and in the opposite sense so that the total output is zero when both detectors have equal inputs. When the input to one detector exceeds that of the other, an output is obtained across the combined load resistance equal to the difference in the individual outputs and of the same sense as the stronger. Each detector has its own input tuned circuit, but these circuits are not tuned to the same frequency, but are mistuned one above and the other below the intermediate frequency.

The conditions are such that when a signal comes through at the exact intermediate frequency each mistuned circuit picks up the same amount of energy and each detector gives the same output. The control voltage is zero and the control valve does nothing. If the receiver oscillator is slightly mistuned, however, the intermediate frequency is not correct and is nearer one detector circuit than the other. The energy fed to one detector then increases and that fed to the other decreases, and the difference of the outputs appears as a control voltage which makes the control valve change its reactance and hence the oscillator frequency. This in turn brings the intermediate frequency nearer the correct value. It can, of course, never bring it exactly to the correct value, for then there would be no control voltage. Some mistuning must always exist, but although this can never be zero, it can be made as small as desired.

Sometimes the tuned circuits of the discriminator are coupled to the input tuned circuit of the detector proper, but H.M.V. isolate the discriminator completely by providing it with its own input IF stage. This probably also gives an advantage in that the input to the discriminator can be made larger.

The second system has the advantage that all circuits are tuned to the same frequency so that lining up is made rather easier. The action of the circuit is, however, rather more difficult to follow. The control arrangements are the same, and two diodes with their outputs in opposition are still used. The diodes are fed in push-pull from the secondary of an IF transformer and also in parallel from the primary. The operation depends on the phase difference between the two inputs which makes the actual voltages applied to the diodes vary in a similar manner to those in the case of the other system.

The merit of this method is that it is somewhat simpler in that it needs fewer parts and is easier to adjust in practice. It is adopted by Murphy in the A52. Actually, an RF pentode is not used for the control valve in this set, but the hexode section of a triode-hexode. This is because this valve can function as a frequency-changer on short waves when AFC is not used. For SW work the set is actually a double superheterodyne, the first intermediate frequency being 3.1 Mc/s.

One point to be noticed this year is a considerable reduction in the number of sets fitted with variable selectivity. It is retained by Dynatron, however, who have an elaborate arrangement whereby switches change the mutual inductance between IF coils and at the same time alter the damping of the tuned circuits. For local reception the receiver is converted to a straight set.

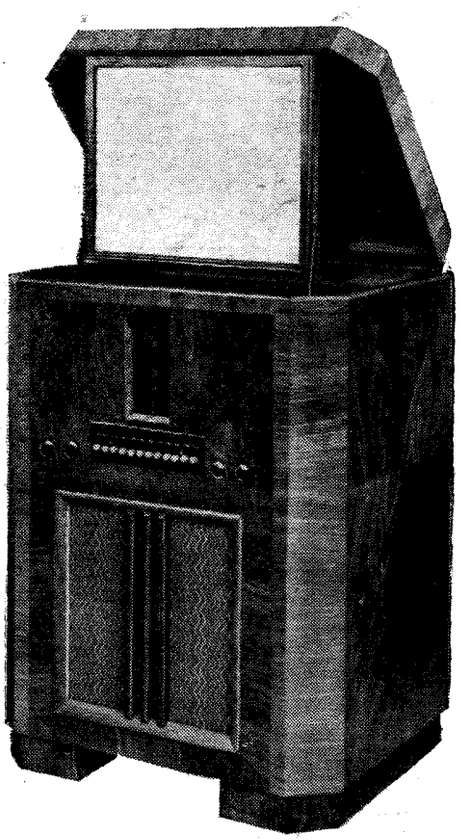
TELEVISION RECEIVERS

Large-, Medium- and Small-Screen Models

THERE is no question that the most obvious trend in television equipment this year is towards the use, in certain models, of small cathode-ray tubes, with consequent saving of cost. The small tube naturally gives a small picture, and among those offered for sale the smallest is about 5in. in diameter. In spite of the publicity given to these receivers, however, they are probably exceeded in number by apparatus embodying large tubes, and there are also more receivers this year of the projection type giving really large pictures.

Beyond a greatly increased tendency to the use of magnetic deflection and focusing there is as yet little evidence of any approach to a standardisation of design such as that found in the case of broadcast receivers. In the case of television all the possible permutations and combinations of valves and components have yet to be tried out, and there is the happy result that different manufacturers have found widely different solutions to their problems.

Present equipment can conveniently be divided into four categories—large-screen projection types, large-tube models (12in.-16in.), medium-tube sets (9in.-12in.), and small-tube receivers with tubes smaller



The Baird Projection Tube Receiver, Model T19.

than 9in. Except in the case of the projection models, all equipment is of the cathode-ray type.

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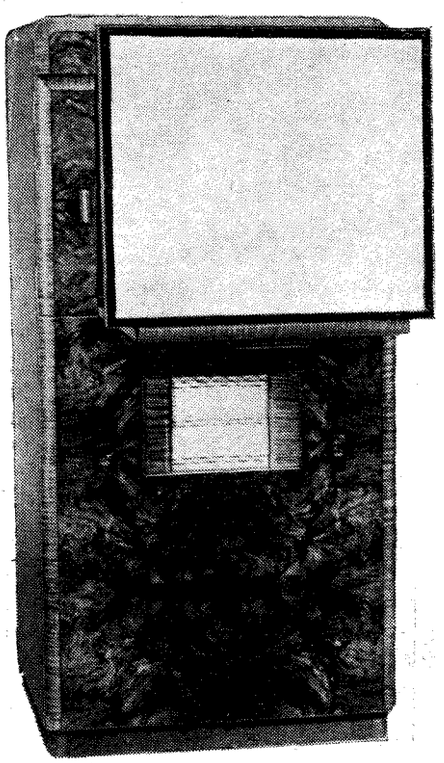
The CR tube is adopted by most firms for the large-screen equipment, a small tube of some 4-5in. diameter being used and operated at 20,000-25,000 volts, so that a very bright picture is obtained on the fluorescent screen. This is projected on to the viewing screen by means of a lens of about f/2 aperture. The screen is usually about 20in. × 18in., and very good pictures are secured.

H.M.V. and Philips have equipment of this nature, and, indeed, have had for a year or so now, but other firms have recently turned their attention to projection apparatus, and Baird and Pye must be included among them. The Baird equipment, which is priced at 150 gns., offers a choice of two picture sizes; the smaller size is 18in. × 15in., and the viewing screen folds in the cabinet lid when not in use. When a larger picture is desired this screen can be removed and another measuring 24in. × 19in. substituted. The

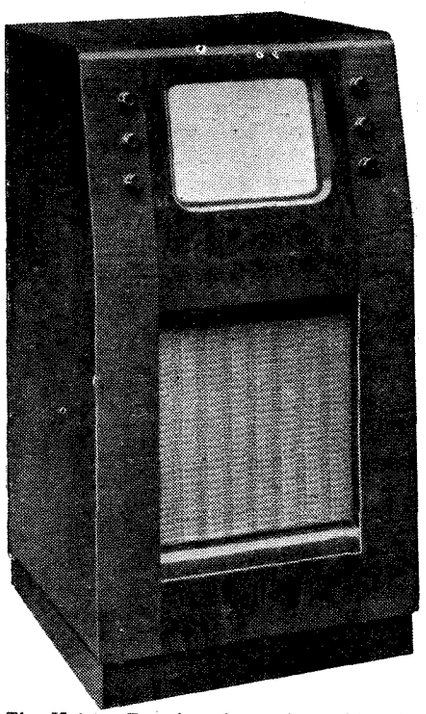


Ekco-Scophony Model ES104 receiver with screen 24in. by 20in.

picture obtained is a good black and white with a large viewing angle. The actual receiver is a superheterodyne, and H.M.V. and Philips also adopt this type of set. Pye, however, use tuned radio-frequency amplification, the actual receiver being very similar to that used in their model 815, save that a VF stage is included. The picture size is 18in. × 15in., and the apparatus costs 195 gns.

Both Scophony and Ekco-Scophony are showing equipment of an entirely different type. No cathode-ray tube is used, for there is mechanical scanning. A mirror-drum of roughly 12in. diameter is used for frame scanning, and a miniature polygon of stainless steel revolving at 30,375 RPM for the line. A 300-watt mercury lamp acts as the light source, and modulation is effected with the aid of the supersonic light relay which permits the resolution of nearly 200 picture elements simultaneously. Including the lamp, a total of thirty-nine valves is used, and the power consumption is of the order of 1 kW.

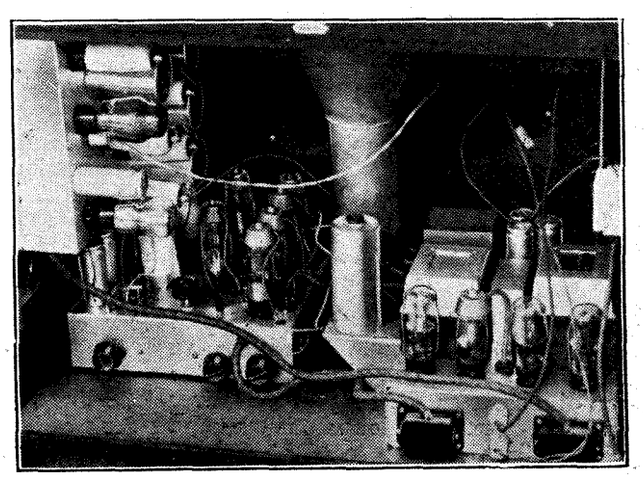
Turning now to the large-tube types, many of the receivers in this class are the same as those produced a year ago, and have only minor modifications. As



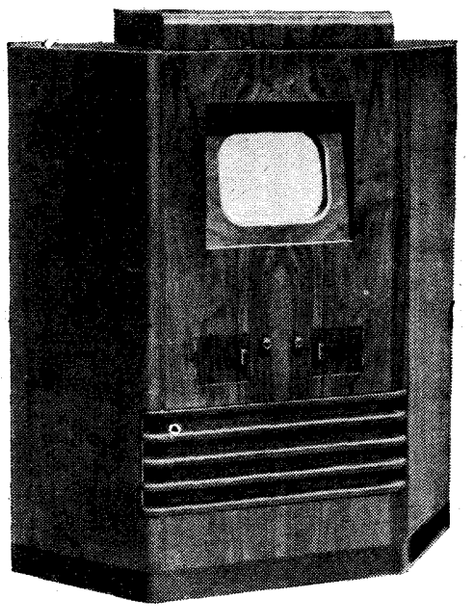
The Kolster-Brandes 780 receiver with 12in. tube.

they are not "new models," they do not receive the same publicity as many of the smaller types, but they nevertheless represent a very important section of television apparatus, and by virtue of the picture size and general performance are exceedingly well suited to the requirements of the average viewer.

H.M.V. and Marconiphone retain TRF amplification for sets in this category, and the 12in. tube has magnetic deflection with electrostatic focusing. It is fed directly from the diode detector. The G.E.C., however, adopt the superheterodyne and one VF stage; the large model produced by this firm has a 16in. tube mounted vertically and viewed through an inclined mirror. In the Baird T18 model direct viewing of the 12in. tube is adopted, and it is only in their radio-gramophone-television model that a mirror is used. Cossor also adopt direct viewing, but Murphy Radio use a mirror for their large-tube model. This is



An interior view of the R.G.D. 382 receiver with electrostatic tube.



Tannoy receiver with only two controls.

the A42V, with a 12in. tube having electrostatic deflection and focusing. Gas-triode saw-tooth oscillators are used in the time-bases with triode push-pull amplifiers. The receiver is a superheterodyne with an amplitude filter fed off the cathode circuit of the VF stage; this filter is unusually complex, and consists of a duo-diode, the two halves of which give line and frame sync pulses in their outputs. For the frame a phase reversing stage follows with circuits designed to maintain the sharpness of wavefront of the pulses.

R.G.D. also adopt electrostatic deflection and focusing in their model 382 at 75 gns. The receiver is a superheterodyne with one RF stage and triode-hexode frequency-changer common to both sound and vision. There are then four IF stages working at 13 Mc/s, and both sidebands are retained; a diode detector follows, and there is then a VF stage, which feeds the CR tube with DC restoration. Actually, the full output of the VF stage is applied to the sync separator, and a portion of it only to the tube. A saturated pentode forms the amplitude filter, and gas-triodes are used for the saw-tooth oscillators. There are two sound IF stages on 9.5 Mc/s, followed by a diode detector, a

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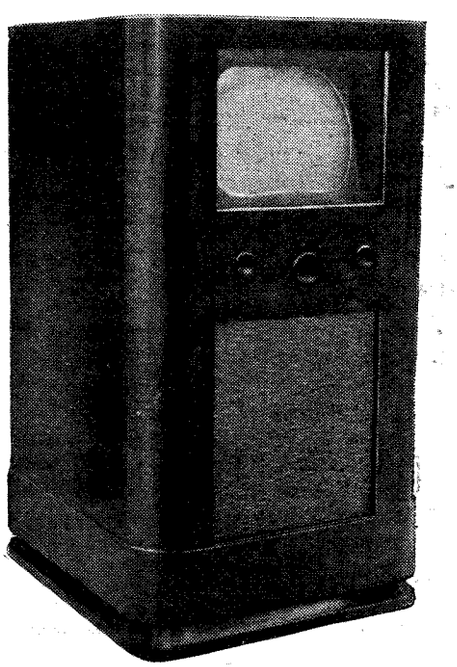
triode AF stage, and output pentode with negative feed-back.

The Tannoy apparatus is noteworthy for having only two controls, brilliance and sound volume. It is a superheterodyne with an intermediate frequency of 8.2 Mc/s and four IF stages, preceded by a triode-hexode frequency-changer and one RF stage. A diode is used for detection, and there is one VF stage which feeds the tube through a network which partially removes the DC component, it being claimed that this gives better results than either its complete retention or removal. Following the VF stage, there is the sync separator, which comprises a diode, and a pentode pulse shaping valve. Gas-triode saw-tooth oscillators are used. One unusual feature is the provision of an indicator to call attention to the equipment when it is operating with no signal. If the set is left on at the end of a programme an audio warning consisting of a 6,000 c/s whistle starts up when the transmitter closes down.

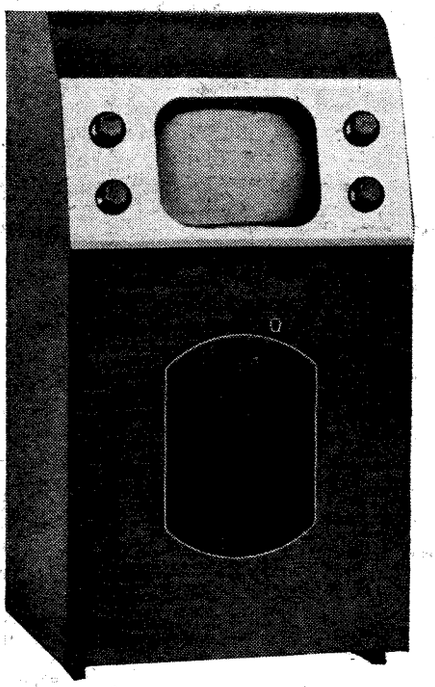
The G.E.C. model BT9121 has several unusual features; in the first place there are two RF stages before the frequency-changer, and only two IF stages operating at 6 Mc/s. Both sidebands are retained, and the band-width is 5 Mc/s. The detector is a diode, and the VF stage is directly coupled to the tube. Gas-triode saw-tooth oscillators are used, and the time-base output is in push-pull as electrostatic deflection is used. Contrary to the usual practice, however, the time-base amplifiers are not RC-coupled push-pull



G.E.C. Type BT 9121 with electrostatic deflection.

triodes, but single output pentodes coupled to the tube by push-pull transformers. In addition to saving valves, this permits the use of a common HT supply for receiver and time-base. A 12in. tube is used and viewed directly.

Turning now to medium-size apparatus, we come to the new Murphy Radio equipment at the low price of £30. This has a 9in. tube with electromagnetic deflection and focusing; it is mounted for direct vision. The receiver has one RF stage,



Murphy television receiver with 9in tube.

frequency-changer, and three IF stages; the detector is a diode, and there is one VF stage directly coupled to the tube. A duo-diode serves as a sync separator, and the time bases consist of gas-triode oscillators followed by pentode output valves which are transformer coupled to the deflecting coils. A special point is the mounting of the chassis in the cabinet on pivots. Normally it is nearly vertical, with the underside accessible from the rear, but when necessary it can be swung down together with the tube so that the upper side can be got at.

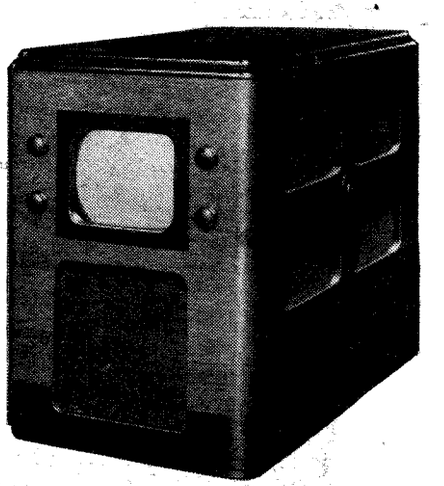
The Baird 9in. tube model is the type T20 at 35 gns. The receiver is a superheterodyne, and the tube is magnetically deflected and focused. Cossor also use a magnetic tube, but a very unusual feature is the adoption of a permanent magnet for focusing. An initial adjustment is provided by a sliding collar, but an electrical control is arranged for the final focusing; this is carried out by a variation of gun voltage. The receiver has one RF stage, triode-hexode frequency-changer, two IF stages, duo-diode detector, and one VF stage. Both sidebands are retained with a band-width of 4.5 Mc/s. The time bases are of the hard-valve type.

A receiver of very similar general type is used in the small set produced by this firm, which sells at 23 gns. This is the model 54 with a 6in. electrostatic tube. The tube is of special construction and does not require a push-pull output from the line time-base. A single-valve squegging oscillator is consequently employed for the line deflection. Push-pull is needed for frame, and here a special triode-pentode is used. For sync separation a split-anode tetrode is used and fed from the detector.

Apart from their projection model, Pye market two general types, the models 815 and 817. The former is priced at 30 gns. and gives a picture 7½in. × 6in. It is a TRF set with five RF stages and a push-pull diode detector which feeds the CR tube directly. The band-width is 3 Mc/s. Electromagnetic deflection is used; for line there is a hard-valve squegging oscillator for producing the sawtooth waveform, and this is followed by a pentode amplifier transformer coupled to the deflecting coils. For frame, a similar arrangement is used but with a triode-hexode. Two RF pentodes with direct connection to the detector are used for sync separation.

The smaller model, 817, at 21 gns., is very similar. It gives a picture 4in. × 3⅜in., and has only four RF stages with a band-width of 2.5 Mc/s. In the time base one triode-tetrode forms the line oscillator and output valve, and one triode-hexode is used for frame. A single-valve sync separator is used. The sound channel is only complete up to the detector, for it is intended for use in conjunction with an ordinary broadcast set, the detector output being connected to the pick-up terminals of the latter.

Receivers of the same general type are marketed by Invicta, and H.M.V. and Marconiphone also have models with a 5in. tube. These have the type numbers 904 and 706 respectively and are superheterodynes with one RF stage, triode-hexode frequency-changer, three IF stages and anode bend detector. A magnetic tube is used, and its cathode is directly coupled to the detector. There is a two-valve sync separator and a total of four valves in the time-bases. Including an



Cossor Model 54 with 6in. tube.

all-wave broadcast set, the price is 29 gns. Somewhat similar receivers with a 7in. tube are available at 45 gns.

Although little mention of it has been made, the television receivers all include a sound channel for the sound accompaniment to vision, and this is usually complete up to and including the loud speaker. Many sets also include an all-wave broadcast set, and most of the models described

are available in several different styles. The same vision unit is employed, but it may be had in conjunction with television sound only or with an all-wave set, and sometimes also with an automatic record-changer.

TEST GEAR

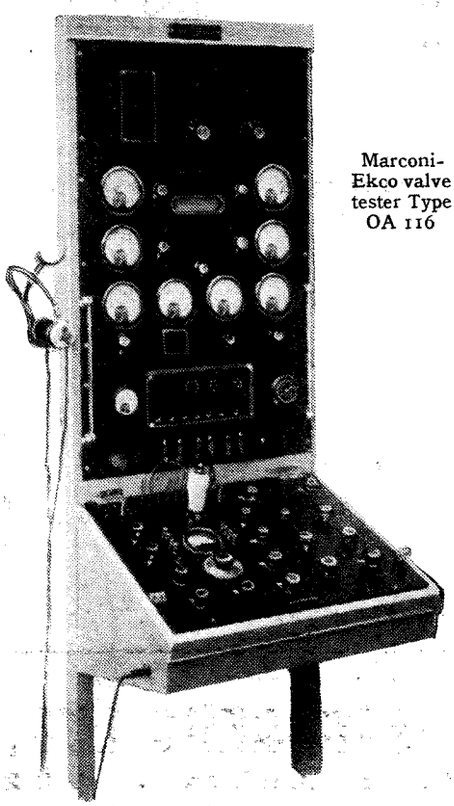
Measuring and Fault-Finding Apparatus

THE design of test apparatus for the servicing of wireless sets, or for routine tests during the course of production, has now reached such a high standard that the difference between this class of gear and what is usually described as laboratory apparatus is far less marked than it was a few years ago. Yet on the whole the cost of this apparatus remains well within the reach of the average serviceman.

Actually, few changes have been made in the new season's models and where modifications have been made they are mainly with the view of extending the scope of the apparatus or for simplifying its operation.

For example, the Automatic Coil Winder Co. hitherto supplied two panels of valve-holders for the Avo Valve Tester, but now faced with the problem of having to cater for some new valves with the possibility of still further additions in the near future, these two panels have been replaced by a new one of rather ingenious design.

One only of each kind of valveholder in general use is now fitted, and these are wired up to a series of nine rotary switches so that the sockets on each valveholder



Marconi-Ekco valve tester Type OA 116

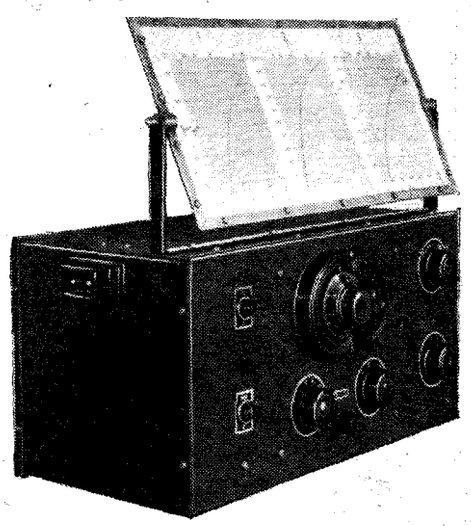
can be joined in the appropriate manner to the main test panel for any type of valve.

The main test panel containing the meter, power supply and circuits for the measurement of mutual conductance remains unchanged.

The value of mutual conductance measurement as an indication of the condition of a valve is further exemplified by the fact that tests based on this principle are made by the Tech Valve Tester shown by Norman Rose.

A complete analysis of a valve can be made with the apparatus shown by Marconi-Ekco Instruments. Their Type OA 116 valve-testing equipment is designed for rapid and accurate measurements of mutual conductance, AC resistance and amplification factor of any type of receiving and low-power transmitting valve.

The Radiolab range of test instruments includes a comprehensive valve test set as well as simpler types for the serviceman. Instruments of this kind are made also by Weston and Bulgin.

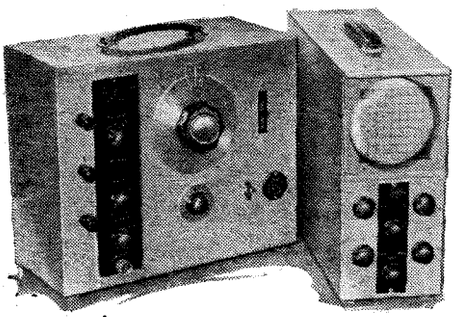


Mullard signal generator, Type GM 2880F.

As some means for generating an artificial signal are indispensable for testing and aligning a modern wireless set every firm interested in the production of test apparatus has one or more models. The latest improvement, especially in those instruments that are produced for the serviceman's use, is the inclusion of the television wavelengths. Extending the range to 50 Mc/s would actually satisfy present requirements, but in the Avo all-wave oscillator the calibration is carried to 80 Mc/s. Admittedly, the range 30 to 80 Mc/s is provided by the second harmonics of the 14 to 40 Mc/s range but this is not an uncommon practice and many other makers adopt the same idea. Provided a clearly marked scale is fitted the use of second harmonics is quite practical.

It is now customary practice to include a modulating valve generating a 400 c/s audio tone which can also be employed separately if required for testing AF equipment. Where the depth of modulation is fixed it is given as 30 per cent. Another feature of the latest models is that provision is made for modulating the RF from an external source.

In the Pye Trimeasy signal generator three internal modulating frequencies are provided, these being 400 c/s, 10 kc/s and 150 kc/s; the latter is for testing the line and frame synchronisation controls in television sets. Test oscillators of the servicing variety are now made by Avo, E.M.I. Service, Hurt, Pye, Radiolab and Weston.

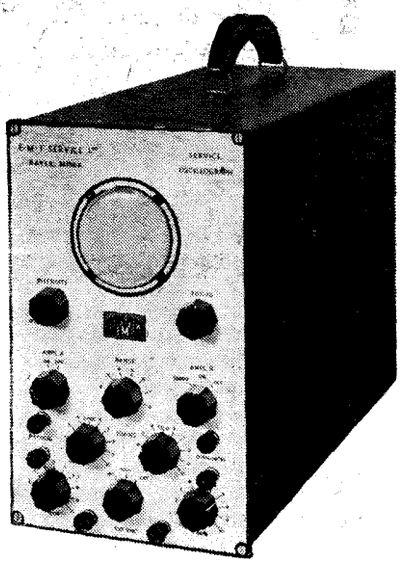


Cossor Ganging Oscillator and Oscilloscope.

Used in conjunction with a CR Oscillograph a signal generator can be employed for the visual examination of IF response curves. This can be done by changing the RF oscillator tuning so that it covers a range of frequencies within which the amplifier response should lie. If one such sweep were made a curve would be traced by the spot on the screen of the CR tube and in order to produce a stationary image the oscillator is made to repeat its excursions at a suitable rate.

This is sometimes referred to as "wobbling" the oscillator.

Though this could be done by mechanically rotating a small variable condenser joined in parallel with the main tuning condenser, electrical means are usually preferred and this is the system employed in the Cossor Ganging Oscillator as well as in the Mullard Signal Generator. Mullard, however, supply a separate unit for modulating or "wobbling" the frequency of the test oscillator.



E.M.I. Service oscillograph.

Cathode-ray oscillographs are being used extensively for testing both radio and sound amplifying equipment and the complete equipment in portable form is now

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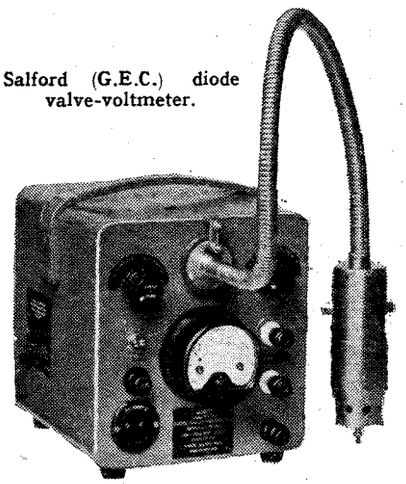
available at a reasonable price. Though portable they rely on the mains for their operating voltages.

The Cossor Oscilloscope, Model 3332 costs £20, for example, one of the Mullard Cathode-Ray Oscillographs, Model GM-3153, is priced at £25, while the E.M.I. Service Oscillograph costs £25 also. Each

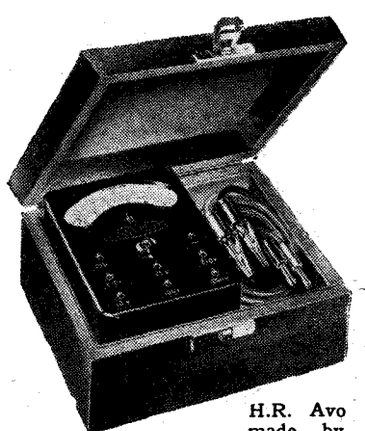


Salford (G.E.C.) diode valve-voltmeter.

of these models is self-contained in that they include horizontal time base, mains equipment, an amplifier for the signal input to the vertical plates, focus, shift and synchronising controls.

Morris and Co. have also a complete oscillograph with a 3in. tube, time base and amplifiers at the price of £10 10s.

Test equipment that is built with a high order of accuracy and which comes under the heading of laboratory apparatus is shown by Marconi-Ekco Instruments. These include standard signal generators, a beat frequency oscillator having a range of 10 to 12,000 c/s and with an accuracy of 2 c/s, bridges for inductance, capacity, resistance and electrolytic condenser measurements, as well as many



H.R. Avo Minor made by Automatic Coil Winder Co.

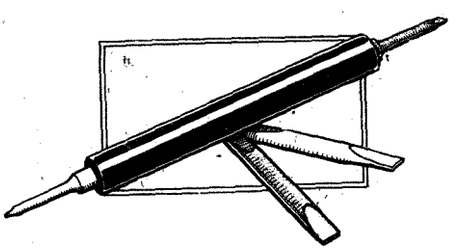
other pieces of apparatus designed for use in the test room of receiver and component manufacturers.

An interesting range of meters and test instruments is now being made by Salford Electrical Instruments (G.E.C.).

There is a range of valve voltmeters, the smallest of which, the Type 105X, employs a diode valve heated by a self-contained torch battery. It will measure voltages up to 100 RMS in three ranges. Its frequency range is 20 c/s to 10 Mc/s.

In the Type 107X the valve is housed in a screened case on the end of a flexible metal tube and this model is accurate up to 100 Mc/s. Measurements are effected by charging a condenser through a diode and then measuring the voltage by means of an electrostatic voltmeter. It can be supplied for working over any one of a number of standard ranges, the lowest being 50 to 300 volts RMS and the highest 400-2,000 volts RMS. The input capacity is very low, being 1.5 m-mfds with a screened valve. There is also a multi-range valve voltmeter in this series as well as one with an acorn triode having an input impedance of 700,000 ohms at 50 Mc/s.

Single- and multi-range AC and DC meters for voltage and current measurements are obtainable in a wide variety of types and sizes from Ferranti, Weston and Radiolab. There is a new Avo instrument described as the H.R. Avo Minor. It embodies a very sensitive micro-ammeter movement, its two current ranges being 0-50 and 0-250 microamps respectively. As a voltmeter its internal resistance is of a correspondingly high order, being 20,000 ohms per volt on all the six voltage ranges. The lowest is 0-2.5 volts and the highest 0-1,000 volts DC.



Pye service trimming tools.

A comprehensive test set with an internal resistance on its voltage ranges of 20,000 ohms per volt is made by Weston, and is described as the Super Sensitive Analyzer.

There is a new multi-range AC and DC test set, having 28 ranges among the Salford products. This is a very versatile instrument as its scope can be extended by the use of external shunts, etc.

There are many items of interest to the serviceman, and for that matter to the home constructor, that might be described as testing accessories. Valveholder adaptors with split socket connections are shown by Bulgin, while insulated trimming tools for adjusting IF and RF trimming condensers may be obtained from Pye, E.M.I. Service and Bulgin.

VALVES AND CATHODE-RAY TUBES

Developments in "Glassware"

TO the casual observer the most striking tendency in the valve world must be the increase in the number of different types of valve base. It would appear that each firm will soon have one, or even more, of its own!

All makers still retain the "standard" British bases with 4 to 9 pins for a wide range of valves and are still making additions with these bases. Last year Marconi and Osram introduced the American, or International, octal base for their 6.3-volt series of valves with characteristics similar to those of American types. Quite recently, Mullard have marketed a range of 6.3-volt valves with the Continental side-contact base, and Mazda have produced 2-volt battery and 4-volt mains valves with an octal-base which differs from the American. Tungsram market one range of valves with the American octal base, and another with the Continental side-contact, and this is in addition to other valves with the "standard" bases.

The valves in the Mullard and Tungsram ranges with the side-contact base are known as the "E" series and are characterised by possessing heaters which consume 0.2 ampere only in the case of most specimens. The valve of greatest interest is probably the EF8, which is intended for use as a first-stage amplifier. It is a hexode; the control grid surrounds the cathode and there are the usual screen and suppressor grids. Between the control and screen grids, however, there is an extra grid which is maintained at earth potential and which is wound turn for turn with the screen grid. As a result, the electrons are forced into beams so that the majority pass through the turns of the screen-grid without striking them. The screen current is thus abnormally low, being about 0.25 mA only, and the noise introduced by the valve is also low. It is claimed that through the use of this valve an increase in signal-noise ratio can be secured. Another valve in this range is the EF6—an RF pentode with an input resistance of 9,000 ohms at 60 Mc/s.

These valves have mutual conductances of the order of 1.8-2.0 mA/V and the adoption of these moderate figures, compared with those of a few years ago, does represent a distinct trend. Not only are these modest figures to be found in the "E" series of valves, but also in the Marconi and Osram International range. With the RF pentodes of these 6.3-volt valves, the mutual conductances are some 1.2-1.6 mA/V and similar figures are to be found for earlier 4-volt valves marketed by this firm, such as the W42.

This tendency to adopt lower values of mutual conductance probably results largely from an increase in uniformity of different specimens coupled with some reduction in the cathode heating power. Moreover, for broadcast purposes high values of mutual conductance are usually unnecessary with modern circuit design.

This is by no means the case with television, however, and among valves intended for this purpose the aim is to get the highest possible mutual conductance with the lowest inter-electrode capacities. The one is of no use without the other, for if a doubling of the mutual conductance results in a doubling of the total circuit

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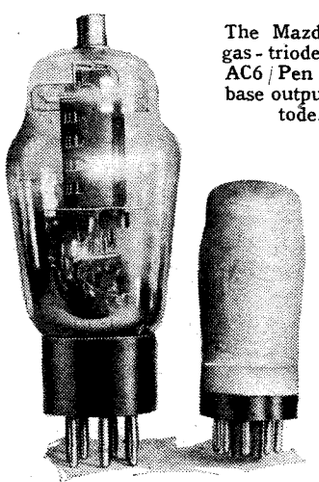
capacity, one is no better off. The Osram KTZ41 has a mutual conductance of 12 mA/V—a very high figure for an RF tetrode. The Mazda SP42 has a mutual conductance of some 8.5 mA/V, and by virtue of its octal base very low inter-electrode capacities are claimed.

Mullard, of course, retain the well-known TSP4, but now have a secondary emission valve, the EE50. This valve is of all-glass construction, the usual moulded base being absent. It has a mutual conductance under normal operating conditions of 14 mA/V. It takes 10 mA anode current at 250 volts and 8 mA auxiliary cathode current. The heater has the standard rating of 6.3 volts, 0.3 amp, and the input and output capacities are respectively 7.3 $\mu\mu$F. and 7.1 $\mu\mu$F.

For television time-base work Mazda have the T41 gas-triode. This is similar to the T31, but is intended for low voltage operation and is fitted with an octal base. For the output stage with magnetic deflection this firm has the AC6/Pen; this is substantially the same as the AC4/Pen, but has a top-anode connection so that it can withstand the high peak voltages generated on the fly-back.

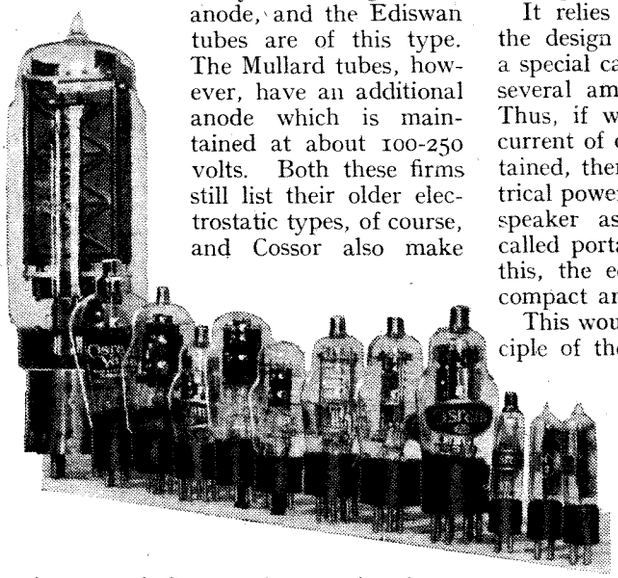


The Mazda T41 gas-triode and AC6/Pen time-base output pentode.

Osram have the KT8, a top-anode tetrode, which is otherwise similar to the KT66. Although suitable for television work it is classed as a transmitting valve and is rated for 600 volts anode potential. As an RF amplifier for Class C telegraphy it has the useful output of 25 watts at 60 Mc/s. A larger valve is the DET 14; it has a 7.5-volt 3-amp filament, and is a triode rated for 1,500 volts and 55 watts anode dissipation. Among large output valves made by this firm must be mentioned the DA 250, a pair of which in Class AB2 will give an output of 800 watts.

Turning now to cathode-ray tubes, there is an obvious tendency towards the production of shorter types. Such tubes are invariably of the magnetic type, and although the reduction in length is advantageous from the point of view of cabinet size it is not without its attendant drawbacks. The short tubes need more carefully designed deflecting coils if an undistorted spot is to be obtained in the corners of the picture, and a considerably greater deflecting power is needed.

In general, magnetic tubes have only the cathode assembly, control grid and anode, and the Ediswan tubes are of this type. The Mullard tubes, however, have an additional anode which is maintained at about 100-250 volts. Both these firms still list their older electrostatic types, of course, and Cossor also make



A group of Osram valves ranging from the DA 250 on the left to the deaf-aid types on the right.

both kinds. This firm, however, lists chiefly electrostatic models and has a very wide range of types for both television and oscilloscopic uses.

G.E.C. have two small oscilloscope tubes with screens of some 1.5in. and 2.5in. diameter, while Hivac have a 3in. model. The very small tubes need only about 300-500 volts for good operation, and the larger types some 600-1,000 volts, so that their use becomes quite economical.

Vacuum Science Products have a range of cathode-ray tubes which are especially interesting since they differ in several ways from what is fast becoming standard practice. In the first place the tubes are unusually long and so require an unusually low deflecting power. Secondly, a different modulating system is used; instead of employing the cathode shield for this purpose, a separate grid is interposed between the cathode shield and first anode. It is claimed that an input of only 6 volts p-p is needed for modulation. Tubes are available for all-electrostatic or all-magnetic deflection and focusing, or for a combination of the two.

Of particular interest to set makers is a tube with a built-in picture which can be used to provide a standard picture for test purposes. The amplifier needed can be an electron multiplier, types of which are produced by this firm, as well as a wide variety of photo-electric cells.

PUBLIC ADDRESS

Microphone and Amplifier Developments

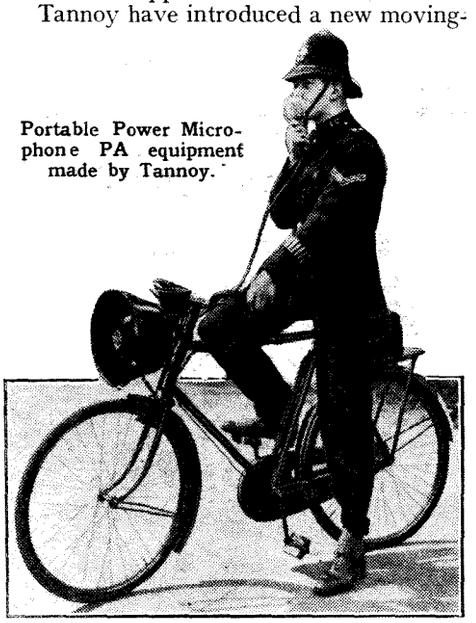
A NOTABLE contribution to the technique of sound amplification has been made by Tannoy, which firm is showing this year a portable loud-speaking equipment consisting of a microphone, a loud speaker, and a 12-volt battery. There are no valve amplifiers at all in this apparatus.

It relies for its operation solely upon the design of the microphone, which is a special carbon type capable of handling several amperes of current at 12 volts. Thus, if when spoken into a change in current of one or two amperes can be obtained, there will be almost as much electrical power available for operating a loud speaker as is obtained from many so-called portable PA amplifiers. Added to this, the equipment is very much more compact and *really* portable.

This would appear to be the basic principle of the Tannoy Power Microphone equipment. The microphone can be used with any type of loud speaker, though a suitable matching transformer must be used. Current is drawn from the battery only for very short periods, as there is a thumb-operated switch on the microphone handle that has to be depressed when speaking. The microphone is insensitive to extraneous noises, so that "howling" or acoustic feedback troubles do not arise. It is claimed that intelligible speech can be projected up to a distance of 300 yards.

There are no particularly important changes in the general design of public address equipment this year. Such improvements that have been made are mainly devoted to reducing the size and weight of the portable units, though some interesting and new microphones have made their appearance.

Tannoy have introduced a new moving-



Portable Power Microphone PA equipment made by Tannoy.

coil microphone of high sensitivity and possessing a wide angle of pick-up. Both portable and rack-mounted installations are shown by E.M.I. Service, but, as with all other makers, their units are essentially representative, as in this class of work much of the apparatus is designed especially for the particular situation and the service it has to perform. E.M.I. Service make PA microphones ranging from

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a carbon model costing £1 17s. 6d. to a high-grade Reisz instrument at the price of £13 12s.

R. A. Rothermel specialise in the production of piezo-electric microphones; examples of the several sound-cell pattern as well as of a popular-priced diaphragm type are shown on their stand. The latter has a good response characteristic, yet gives a relatively large output for a microphone of this kind.

An inexpensive carbon transverse current microphone can be obtained from Morris and Co., which firm is showing also a representative range of Premier power amplifiers in sizes of from 3½ to 60 watts for AC as well as for AC/DC operation.

Some very compact 12-watt amplifiers are now made by G.E.C. On the other hand, quite large models in the rack-type assembly can also be obtained. Here again the models exhibited must be regarded as merely representative of the firm's products.

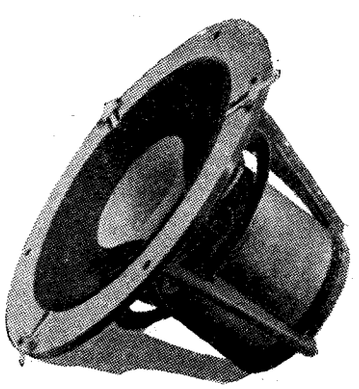
LOUD SPEAKERS

The "Infinite" Box Baffle

ALTHOUGH their outward forms change from year to year, fundamental improvements in design are not numerous. There is a continual modification of detail as in the totally enclosed air gaps of the latest Rola speakers and the reductions in weight of magnetic material for a given performance in their small units for the set manufacturer.

High-grade loud speakers such as the B.T.H. R.K., the Rola G12, and the Celestion Auditorium speakers continue practically unchanged. Their performance on plane baffles is widely acknowledged, and it would seem unprofitable to wait for any closer approach to perfection along these lines.

Goodmans Industries evidently share this view, for they have recently done a good deal of research on box baffles and



Loud speaker unit developed by Goodmans Industries for use in conjunction with an "infinite" box baffle.

on the loud speaker units, which must be specially designed to operate with them. Examples of simple baffles of the bass reflex and labyrinth type, which are well within the scope of the amateur carpenter, are shown, but the most interesting exhibit on their stand is a new type of unit designed specifically for use with a totally enclosed "infinite" box baffle.

The idea of totally suppressing the out-of-phase radiation from the back of the diaphragm is an attractive one. Unfortunately, total enclosure increases the compliance or restoring force on the diaphragm at low frequencies, reduces the output, already halved for most frequencies by suppressing the back radiation, and raises the fundamental resonance of the diaphragm, thereby still further reducing the output below this frequency.

In the unit which Goodmans have produced for this special purpose, practically the whole of the restoring force is supplied by the air compliance. The edge of the diaphragm is suspended on three flexible tapes, and the back centring spider is very little less in diameter than the cone itself. Outside the cabinet the fundamental resonance is 22 c/s, and this rises to 40 c/s with the compliance of the air volume in the cabinet. It will be appreciated that the design of cabinet and loud speaker must go hand in hand, and the former must now be regarded as an integral part of the reproducer.

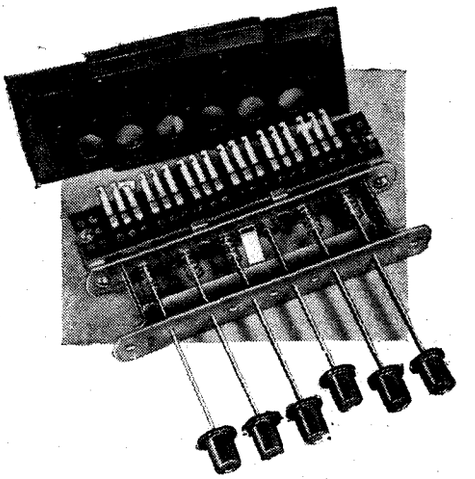
To reduce as far as possible the high-frequency reflection from the inside of a conventional pressed-metal chassis, the diaphragm support consists of three prongs cast integrally with the base to which the massive permanent magnet is bolted. The coil is of low resistance, and a high damping factor is obtained, an important point, since without it the occasionally higher excursions from the mean position might be detrimental to transient response. The assembly has other characteristics which make it specially suitable for domestic listening, and we shall look forward to testing its performance under more favourable conditions than those at the Show.

COMPONENTS

Catering for the "List of Parts"

PUSH-BUTTON tuning, which is one of the main features of this year's Show, is brought within the range of the home constructor by the introduction by Bulgin of a series of switch assemblies designed especially for this purpose. These switches are of the kind that lend themselves admirably to the capacity-substitution system, and they can be obtained in a variety of combinations with up to eight push-buttons on a single unit. Actually, each push-rod operates two switches, each of which has three fixed contacts and these can be either a three-point make-and-break or a single-pole change-over switch. Sixteen such combinations are possible in an eight-way unit, or some could be double-pole change-over by interconnecting the two switches associated with any one push-rod. It will thus be seen that switches of this kind have many applications.

In any system of pre-set tuning condensers of very high stability are essential, unless some form of automatic tuning correction be employed. The use of certain kinds of ceramic material has contributed



Bulgin push-button switch unit.

largely towards this end; some makers are actually depositing metal on the ceramic base to form the fixed plate thus removing one more possible cause of capacity variation. Careful attention to the nature of the metal, and the method of bending the spring strip that varies the moving plate, has still further improved the performance of these condensers. Trimmer condensers that exemplify this form of construction are made by Dubilier and by Cyldon.

In general the capacity of this kind of condenser is not large being of the order of 50 m-mfds and fixed condensers of suitable capacity will have to be joined in parallel in most cases. Alternatively, there are available larger pre-set condensers in which quite high stability has been achieved by careful attention to the design.

Ceramic is now employed as the dielectric in fixed condensers of from one or two m-mfds up to 1,000 m-mfds. Both T.C.C. and Dubilier make condensers of this pattern and they are described as discs, cups or tubes according to the actual shape of the ceramic body.

Eight-bank trimmer assembly made by Cyldon.

Another method of achieving a high stability is to deposit metal on both sides of a strip of mica and then either enclose this unit in a moulded bakelite or ceramic case or fit protecting plates on each side.

This pattern is described as silvered mica, metallised mica or just mica condensers, according to the particular method employed by the different manufacturers. They are shown by Bulgin, Dubilier, Polar and T.C.C.

Ceramic in one form or another, for this word relates to a number of fire-treated

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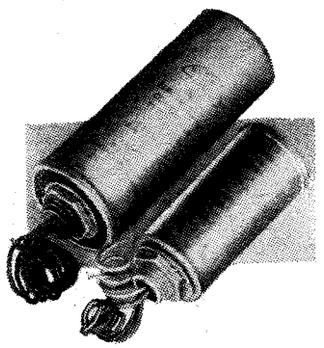
preparations of which Frequentite shown in a host of different parts and mouldings by Steatite and Porcelain Products is one, is being used for valveholders, switches and short-wave coil formers. Ceramic valveholders figure largely among the items shown by British Mechanical Productions (Clix), but both Bulgin and Stratton (Eddystone) also use this material for many of their products. To this list of firms might be added Polar, for in the Wearite switches shown on this stand ceramic plates are used.

Porcelain, another of the ceramic family, forms the insulators on many of the high-voltage condensers made by Dubilier and T.C.C., while other kinds of ceramic are employed as supports and insulators as well as for dielectrics in condensers.

An interesting development is seen in connection with dry electrolytic condensers. By a new method of construction it has been found possible to reduce the physical size without lowering the operating voltages. Some of the new patterns seen on Dubilier's stand are only about one quarter the volume of the standard pattern of equivalent voltage rating, but they do not supplant them; the larger models are still retained.



Dubilier Drilitic condenser and standard model of same capacity and rating.

In dry electrolytic condensers a certain amount of heat is developed, due largely to the ripple superimposed on the DC voltage. By reducing the size, apparently, the maximum ripple voltage is also lowered, though the DC operating voltage may be the same. Thus the miniature pattern must be used with discrimination.

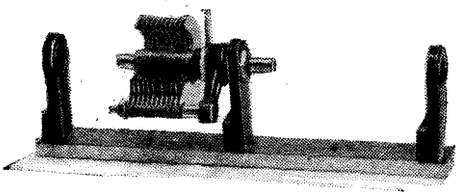
Dubilier call their new small size Drilitic; T.C.C. have some also and describe theirs as Midget or Minor according to whether they are assembled in tubular or in rectangular cases. The T.C.C. models are of a surge-limiting kind and though rated at 500 volts DC peak working will stand short-period operation at 600 volts DC without damage.

This surge-limiting, or surge-proof feature is quite a new development in connection with this class of condenser. Incidentally, the Dubilier products also embody this feature.

Short-wave components figure prominently in this year's Show. Bulgin has a long range of new components from which to choose; there are some new short-wave condensers, coils, insulators, reduction drives and a host of other items all of which will profoundly interest the amateur experimenter.

Stratton have improved many of their existing components, added others and generally made things much easier for the short-wave listener and transmitter who make their own sets.

One example will suffice to illustrate this point. When ganging two or more variable condensers difficulty is sometimes experienced in assembling the supporting brackets so that all condenser spindles are dead in line. The use of flexible couplers permits a certain amount of misalignment, but if this is carried too far it throws an excessive strain on the driving mechanism and may lead to slipping when friction drives are employed.

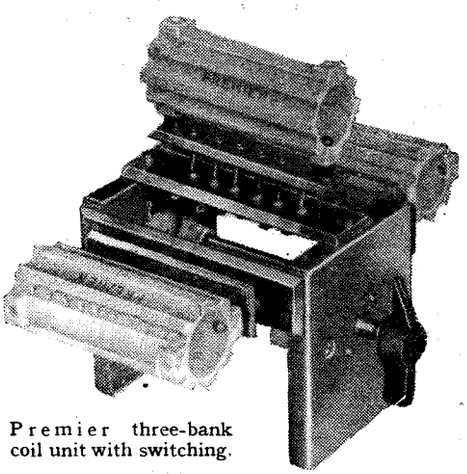


Condenser mounting cradle made by Eddystone.

To simplify the alignment of condensers Stratton has designed a condenser mounting cradle that supports on insulated pillars three of their Microdensers, the spacing being just sufficient to accommodate a flexible coupler and a large, square screening plate. A most useful accessory.

If one prefers to use a ganged condenser with either two or three units of about 90 m-mfds each, and with comparatively wide vane spacing, the new Polar short-wave gang condensers admirably satisfy these requirements. The rotor spindle is carried in ball bearings in which phosphor bronze balls are used.

Some well-made condensers having Trolitul insulation which, incidentally, has particularly good high-frequency characteristics including low loss, are to be seen



Premier three-bank coil unit with switching.

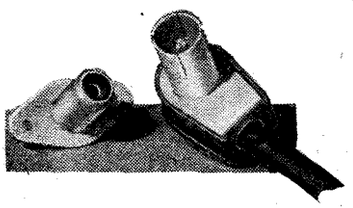
on Morris and Co.'s stand, where the well-known Premier Products are shown.

The transmitting amateur is well catered for by this firm as they are making a particularly wide range of modulation, mains and output transformers. Modulation transformers to match any audio stage to any RF stage with load impedances between 500 and 20,000 ohms either way, and for transmitting powers of 50, 150 and 300 watts are now available at astonishingly low prices, yet the transformers are built on most generous lines. There are mains transformers up to several thousand volts output.

This firm has introduced an ingenious three-bank coil-holder, including two ceramic-plate switches and plug-in coils. It is intended for use in transmitters where quick change from one waveband to another is required. The coil formers are available in two sizes, viz., 1½in. and 2½in. diameter; they are made of ceramic and are ribbed and notched for spaced windings.

Special transmitting condensers in single, dual and split-stator varieties and for operating voltages up to 5,000 and having the appearance and finish of precision condensers are shown by Sydney S. Bird (Cyldon). Eddystone also have a range of this class of condenser.

Television has produced a number of new components mainly in connection with the insulation of high-voltage lines. Plug and socket connectors of this kind have been developed by Belling and Lee, and this firm has also introduced a range



Belling-Lee Coaxial plug and socket.

of television aerials complete with fittings of various kinds for erecting on chimney stacks and on the side of a house; Bulgin, E.M.I. Service and H.M.V. also have several aerials of this kind.

In view of the widespread use of electrical apparatus for domestic purposes, Belling-Lee have now greatly extended their range of interference suppression devices which are effective for both sound and television broadcasts.

Anti-interference aerials are now obtainable in a variety of forms from Belling-Lee, Bulgin, E.M.I. Service, Pye, H.M.V. and R.G.D. Some of these cover all wavebands, including television.

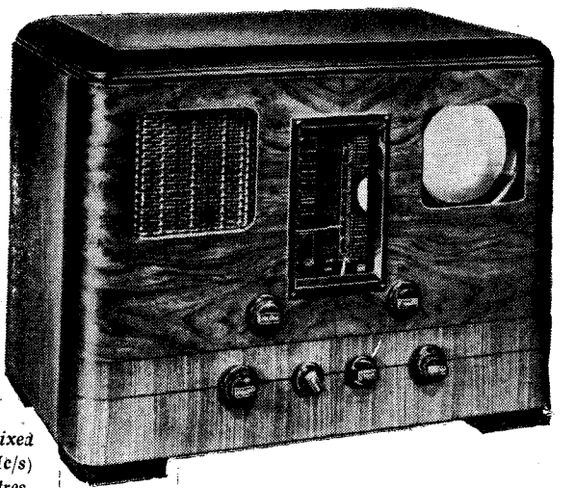
Scotland on the Air. Compiled by George Burnett. Published by The Moray Press, 126, Princes Street, Edinburgh. Price 3s. 6d.

THIS book, the first to be published dealing with a B.B.C. Region, is a combined effort by members of the B.B.C. Staff in Scotland. It has been compiled and edited by George Burnett, the Corporation's Scottish Public Relations Officer.

It covers in an interesting and descriptive manner the ins and outs of the fifteen years of Scottish broadcasting. There is, of course, little difference between broadcasting in Scotland and broadcasting in England, but the book makes good reading, having come from some twenty different pens—the Director-General's to a commissionaire's.

H.M.V. MODEL 904

A Receiver for Television and All-wave Broadcast Reception at 29 Guineas



FOR every present owner of a television receiver there must be a hundred who have privately resolved or publicly asserted that they would acquire one "as soon as the price came down to that of a good table model receiver." The Gramophone Company now offers the means of redeeming that promise; it goes further and includes the good table model receiver in the bargain.

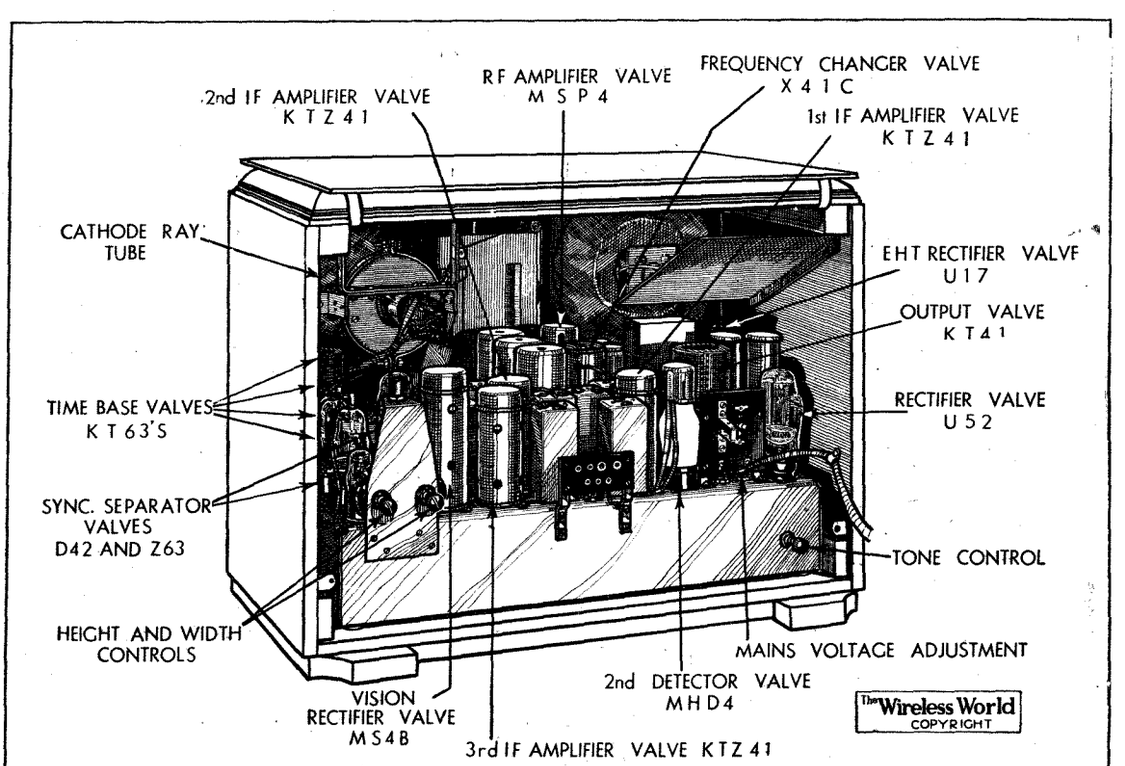
The 5-inch tube may at first sight appear small, but so do the 10-inch tubes of more expensive sets when compared with 16 mm. home cinema pictures, and the latter by comparison with the public cinema screen. Fortunately the eye is as accommodating as the ear has shown itself to be when listening to the full orchestra through a small loud speaker; provided the matter is sufficiently interesting one soon forgets the limitations of the medium. Arguing on these lines we might say that a still smaller picture would suffice, but the present vogue for miniature cameras and the manner of their use supplies the right answer. No one thinks of showing direct prints from these postage stamp negatives but everyone is satisfied with a "big print" measuring $4\frac{1}{4}$in. x $3\frac{1}{4}$in., and a post card enlargement is regarded as something of a luxury as far as comfort of viewing is concerned. A post card placed over the screen of the Model 904 leaves a good deal of the height of the picture uncovered and only just overlaps the length.

None of the essential controls of picture size, shape or quality has been omitted to cheapen the receiver. Consequently it was easy to ascertain that whereas a rectangular picture with the corners touching the edge of the tube was too small, a picture nearly filling the end of the tube with portions of the edges barely showing was just right.

The ratio of width to height having been adjusted by means of the auxiliary controls at the back of the set, all other qualities of the picture are taken care of by the controls on the front panel. The settings of the concentric frame and line hold controls are by no means critical and should present no difficulty to a beginner once he has learned to distinguish the effects of wrong adjustment in each case. It was also gratifying to find that alteration of the height and width controls had very much less than the usual effect on synchronisation. Contrast and brilliancy controls are also arranged concentrically and an ample range is provided to give the best possible compromise for viewing either in moderate light or in complete darkness.

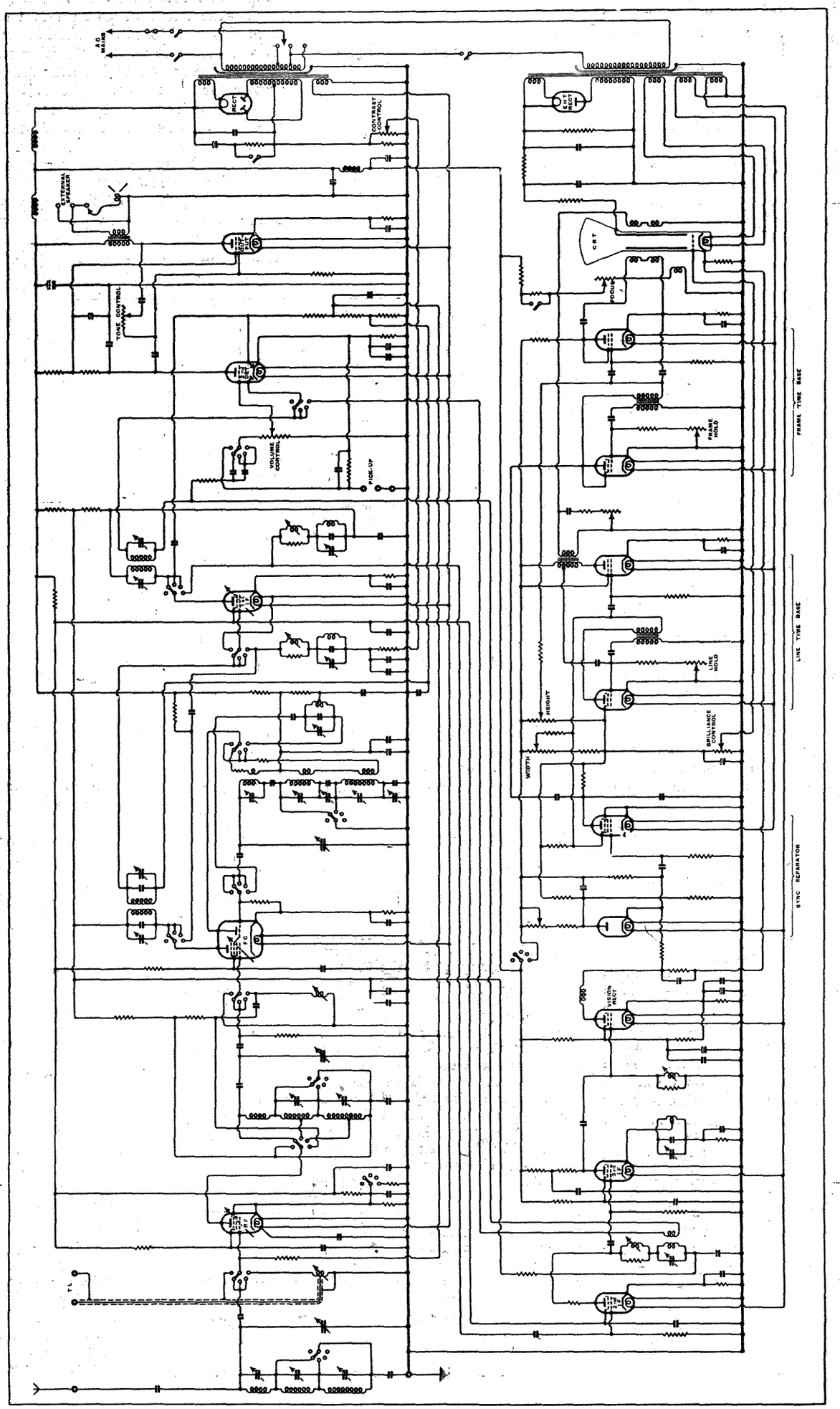
Focusing is sharp and the drift due to warming of the magnet coils is small. Attention to this control is not called for more than twice during an hour's transmission. Definition is excellent and the band width of the amplifiers appears to be exactly right having regard to the size of the picture. The curvature of the end of the tube is designed to give clear vision over an angle of about 120

FEATURES. ***Waveranges.***—*(1) Fixed tuning for Alexandra Palace, vision (41 Mc/s) and sound (41.5 Mc/s). (2) 16.5-50 metres. (3) 200-520 metres. (4) 725-2,000 metres.* ***Circuit.***—*(Television and Broadcast) Pentode RF ampl.—triode hexode frequency changer—tetrode IF ampl.—double diode triode 2nd det.—tetrode output valve. Full wave rectifier. (Supplementary television stages). Tetrode 2nd IF ampl.—tetrode 3rd IF ampl.—tetrode anode bend 2nd. det.—sync separator (diode and pentode)—two tetrode (triode connected) frame time base valves—two tetrode line time base valves Half-wave EHT rectifier.* ***Controls.—(Broadcast)*** *(1) Tuning. (2) Volume and on-off switch. (3) Waverange, television and gramo. switch. (4) Tone.* ***(Television)*** *(1) Focus. (2) Brilliance (3) Line hold. (4) Frame hold. (5) Height. (6) Width.* ***Price.***—*29 guineas.* ***Makers.***—*The Gramophone Co., Ltd., 98-108, Clerkenwell Road, London, E.C.1.*



By giving close attention to screening, the fifteen valves have been assembled in a single compact chassis. The Television tube is on the left and its focus and deflection coils are also screened.

A CIRCUIT OF UNUSUALLY WIDE SCOPE FOR A TABLE MODEL RECEIVER



The valves in the top line are used for television as well as for broadcast. A separate mains transformer supplies the heaters of the remaining television valves and the HT for the cathode-ray tube.

H.M.V. Model 904—

degrees, and with normal eyesight one can enjoy the programme at any distance from one to five feet.

Care is necessary in the choice of a suitable aerial. This point was emphasised when the receiver was tried first with a dipole with reflector (not H.M.V.) which showed some discrimination against the sound and called for a setting of the contrast (RF gain) control which gave too hard a picture when adequate volume was reached.

Sound and vision signals are amplified simultaneously by the earlier stages of the broadcast section of the receiver, the response being broad enough to cover both hands. The IF amplifier in the main broadcast receiver has tuned anode circuits in series for the vision and sound beat frequencies, and its output is passed to a separate television IF amplifier. The sound signals are taken by a coupling coil to the sound detector and output stages of the broadcast receiver, and the vision frequencies are again tuned-anode coupled to a third IF amplifier with negative feedback for vision only.

Anode Bend Vision Rectifier

The vision rectifier is an anode bend detector and as the output is negative for signals corresponding to white the connections to the grid and cathode of the CR tube are the reverse of those used in the case of a diode.

A diode across part of the anode load of the vision rectifier acts as sync separator in association with a pentode amplifying and phase reversing valve. The frame pulses are taken from the anode through a suitable integrating circuit and the line pulses are derived from the screen.

The time bases are of the hard valve type with oscillators and associated amplifiers designed to give a linear sweep with the required voltage output in association with the magnetic deflecting coils. Tetrodes connected as triodes are used for the frame and tetrodes for the line.

A separated mains transformer and half-wave rectifier supplies the extra high-tension for the anode system of the tube. The heater current for those valves which are devoted entirely to television is also taken from this transformer which is switched on when the waverange switch is turned to the television position. When receiving television the mains consumption is of the order of 200 watts, and for normal broadcast reception this is reduced to 85 watts.

The performance of the broadcast receiver section of the Model 904 was better even than we expected it to be. Selectivity that gives clear reception of the Deutschlandsender on long waves, and no interference outside one channel on either side of London Regional at a distance of 15 miles is backed by a high degree of sensitivity which is well maintained to the extremes of the medium- and long-wave ranges. The short-wave range was particularly good, and we have seldom heard as good a signal-to-noise ratio, even in a set with a tuned RF stage. Working by the feel of the controls and the general level of background noise one is apt to have the volume up much too far until a signal is received, when the sensitivity will at once be obvious. This RF stage is undoubtedly pulling its weight, not only as regards signal-to-noise ratio, but also in suppressing second channel interference which could not be detected by the presence of repeat points.

The loud speaker gives a remarkable performance for its size which has been governed apparently by considerations of cabinet symmetry. The bass is all that one could wish from a table model, and the small diaphragm is well able to do justice to the extended frequency range available on the television sound channel. If the response is a little too crisp and hard for some types of transmission, there is a tone control at the back of the chassis which cuts top and incidentally volume as well if used too drastically.

The same receiver equipped with a 7-inch tube (Model 905) giving an effective picture size of 6¼ inches x 5 inches is available for 35 guineas, and an instrument table designed to match either model can be obtained for 3 guineas extra.

Random Radiations

By "DIALLIST"

Elaborate Arrangements

THE "piping" arrangements for signals to the stands at the Exhibition turn out to be a good deal more elaborate than the original announcements about them indicated. The supply which simulates reception from a local station has an intensity of approximately 20 millivolts and is of the high-fidelity order, being to all intents and purposes flat from 30 to 12,000 cycles and having a harmonic distortion of less than 3 per cent. for 90 per cent. modulation. It should therefore give the receivers on the stands a very fine opportunity of demonstrating what they can do. You can pick out pretty easily the sets with good "top" from those with little or none. The "foreign station" supply has an intensity of 2 millivolts and is accompanied by adjacent-channel transmissions 9 kilocycles above and below. Their intensity is a good deal lower than that of the main transmission, but their presence does give some chance of gauging the selectivity of the receiver.

▪ ▪ ▪

Far Afield

READING Sir Eric Teichman's "Journey to Turkistan" recently I was very interested in the account of his discovery of an old Marconi wireless station at Urumchi, in Sinkiang. Three of these stations, it appears, were bought by the Chinese Government shortly after the War and were erected at Kashgar, Urumchi, and Urga, to form a chain of communication between Peking and the remotest parts of Central Asia. The transportation of the apparatus across the deserts and the mountains of Mongolia and Turkistan is described as one of the epics of engineering history. I should think it was! The route from Peking to Kashgar begins with 350 miles of mountain railway. After that there are 2,550 miles of roads of the most elementary kind, which climb mountains, drop into valleys, and wind across the desolation of deserts. The three stations, which were roughly 700 miles apart by air, were in use for some little time in the early 1920's, but were then captured and put out of use by raiding bands. They must, I imagine, have been spark stations of the medium-wave type, since short waves were not then used commercially. What their power rating was I don't know, though it can't have been very small if each maintained touch with the next, over 700 miles of mountain and desert. I have written to the Marconi Company to ask whether they have any particulars, and will let you know if they have.

▪ ▪ ▪

Car Ignition Interference

SOME very interesting letters have reached me from readers on the subject of car interference. You may remember that one of the points originally raised in these notes was that cars going up a slope caused more intense interference with radio reception than those travelling in the opposite direction down the slope. In view of what readers tell me, there seems to be no doubt at all that the greater interference produced by a car going up hill is due to the larger intake of gas and consequently higher pressure in the cylinders when the throttle is opened widely. One reader gives some most interesting experiences with vehicles fitted with short-wave transmitting and receiving gear. On one occasion he was driving a car himself and wearing headphones connected to the receiver at the same time. He found that the instant he put his foot down on the accelerator there was a marked increase in the interference, which died down again as soon as the pressure was relaxed. He points out that if the strengthening of the interference was due to quicker "revving" on the part of the engine when a driver was rushing a hill there would be a change in the note of the signal owing to the sparks occurring more frequently. Possibly; but as ignition-interference is just a noise—and a very nasty one—a change in pitch might not be particularly noticeable.

Interference Ranges

In some of these vehicles screening boxes were used to suppress interference. These answered well enough when they were brand new, but constant adjustments were needed after a little use, and, even so, the screening did not remain highly effective. It was found also that the capacity of the screening boxes caused plugs to burn out rapidly, as its effect was to concentrate the energy of the spark into one brief rush at very high temperature; without the screen the spark was less fierce and of longer duration. Much more satisfactory results were obtained by the use of resistances. It was found best to have one of 2,000 ohms at each end of the

central distributor lead, and one of 1,000 ohms at each end of the plug lead. Suppression was then excellent, and the plugs lasted as well as those of an untreated car. My correspondent was able, when stranded by the roadside through lack of petrol one day, to experiment on the distances at which radiation from ignition systems could cause interference. His aerial was then not far from telegraph wires running along the road. He found that in these circumstances some cars could be detected in the headphones when they were a good mile away.

Reradiation

He deduced that this was due to reradiation from the telegraph wires, and this received confirmation later when similar experiments were made in places where there were no telegraph wires. He holds that those who have found that very high receiving aerials do not counteract car ignition interference may be suffering from reradiation effects. This, he suggests, would explain the fact that aerials of no great height are found effective in combating such interference in Central London, where telegraph and telephone cables are in underground conduits. Readers' views on the subject and their experiences would be welcome.

Frame *versus* Indoor Aerial

THE letter from "M. V. C." in the August 18th issue of *The Wireless World* must have given many readers to think. I have made considerable use of a variety of frame aerials during the past few years, and I must say that I have a strong preference for this type of collector over the picture-rail indoor aerial or anything of similar nature. Used with the right kind of set, the frame can give remarkable results, and it certainly does seem to bring in less interference than the ordinary indoor aerial. I prefer to use sets of untapped frames to cover wavelengths between 200 and 2,000 metres rather than make a single one with tappings do the job by itself. Some time ago I evolved a plug-in system for frames which has proved completely satisfactory. The turns, suitably spaced, are wound on light wooden formers, each of which is fitted with a jack-plug of the large, heavy-duty type. The base consists of a box with a polished top, in the middle of which the jack is mounted. There are three contacts and three terminals, so that a tapped frame can be used if required for any special purpose. Don't try to use ordinary small plugs and jacks; their springs are not strong enough to stand up to this kind of work.

McCarthy Radio

PRACTICALLY all the receiver chassis in the 1939 McCarthy programme are redesigned versions of the previous season's models which have proved so popular.

Entirely new designs include the RS739 and the PP1939. The former is a 7-valve set with four wavebands going down to 13 metres and costing £10 17s. 6d., and the latter is an ambitious communication type receiver with contrast expansion, variable selectivity and four 6L6 beam pentodes in parallel push pull giving an output of 28 watts. There are six wavebands giving continuous coverage from 4.5 to 2,000 metres, and the price is 32 guineas. The address of the makers is Browning Radio, 92, Queensway, Bayswater, W.2.

The Wireless Industry

THE Ardente "Touch-phone" intercommunication system is described in a leaflet just issued by Ardente Acoustic Laboratories, Ltd., 11-12, Pollen Street, Maddox Street, London, W.1.

Ardente has recently undertaken twelve complete hospital wireless installations for the Kent County Council. This is believed to be the largest contract of this kind ever placed in this country.

Grampian Reproducers, Ltd., Kew Gardens, Surrey, announce their new season's programme of P.A. equipment; substantial reductions in price of much of the apparatus are made possible by an increased output.

The business hitherto transacted at the Holborn branch of the Peto Scott Company will be transferred to the head office, 77, City Road, London, E.C.1. The opening of a new West End showroom will shortly be announced.

Mr. Frank Heaver has resigned from the position he has held for many years as Sales Manager of R. A. Rothermel Ltd., and British Centralab, Ltd.

The Board of Directors of E. K. Cole, Limited announce that Mr. W. S. Verrells has relinquished his appointment as Managing Director, but will continue as Chairman of the Company. Mr. Eric K. Cole has been appointed Managing Director.

A new and comprehensive catalogue of laboratory and test equipment has now been issued by Marconi-Ecko Instruments, Ltd., Electra House, Victoria Embankment, London, W.C.2.

A complete catalogue of the new season's Pilot receivers is available from Pilot Radio, Ltd., 87, Park Royal Road, London, N.W.10.

The United Insulator Company, of 12-16, Laystall Street, London, E.C.1, agents in this country for the German Hescho Company, point out that the Hescho condenser illustrated on p. 149 of our issue of August 18th (Berlin Show Report) cannot correctly be described as a trimming condenser. Actually it functions as a temperature coefficient regulating device; rotation of the adjusting screw alters the temperature coefficient but has a relatively negligible affect on capacity value.

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, SEPTEMBER 1st.

Nat., 6.25, Music by Armstrong Gibbs—The B.B.C. Singers (B). 7, Mantovani and his Dance Orchestra. 8, Promenade Concert, with Harriet Cohen, solo pianoforte.

Reg., 8, "Vocal Girl Makes Good," musical comedy. 9, Billy Cotton and his Band. 9.30, Speedway Commentary from Wembley. 10.5, "Loreley," Act II of the opera from the Turin studios.

Abroad.

Strasbourg, 8.40, Symphony Concert, conducted by Mengelberg, from the Lucerne Musical Festival.

Rome Group, 9, "Loreley," opera (Catalani).

FRIDAY, SEPTEMBER 2nd.

Nat., 6.45, Mazurkas, played by Cyril Smith, pianoforte. 7.15, "Vocal Girl Makes Good." 8.15, Radio Roadhouse. 9, Billy Gerhardi and his Band. 10.5, Talk by Sir Alan Cobham—"Up Against It."

Reg., 6.30, "Cabaret Cruise," from the Television studio at Radiolympia. 8, Beethoven Promenade Concert, Albert Sammons, violin. 9.10, "Death at Newtownstewart," the famous Ulster crime of the seventies.

Abroad.

Bucharest, 8.30, "Tosca," opera (Puccini).

Rome Group, 9, "Paganini," operetta (Lehár).

SATURDAY, SEPTEMBER 3rd.

Nat., 5, Henry Hall and his Orchestra. 8, Variety, including Sydney Howard and Arthur Riscoe. 9.10, "The Fall," an adaptation of Stacy Aumonier's story.

Reg., 3.30, Music of the Sea. 7, London's Navy Week. 8, A.R.P. in the Factory, talk. 8.15 and 9.55, Tchaikovsky Promenade Concert.

Abroad.

Cologne, 8.10, "Cavalleria Rusticana," opera (Rossini).

SUNDAY, SEPTEMBER 4th.

Nat., 1, Guitar Solos by Mario de Pietro. 3.40, "Unusually Yours" John Rorke. 6.50, The Lener String Quartet. 9.5, "The Snow Queen," from the Hans Andersen fairy tale.

Reg., 4.30, "Adventure and Service," communication and transport in Australia. 6.20, "The St. Lawrence," the history of Canada's great river. 10, John Wills, pianoforte, and Frederick Riddle, viola, play a Brahms Sonata.

Abroad.

Leipzig, 7, "Don Giovanni," opera (Mozart).

Rome Group, 9, "The Mastersingers," opera (Wagner).

MONDAY, SEPTEMBER 5th.

Nat., 7. "Mr. and Mrs. Neemo," variety with Billy Caryll and Hilda Mundy. 7.45, Fred Hartley, pianoforte. 8.35, Wagner Promenade Concert. 10.5, The Past Week.

Reg., 7, Close to Earth—talk. 8.30, Variety from the Gaumont Cinema, Holloway, with Jessie Matthews and Will Hay. 9.15, "The St. Lawrence." 9.45, Louis Levy presents "You Shall Have Music."

Abroad.

Munich. Relays throughout the day from the Reich Party Congress at Nürnberg; including speeches by Herr Hitler and Herr Goebbels.

Milan Group, 9.30, Concert from the International Festival of Contemporary Music at Florence.

TUESDAY, SEPTEMBER 6th.

Nat., 7.20, Quentin Maclean from the Trocadero Cinema, London. 7.45, Selections from Band Waggon. 8.30, Seaside Nights—The Isle of Man.

Reg., 8 and 9.45, Schumann Promenade Concert, with Maurice Cole, solo pianoforte. 8.50, Homeless People. 9.30, Short Variety.

Abroad.

Radio Eireann, 8.20, "Tannhäuser," opera (Wagner), from the Unitarian Church, St. Stephen's Green, Dublin.

Luxembourg, 9, Excerpts from "The Damnation of Faust," opera (Berlioz).

WEDNESDAY, SEPTEMBER 7th.

Nat., 3.5, Commentary on the race for the St. Leger. 7.30, "On Trek," another African Bush episode. 8, Bach Promenade Concert. 10.5, Relay from America, "On This Side of the Water," talk by Raymond Gram Swing.

Reg., 7, By Act of Parliament, talk. 8, "Virginia," musical comedy. 9, Mantovani and his Tipica Orchestra. 9.35, "Brigade and Exchange," to the memory of the fallen.

Abroad.

Brussels 1, 9.15, "Le Violineux," operetta (Offenbach).

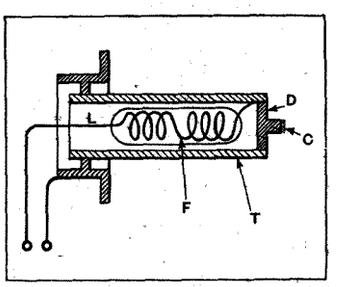
Milan Group, 9.0, "The Mastersingers," opera (Wagner).

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

NON-INDUCTIVE CATHODES

THE heater element for an indirectly heated cathode is capable of producing a magnetic field which, particularly in the case of a cathode-ray tube, tends to have a disturbing effect on the electron stream. Attempts have been made to prevent this by using a bifilar heating-wire, but it is found that the potential difference which then arises between adjacent turns, near the input end, is sometimes sufficient to break down the insulation—unless the tube is also made of large diameter near the danger point.



Heater and cathode assembly for a CR tube.

The drawing shows a simpler method of overcoming the difficulty. The heating-filament F consists of two spirals which are arranged in series and reversely wound. The free end of one spiral is connected to the cathode disc D provided with an oxide-coated point C from which the electrons are emitted. The other free end is joined to the supply lead L, the return current flowing through the metal tube T. The reversed spirals reduce the axial magnetic field, whilst any transverse field is minimised by the fact that both windings are coaxial.

V. Zeitline, A. Zeitline, and V. Kliatchko. Convention date (France), December 22nd, 1936. No. 485548.

o o o o

DIRECTION FINDING

THE critical point of minimum reception on a frame aerial is liable to be "shifted" by the action of stay-wires and other neighbouring conductors, which pick-up the incoming signals and reradiate them in such a way as to distort the original wave-front. This is known as "mast effect." A somewhat similar trouble is caused by the iron or other conducting bodies forming part of the structure of the craft carrying the direction-finder. This produces what is known as quadrantal error, or "radio bias."

Both types of error can be compensated in a given DF installation, the one by injecting a "balancing" voltage, the other by using a correcting-cam with a sinusoidal contour. So long as the signals are of the order of 1,000 metres or over, the correction can be made once and for all.

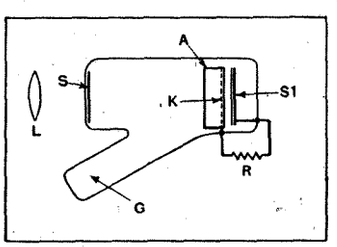
But with short-wave signals, the correction required for quadrantal error is found to vary considerably as the signal wavelength is changed. According to the invention, a single conical-shaped correcting-cam is used and is made with a contour which varies from point to point along its length, so that the degree of correction can be changed with the signal wavelength. The particular contour required for a given wavelength is selected automatically by a link which is ganged to the tuning control of the direction-finder.

Marconi's Wireless Telegraph Co., Ltd. Communicated by Telefunken Ges. Für Drahtlose Telegraphie m.b.h. Application date November 20th, 1936. No. 485583.

o o o o

TELEVISION TRANSMITTERS

AN image of the picture to be televised is projected through a lens L on to a photo-sensitive screen S. The electrons emitted from the latter are then focused by an electron-optical lens (not shown) on to a film or screen S1 made of a heavy metallic oxide or other semi-conducting material, which has a high transverse or front-to-back resistance. This produces an electric image of "point charges" which, when scanned by the electron stream from the gun G of the tube, releases a stream of "secondary" electrons. The latter vary in density, from point to point of the screen S1, according to the distribution of light and shade on the original picture.



Television camera embodying a form of electron multiplier.

The secondary electrons are collected by a grid K (or by a "ring" anode A) and flow back to the screen S1 through an external circuit containing a resistance R, from which the signalling voltages are tapped off and amplified prior to transmission.

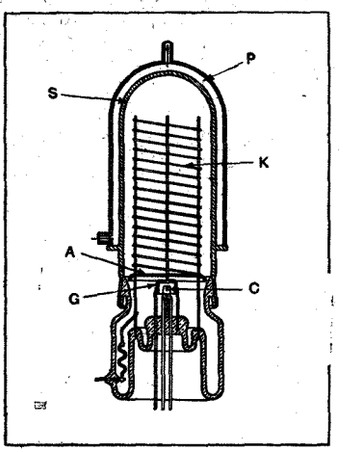
Telefunken Ges. Für Drahtlose Telegraphie m.b.h. Convention date (Germany), August 19ht, 1935. No. 485453.

o o o o

ELECTRON MULTIPLIERS

HIGH-FREQUENCY oscillations are generated by the impact of an electron stream on a single cup-shaped electrode, from which secondary electrons are emitted so that they oscillate from side to side of the electrode surface.

As shown in the figure, primary



High-frequency oscillation generator of the electron multiplier type.

electrons are projected upwards from a cathode C, control grid G, and anode A, which act in the same way as the "gun" of a cathode-ray tube. The resulting stream is of the order of a few milliamps, and passes through the centre of a spiral-wire "grid" K, which carries a high voltage. The secondary emission electrode S is shaped as shown, and may be cooled by a stream of water flowing through the outer conduit P.

The primary electrons are attracted through the highly charged open turns of the spiral "grid" K on to the surface S, where they produce secondary electrons. These are drawn back through the wires K on to the opposite surface of S, and then oscillate to and fro. The current so built up is fed to an external tuned circuit. The tube is said to be capable of producing an output of the order of 10 kilowatts.

Farnsworth Television Inc. Convention date (U.S.A.), January 27th, 1936. No. 485620.

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LOUD-SPEAKER DIAPHRAGMS

A SPEAKER diaphragm made from a thin sheet of synthetic resin is more rigid than one made from moulded paper pulp, though the latter can be made in shapes which it is difficult to produce in the former material.

A loud-speaker diaphragm having both advantages is produced, according to the invention, by moulding a paper-pulp cone in the ordinary way, dipping it into a phenol-aldehyde varnish, drying it in a hot oven, and then pressing it between highly polished dies. The finished article is a one-piece seamless cone which can be made of any desired depth, with an integral rigid neck of standard size to take the moving-coil former.

J. A. Briscoe, J. H. Nelson, Celestion, Ltd., and Murphy Radio, Ltd. Application date August 18th, 1936. No. 485550.

o o o o

PHOTO-ELECTRIC CELLS

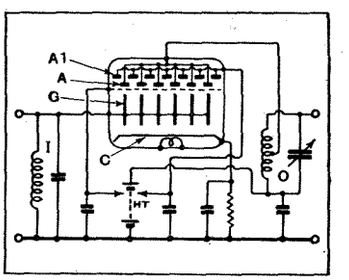
A LIGHT-SENSITIVE electrode for a photo-electric cell is made by coating a foundation disc of selenium with a "composite" film of metals, including cadmium and platinum. The film is deposited by sputtering from a single electrode made of cadmium and small "insets" of platinum. The operation is preferably performed in an atmosphere of argon, the "flashing" being intermittent so as not to overheat the selenium base.

The British Thomson-Houston Co., Ltd. Convention date (U.S.A.) May 29th, 1937. No. 485530.

o o o o

THERMIONIC VALVES

THE drawing shows a construction of valve in which the grid control over the electron stream is exercised partly by intensity or space-charge action, and partly by lateral deflection. The grid G consists of a number of flat plates, which are arranged in parallel planes, at right-angles to the indirectly heated cathode C. The main anode consists of a number of separate plates A, connected together and to the output circuit O.



Electrode assembly in the valve described in the text.

A second and similar set of plates A1 is connected to a tapping on the HT supply. A screening grid, shown in dotted lines, may be inserted between the control grid and the anode assembly, in order to reduce the inter-electrode capacity; it also is connected directly to the HT supply. The input signals are applied to a circuit I across the control grid and cathode.

The shape of the control grid divides the main stream from the cathode into a number of separate "beams" or sub-divisions. The effect of the grid voltage is, in part, to swing or deflect the stream away from the main anodes A, which feed the output circuit, on to the auxiliary anodes A1. In part, it also controls the intensity of the stream as a whole, as it passes from cathode to anode. The tube can be used as a straight amplifier or as a mixing-valve in a superhet circuit.

E. P. Rudkin. Application date, November 20th, 1936. No. 485626.

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CONTENTS

EDITORIAL COMMENT

Public Address and A.R.P.

An Important Aid to Organisation

THE national importance of broadcasting as a means of communication with the public has long been recognised, and it will be remembered that under the terms of the B.B.C. Charter the Government can at any time commandeer the services of the broadcasting organisation should a national emergency arise.

As matters stand at present broadcasting only reaches the individual homes of the nation, and it is necessary to be at home in order to listen.

In a national emergency the tendency will always be for more and more people to congregate out of doors, and this would apply particularly in villages and other small centres of population where the inhabitants would congregate to discuss the situation.

Broadcasting, as at present developed, would not reach these people.

It would seem extremely desirable that public-address equipment should be installed in this country on a much more comprehensive scale than at present. By means of loud speakers it should be possible to address street gatherings at any time if the necessity should arise, either by direct voice through a microphone or by arranging for the broadcast service to be connected to a national public-address network.

In Germany, perhaps more than in any other country, the value of public address has been recognised. At the recent radio exhibition held in Berlin public-address equipment competed with radio in importance on the stands of the manufacturers, and its recognition by the Government as a national asset was everywhere in evidence.

We should do well to profit from the example of Germany in some matters of national organisation.

Surely now is the time to plan a national public-address system for this country, decide the points at which to install loud speakers and make the necessary cable connections instead of waiting until it may some day be a matter of extreme urgency. The loud speakers and cables would have to be placed where they were not liable to damage, and the points of connection to the broadcast service or to microphones would require to be located where they could not be reached by unauthorised persons.

General Application

There are many occasions even in ordinary life where such a system of public-address distribution could be most valuable, especially to the police in putting out urgent messages to the public, either on a nation-wide scale or restricted to some particular area. These uses in themselves might almost justify the establishment of such a network, but coupled with its value to A.R.P. and general emergency requirements the idea becomes of first-class importance.

The responsibility for the cables would no doubt be the concern of the Post Office, and would be an activity of far greater national importance than the proposals for a Post Office broadcast relay distribution on which the Post Office seems prepared to incur such lavish expenditure and which have so greatly disturbed the peace of the radio industry. The supply of speakers and amplifiers would come from the several firms which have had a wide experience of this kind of work and are ready equipped to carry out the installation with efficiency and expedition.

Choke v. Condenser Input

ALTERNATIVE ARRANGEMENTS FOR SMOOTHING FILTERS

COMPARISONS are made between the conventional condenser input circuit for an HT smoothing filter and an arrangement in which a choke is used: it is shown that the lesser-known choke circuit has advantages for many applications.

By M. G. SCROGGIE, B.Sc., A.M.I.E.E.

IN arranging the smoothing circuit following an AC rectifier one has the alternative of starting with a condenser or with a choke, as at (a) and (b) respectively in Fig. 1. It might seem to be a matter of minor importance which is adopted, so long as the total inductance and capacity used in the whole filter is about the same. But actually the two arrangements operate in quite different ways and with very different results, and in order to make an intelligent choice it is necessary to have a clear idea of these differences. Judging from the circuit diagrams that one sees, the advantages of arrangement (b) must be unknown to many people. Possibly one reason for its unpopularity is that compared with arrangement (a) the results depend much more on a correct regard for working principles. So, although it has been very ably explained before* in this journal, a return to the subject may be excusable.

In (a), which is usually described as condenser input, the first condenser acts as a reservoir, receiving gushes of rectified current that periodically restore what is being drawn at a comparatively steady rate by the load. With a half-wave rectifier,

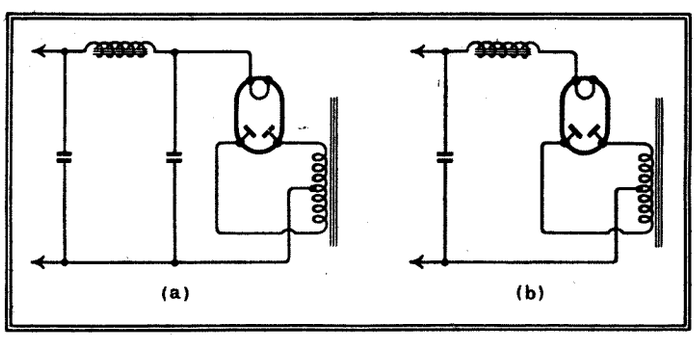


Fig. 1.—The alternative types of smoothing circuit: (a) condenser input, (b) choke input.

which can pass current only during the positive half-cycles of the alternating supply, it is obvious that the replenishing cannot take place during more than half of each cycle. And even with the more usual full-wave rectifier shown in Fig. 1 the current fed into the reservoir is not continuous. In fact, if the reservoir is assumed to be of very large capacity, so that its voltage level drops only slightly between one half-cycle and the next, the replenishing period is crammed into a fraction of the half-cycle, as can be seen from Fig. 2. The rectifier can pass current only when the transformer voltage that drives it is more positive than the back voltage due to the charged reservoir condenser. If no current is drawn by the load, the condenser charges up during the first few half-cycles, and when its voltage reaches the transformer peak voltage no more current flows through the rectifier. If current is drawn, the rectifier voltage drops somewhat during the intervals, as illustrated, and at each peak there is a sharp gush of current through the rectifier.

Supposing the current drawn by the load to be 100 mA, it is obvious that in order to maintain the supply by means of these gushes the peak current through the rectifier must be much greater—perhaps 500 mA, or even more. If the emission of the rectifier is less than this, then the voltage drop across the rectifier becomes abnormally large and is liable to shorten its life very seriously.

The current that flows through the rectifier being also the transformer current, another undesirable result of its highly peaked character is that its RMS value (the value effective in heating whatever it passes through) is considerably greater than its average value (the value that counts at the DC end). It is therefore necessary to provide a larger transformer than would be required for supplying the same amount of power in the form of regular AC, and the losses are greater.

Another feature that can easily be understood from Fig. 2 is that as the current drawn by the load increases, the fall in voltage between one charging peak and the next is steeper, and the average output voltage falls. The regulation, or constancy of voltage under varying current demands, is therefore poor. If an attempt is made to counteract this by increasing the capacity of the reservoir, the peak current to be passed by the rectifier becomes impractically large.

Still another drawback is the severe strain to which the reservoir condenser is subjected. Not only does it receive the full peak voltage of the transformer (less the small drop in the rectifier, which becomes nil if the load is taken off), but in normal circumstances the greater part of the heavy rectifier peak current passes through the condenser also. There is even a possibility, if the capacity is large and the transformer poorly designed, of the condenser resonating with the leakage inductance of the transformer to the principal frequency of the ripple (usually 100 c/s), which would cause the voltage to be higher even than the transformer peak voltage, and the peak current to be correspondingly abnormal. In any case, the conditions make it necessary for the reservoir condenser to be very conservatively rated. And a consequence of the poor regulation is that if for any reason the load current ceases, or nearly so (as may happen while the valves are warming up), the output voltage rises probably 40 per cent. or more above normal, and the components right through the apparatus served by the power unit must be capable of withstanding this.

So the condenser input arrangement requires the transformer, rectifier, reservoir condenser, and perhaps other components, to be capable of handling substantially greater currents and voltages than those represented by the power delivered to the load. And the regulation is bad, however much the resistances of these items may be reduced in the effort to improve it. At no load the output voltage is about 40 per cent. higher than the transformer RMS voltage; at normal

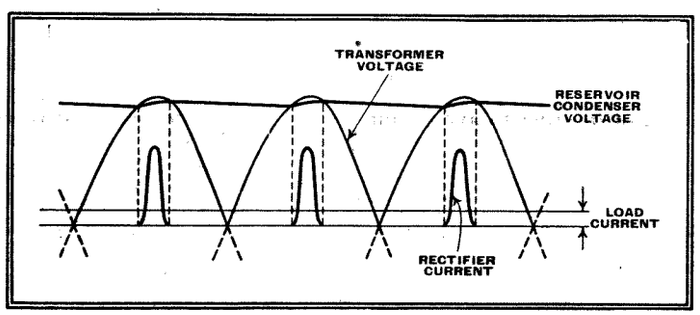


Fig. 2.—Voltages and currents during three half-cycles of a condenser input system. Note that when the capacity of the reservoir condenser is large in relation to the load current the peak current through the rectifier is very large; and that the output voltage is nearly as great as the transformer *peak* voltage.

* By N. Partridge, Dec. 20th and 27th, 1935.

Choke *v.* Condenser Input—

full load it is usually about equal; and if more current is drawn the voltage continues to fall.

That seems to be rather a bad account; how does the choke input compare? Whereas the condenser input smooths out the rectifier voltage into something much more uniform, and in this effort is obliged to accept very large peak *currents*, the choke input tends to keep the rectified current steady and absorbs large peak *voltages* in doing so. Now, the current passing through the choke, and consisting of a series of rectified pulses or half-cycles, can be considered as being made up of a mixture of DC and AC; the DC is the unidirectional current that we want, and the AC is the ripple that must be got rid of in order to avoid hum.

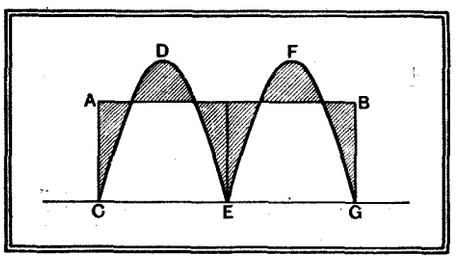


Fig. 3.—With choke input operation, the output voltage AB is approximately equal to the *average* transformer voltage.

As the resistance of the choke is made comparatively low, the DC passes through it more or less unimpeded, but the impedance of the choke to the AC part is very large, due to its high inductance. Now, AC cannot be all "one side of the line"; each positive peak or half-cycle must be followed by a negative half. The positive and negative halves need not be of the same peak values, so long as they are of the same average values. If CDEFG in Fig. 3 represents the voltage output from a full-wave rectifier, and AB represents the nearly steady voltage across the condenser in Fig. 1 (b), then the difference, shown by the shaded parts, must be the voltage taken up by the inductance of the choke. The average depth, and hence the area of the shaded parts, below AB, must be equal to those above. Neglecting for the moment the remnant of ripple across the condenser, AB is a straight line, and represents the average height of the rectified voltage CDEFG above CG, or, in other words, the voltage maintained across the condenser. Neglecting the voltage drop in the rectifier, the height of D and F above CG is equal to the peak transformer voltage, and the output of the filter is therefore equal to the average transformer voltage, which is 10 per cent. lower than the RMS value, assuming a pure wave.

If more current is drawn by the load the voltage remains constant, except for the extra drop in the resistance of the choke, rectifier and transformer, which can all be made quite small. The regulation is therefore very good.

But in arriving at this result it must be admitted that we assumed the inductance of the choke to be so large as to smooth out the rectified current into perfect DC. Of course, this is impossible in practice, and instead of being a straight line AB is wavy. However, the average voltage level remains practically constant unless the inductance is so low as to cause these waves to reach the line CG, in which case the current through the choke ceases to be continuous, and the manner of operation tends towards the condenser input type illustrated in Fig. 2, when the average output voltage rises towards the peak of the input. The minimum inductance needed to avoid this condition is proportional to the load resistance. So if the load is taken off entirely, no amount of inductance can possibly prevent a rise in current.

The theoretical performance of the two systems can be compared by drawing regulation curves, as in Fig. 4, in which the output voltage delivered to the load is expressed as a percentage of the transformer RMS voltage across each half of the rectifier. With condenser input the voltage at no load tends towards the peak value, 141.4 per cent., and falls fairly steeply (A). At full load, using a moderate-capacity reservoir condenser to avoid excessive peak current, the voltage generally comes somewhere near RMS level.

Apart from resistance losses the line with choke input would be level at 90 per cent., but in practice it is likely to be down to 80 per cent., or lower, with a slight slope until, at a critical load current, "reservoir effect" comes into action and the voltage tends towards the peak value (B). This rise in voltage, which might put a dangerous strain on the filter condensers, can be avoided by arranging things so that there is always at least the critical load current flowing. Often a path for current, apart from valves, is necessary in the form of a potential divider for feeding screens, etc., at lower voltages. Or the field coil of the loud speaker may be parallel - fed. If no such useful purposes can be found for this current it is necessary to let it run to waste in a so-called bleeder resistance connected in parallel with the valve feed load.

If the critical load that has to be wasted in this way in the interests of good regulation is a large proportion of the total, it is obviously a bad mark against the choke input system. Assuming a full-wave rectifier working off a 50-cycle supply, the critical load resistance is approximately equal to 940 times the inductance of the choke in henrys. To keep it high, the inductance of the choke must also be high. But in order to preserve the good regulation of the system the resistance of the choke must be very low, and these two requirements are contradictory unless the choke is excessively bulky and expensive. However, noticing that it is only at low current that it is necessary to maintain a very large inductance, one can omit the usual air gap from the choke, so that when the current through it is reduced to the critical load its inductance rises very considerably.

Another, and extremely effective, method of increasing the critical load resistance is to *tune* the choke so that at the fundamental frequency of the ripple (100 c/s in the case we are considering) its impedance is much greater than that due to its inductance alone. An example of this follows shortly.

Advantages for Special Purposes

A comparison of the two systems shows that where very good regulation is essential (as in Class AB, B, C, etc., working) or where large amounts of power are concerned, choke input is much to be preferred. By using a low-resistance choke, and perhaps a mercury vapour rectifier, the output voltage can be kept constant within 5 per cent. over a 10 to 1 variation in load current. In high-power systems there is a very large saving in transformer, rectifier and smoothing condensers. But for such low-power apparatus as the ordinary domestic receiver the saving is so small as is likely to be outweighed by the lower voltage delivered, and good regulation is not needed. So the choke input is of interest for transmitters and high-efficiency amplifiers; the condenser input for small receivers.

To illustrate many of the foregoing theoretical considerations, Fig. 5 consists of some curves giving the results of comparative tests with a simple power unit in which one 8-mfd. condenser followed a 8-H, 120 mA, 220-ohm choke, and another 8-mfd. condenser could be connected in parallel (to give a choke input circuit) or to the opposite end of the choke (to give condenser input). The rectifier was a valve rated at 60 mA. fed from a transformer giving 270+270 volts at no load, falling to about 260 at full load. The choke was not designed for choke input, having a rather high resistance, and the whole circuit was on too small a scale to be suitable, but was convenient to measure, and it does illustrate the contrast between the two types. The regulation curve for the choke input in Fig. 5 (a) is only half as steep as the other, until the critical load is reached, after which it soars.

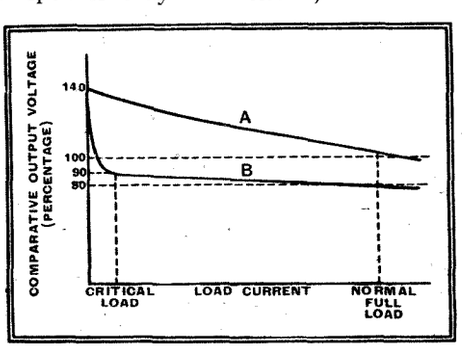


Fig. 4.—Comparative regulation curves of typical condenser (A) and choke (B) input systems. The voltages are given as percentages of the transformer RMS voltage.

By tuning the choke with a condenser —0.11 mfd. was found to be right—the critical load was reduced to a quarter of

Choke *v.* Condenser Input—

its original amount; a mere 5-mA minimum current is enough to keep the voltage within close limits. Incidentally, the choke rated at 8H for 120 mA is thus seen to be 24H at nearly no current.

Measurements of peak voltage across the choke are interesting and are given in the table at the foot of this page.

The choke voltage figures are given in pairs, because the positive and negative peaks of the ripple are unequal. The larger figures are negative, relative to the DC. The most obvious thing is that, as one would expect, the voltages across the choke are very much higher when choke input is used. Bearing in mind that the circuit tested was of much lower power than any in which choke input would be preferred, it can be readily understood that a condenser input type of choke would not do. It must be designed to stand a high voltage between parts of its winding—of the same order, in fact, as the output voltage.

Another thing is that at full load the ratio of negative to negative + positive peaks is approximately what it should be according to Fig. 3, viz., 0.636, and negative + positive is very nearly equal to the transformer *peak* voltage, which was 370.

By inserting a known resistance of 10-50 ohms and measuring the peak voltage across it, the peak current through the rectifier was found. The curves in Fig. 5 (b) show the ratio of this peak current to the steady load current. With condenser input the peak current is at least $3\frac{1}{2}$ times the load current (230 mA when supplying 68 mA), and rises to much higher ratios at low loads. But with choke input the ratio is little over $1\frac{1}{2}$ at full load, which is much easier on the rectifier.

Finally, the peak ripple voltage across the second condenser was measured at full load. With condenser input it was about half a volt, with choke input just over 2 volts, and with tuned choke input $1\frac{1}{3}$ volts. This does not mean that hum would sound less by tuning the choke, for the higher ripple frequencies, which are the most audible, may actually be stronger. But they can be easily dealt with by a slight elaboration of the filter. From the point of view of smoothing efficiency, the condenser input has the advantage.

For feeding a push-pull stage, the output across the condenser of a choke input filter is quite adequately smoothed, and the earlier stages, accounting for a relatively small current, can easily be put through another stage of filter.

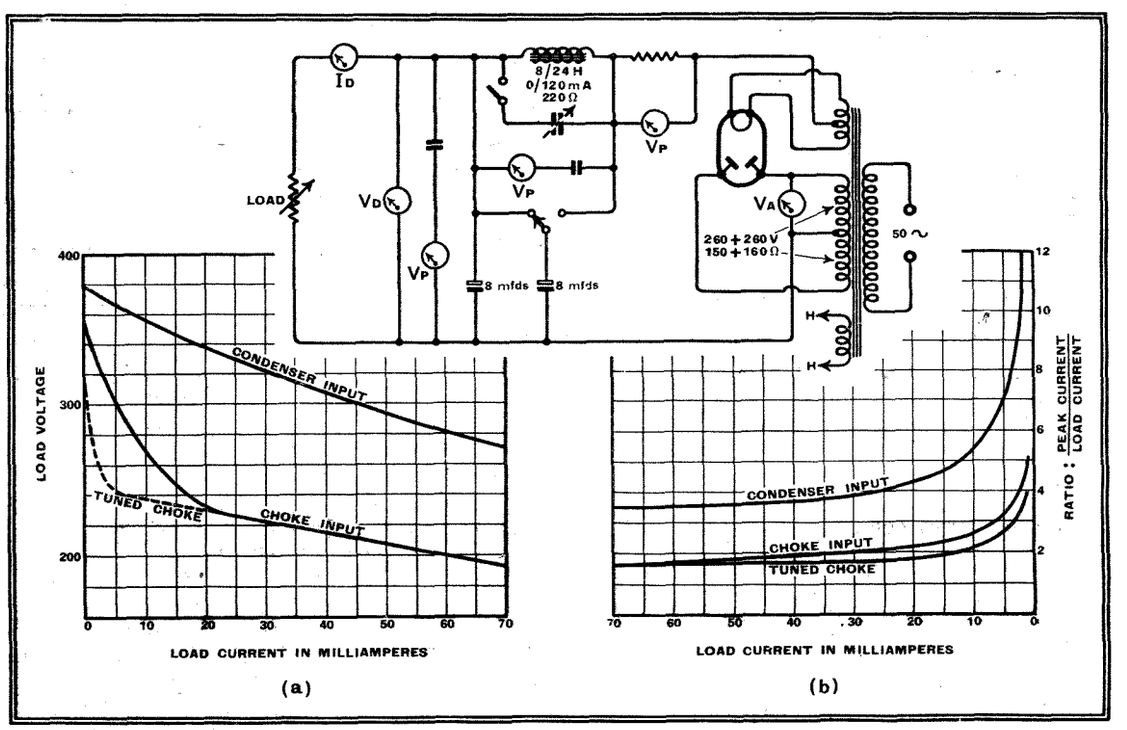


Fig. 5.—Results of measurements carried out on the circuit shown in the inset. As it was originally designed for condenser input, the regulation curve for choke input is not nearly so level as could be obtained with suitably designed components.

Summarising:

The condenser input arrangement (Fig. 1 (a)) gives bad regulation and requires larger and more conservatively rated transformer, rectifier, and reservoir condenser than choke input (Fig. 1 (b)). These disadvantages are of minor importance in low-power apparatus, particularly for Class A amplifiers, in which the load current is practically steady, and the higher output voltage and better filtering efficiency are useful.

On the other hand, the larger the power to be supplied, the more economical is the choke input system, and for supplying Class B and similar systems it is essential; but it must be carefully designed. The choke must be capable of standing a high voltage, should have a low resistance and a rising inductance at low current. It is also helpful to tune it to give minimum output voltage at no load, so as to minimise the critical load current. The critical load resistance, above which the output voltage begins to rise steeply, is given by

$$R_L = 940L$$

where L is the inductance of the untuned choke in henrys at that load, assuming a full-wave rectifier on 50 c/s supply. Or if the choke is tuned, and Z is its impedance in ohms,

$$R_L = 1.5Z.$$

Another use of an input choke is to reduce the output voltage in the most economical manner.

Condenser Input		Choke Input		Tuned Choke Input	
Load Current	Choke Voltage	Load Current	Choke Voltage	Load Current	Choke Voltage
1.9 mA	1.6 1.8	1.7 mA	56 135	1.4 mA	108 150
68.4 mA	23 24	71 mA	147 220	71 mA	142 217

News from the Clubs

Edgware Short Wave Society

Headquarters: Constitutional Club, Edgware.
Meetings: Wednesdays at 8 p.m.
Hon. Sec.: Mr. F. Bell, 118, Colin Crescent, Hendon, N.W.9.

On August 24th, the latest types of Hallicrafters SX-16 and SX-20 receiving sets, lent by Webbs Radio, were tested and afterwards formed the subject of an interesting discussion. Recent activities have included a very successful "Enquiry" evening, and an organised visit to the Radio show at Olympia.

Future meetings will include talks by representatives of A. C. Cossor and the Mullard Wireless Service Co.; a discussion on five-metre receivers owned by members; and a visit of the Walthamstow Radio Society.

Sunday meetings and Morse classes re-commence as from September 4th (11 a.m. to 1 p.m.), and the first Annual Dinner will be held on November 26th at Slaters Restaurant, Oxford Street, W.1, when the guest of the evening will be Mr. Clarricoats, secretary of the R.S.G.B.

The Radio, Physical and Television Society

Headquarters: 72a, North End Road, West Kensington, W.14.
Meetings: Fridays at 8.15 p.m. (during the winter).
Hon. Sec.: Mr. C. W. Edmans, 72a, North End Road, W.14.

The Croydon Air Port transmitting station and aerodrome were visited on August 27th. Among the interesting equipment seen were the main switchboard and transmitters, including the beacon, emergency sets and power plant, and one of the latest short-wave transmitters. The main receiving office and meteorological report receiving room at the aerodrome were also inspected.

The society is holding its Annual General Meeting shortly, when the 1938/39 season commences, and all interested are invited to write for further particulars to the hon. secretary.

New German Valves

Metal Types : Triode-Tetrode for the "Small People's Set"

By "SCRUTINEER"

A comparison in size between valves of the new "Red" series (left) and existing German types

THIS article explains how the new German metal valves differ from their American prototypes. It is also shown how the extremely low cost of the "Small People's Receiver" is partly accounted for by a specially designed detector-output double-valve and low-power rectifier.

FOR economic and other reasons, only a few new valves are to be issued in Germany this year to extend existing ranges. The various valve manufacturers marketing their products in Germany have for some time past worked in close co-operation, and the multiplicity of valve types, so familiar in England, is not known there.

The chief innovation is the range of metal valves of the new E series to be manufactured by Telefunken, Philips, and Tungsram. The complete series consists of thirteen types, of which nine are of metal construction and the remaining four are provided with glass bulbs. Of the four glass types, one is a tuning indicator, two are output pentodes, and one is a high-tension rectifier. The difficulty of obtaining adequate heat radiation from the output pentodes and the rectifier has been circumvented by providing them with glass envelopes instead of metal.

The range has been named the "Harmonic Series" (for reasons which are not very clear), and all types are fitted with a new eight-pin base, which is provided with a spigot after the principle of the Octal base. The pins are arranged in two groups of five and three pins each respectively, and are so connected as to isolate as much as possible the grid lead from the heater leads and also from the anode lead. When the special socket is mounted on the chassis a small metal screen is fastened in position on the under side of the chassis so as to screen the two groups of connecting wires from one another.

While these metal valves are very similar in construction to the American metal valves, the former embody differences in design which are worthy of note, and are stressed in Germany as constituting major improvements.

The electrode systems in the metal types, instead of being vertical, are all mounted horizontally, and this accounts for the greater diameter of the metal shell compared with the American types, but it enables a reduction in height to be effected.

The horizontal disposition of the electrodes makes it possible to support both ends of the complete structure from small metal angle brackets which are welded to the base plate. It is claimed, and probably with some justification, that this method of construction reduces microphonic noise. Since the electrodes are rigidly supported and are short in length it is possible to reduce the inter-electrode clearances, which results in the valves having an improved performance. For example, the clearance between the cathode and the first grid has in some cases been reduced from 0.4 mm. to 0.23 mm. The short length of the cathode also enables a heater to be used which consumes about 1.25 watt, as compared with 2.5 watts in similar glass types.

This feature of short electrode length is rather unusual, and considerable ingenuity must have been exercised in the design of the multiple types, such as the triode-hexode, employing a common cathode.

Top grid connections have been entirely dispensed with in this series, and it is maintained that this enables a simplification in design and construction of sets to be achieved, together with a reduction in the length of "hot" leads to the grids. The practice of bringing out all electrode leads through the base seems to be finding favour both in America and Germany.

It is interesting to note that this range of metal valves is not to be produced in large quantity at first, as such an undertaking might disorganise production of other valve types. It is proposed at present that these valves be fitted only to receiving sets selling for more than Rm.285 (about £25), but that their use will be extended to cheaper receivers as time goes on.

A table giving technical details of these metal valves is given below.

Among the new glass valves are two interesting types which have been speci-

TELEFUNKEN METAL VALVES. NEW E SERIES.

Type.	Description.	Heater. V.	Heater. A.	Ea Max.	Es Max.	Ia Max.	Max. Anode Dissipation.	μ	Ra	Gm Max.	Output Watts.	Remarks.
				V.	V.	mA.	W.			mA/V.	W.	
EB11	Double Diode ...	6.3	0.2	200	—	0.8	—	—	—	—	—	—
EBC11	DD Triode	6.3	0.2	300	—	—	1.5	25	14,000 Ω	2.2	—	Double diode system as in Type EB11.
EBF11	DD VM Pentode ...	6.3	0.2	300	300	—	1.5	—	1.5 meg.	1.8	—	Ditto.
ECH11	Triode-Hexode ...	6.3	0.2	Hex. 300	300	—	1.5	—	1.5 meg.	0.65	—	Conversion conductance.
				Tri. 150	—	—	1.0	20	—	2.8	—	—
EDD11	Double Triode ...	6.3	0.4	250	—	—	3.0	—	—	—	5.5	Class "B."
EF11	VM Pentode ...	6.3	0.2	300	300	—	2.0	—	1.5 meg.	2.2	—	—
EF12	RF Pentode ...	6.3	0.2	300	200	—	1.5	—	1.5 meg.	2.1	—	—
EF13	VM Pentode ...	6.3	0.2	300	200	—	2.0	—	0.5 meg.	2.3	—	—
EFM11	Tuning Indicator ...	6.3	0.2	300	300	—	0.3	—	0.8 meg.	—	—	Glass. Tuning Indicator with VM Pentode amplifying system.
EL11	Output Pentode ...	6.3	0.9	250	275	—	9.0	—	50,000 Ω	9.0	4.5	Glass type.
EL12	Output Pentode ...	6.3	1.2	250	275	—	18.0	—	30,000 Ω	15.0	8.0	Glass type.
EZ11	Full Wave Rect. ...	6.3	0.29	250+250	—	50	—	—	—	—	—	—
EZ12	Full Wave Rect. ...	6.3	0.85	500+500	—	100	—	—	—	—	—	Glass type.

New German Valves—

ally designed for use in the new Deutscher Kleinempfänger or Small People's Receiver, already mentioned in *The Wireless World*. This receiver sells for Rm.35 (about £2 18s.) and is fitted with valves of Types VCL11 and VY2. The first valve is a combination of a high-amplification triode and an output tetrode, and the second is a small half-wave rectifier for the HT supply. The heater of the VCL11 is rated at 90 V., 0.05 A., and that of the VY2 at 30 V., 0.05 A.

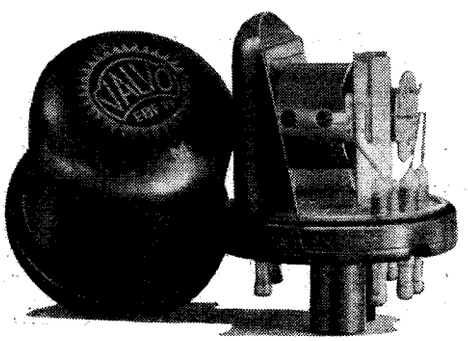
The design of both portions of the VCL11 has been carefully worked out so that the triode part will, on an average signal, give an adequate output for the tetrode without recourse being had to transformer coupling which is not embodied in the receiver on account of expense. The amplification factor of the triode is about 65.

The tetrode has been designed to have a high mutual conductance, actually 5 mA/V, and gives an output of 0.8 W. with 3 V. input.

The electrodes of this double valve are mounted vertically one above the other with a common cathode, the small triode portion being at the top.

The rectifier is of very small dimensions and in appearance somewhat resembles a small detector diode such as is used in this country. The maximum rectified current that it is rated to supply is 25 mA.

It is understood that it is largely due to the design of these two valves, not only from the point of view of circuit simplification, but also from economy of production, that the Small People's Receiver has been produced at such a low price.



A double-diode V-M pentode in the new metal series. Note the horizontal arrangement of the electrodes in the cut-away view.

Impressions from Olympia

"DIALLIST" LOOKS BACK AT THE SHOW

WHATEVER other opinions there may be about the 1938 Radiolympia, there must be unanimity on one point: television stole the show! It wasn't perhaps surprising that it should, for in their preliminary notices, and particularly in the headlines introducing them, most of the lay papers had let themselves go on television, with just a mention here and there of press-button tuning. Even the Exhibition poster displayed a solid and substantial-looking Eye, but the mere filmy ghost of an Ear.

Television certainly gives a very good account of itself. The "piping" of the stands from the central television transmitter must have been a stupendous piece of work; its results were a credit to everyone concerned.

And if television was the chief bait, the public seemed to be swallowing it hook, line and sinker.

Standing up in the gallery, it was amazing to look down on the doings of the crowds below. At one moment they would be circulating quite normally round the stands. Then, almost suddenly, the aisles were as little populated as the streets of Paris after a whiff of Napoleon's grape-shot; the crowds were massed in and around the stands where televisors were at work. There were so many instruments in operation and the arrangements were so good that everyone who wanted to become a televiewer seemed to be able to do so without much difficulty.

The Television Studio

Less happy were those who parted with their nimble sixpences at the turnstiles guarding the Television Studio, which this year took the place of the theatre. There it was a case of getting into a tightly packed queue, which imposing commissionaires endeavoured to keep moving at a brisk pace. I have no doubt that those who were on the inside of the queue had a good view of the rites performed in the Studio. Myself, I have a deeply rooted objection to enacting the part of the jam in the sandwich; hence, I didn't strive to be on the inside. Like many others, all that I obtained for my sixpence was a vision of heads and hats, with occasional glimpses of white-coated engineers and production folk doing vague things on the other side of the glass. I understand that the Exhibition organisers wanted to put up a tiered track round the Studio, so that everyone could get his or her money's worth; the L.C.C., however, put its united foot firmly down on that. Anyhow, of the five thousand an hour, whom it was arranged to marshal round the outside of the Studio, I am sure that a good proportion couldn't have managed to see very much. Rather a pity, one feels.

Press-button tuning has undoubtedly caught on with listeners at large. It was absorbing to examine the many ingenious systems evolved by manufacturers for making this kind of tuning as simple and as effective as possible. Most have realised the paramount importance of eliminating the effects of oscillator creeping and have tackled the problem seriously. I can't help thinking that sets fitted with automatic frequency control are going to prove the most satisfactory; but, naturally, this refinement is confined mainly to those selling at the higher prices. Well-designed sets without AFC will doubtless prove satisfactory; but one shudders to think of the adventures in store for those who go in for such cheap-jack press-button sets as will in all probability make their unhallowed appearance.

Silent Background

The Shows of previous years have mostly had their surprise items—though sometimes the surprise has been that there weren't any surprises. In a normal year the new "silent" pentodes (which are actually hexodes) might well have been hailed as one of the outstanding features. Hiss and other background noises have always formed one of the superhet's greatest drawbacks in the eyes—or, rather, the ears—of the ordinary listener, and particularly the long-distance enthusiast. The principle of the new valves appears to be sound enough, and if they prove in practice to be as good as they look on paper they will come as boons and blessings. It is not much fun to have a superhet which is potentially highly sensitive if you can never use it with the volume control much beyond the half-way position owing to the intolerable noisiness which occurs if you turn any farther.

I was rather surprised not to see more receivers of the communication type on the stands. There would undoubtedly be a considerable demand for these, were they available, not only amongst dyed-in-the-wool D-Xers, but also amongst those who dabble in long-distance reception on both the medium and the short waves.

Such communication type receivers as were on view were beautiful pieces of work, and I spent no small part of my time at the Show in examining them enviously and in working the delightful tuning drives with which they were equipped. What a joy it is to handle a large, free-running knob, and to observe the hairs-breadth movements of the pointer that can be made in either direction without a sign or a trace of backlash.

I wonder if you realise how many of those bigger sets, which we have so long waited to see, were on view at this year's exhibition? At first I thought that there were comparatively few, for exhibitors seemed rather coy about featuring them strongly; they felt, perhaps, that it was good policy to concentrate their energies on televisors and the smaller push-button sets whilst the going in those quarters was obviously so good. Actually, when I came to count up the receiving sets (not radiograms) containing seven valves or more in addition to the rectifier, I reached the surprising total of twenty-seven different models. Many of these are 9- and 10-valve receivers with a variety of useful refinements, and some are bigger than that.

That New Set

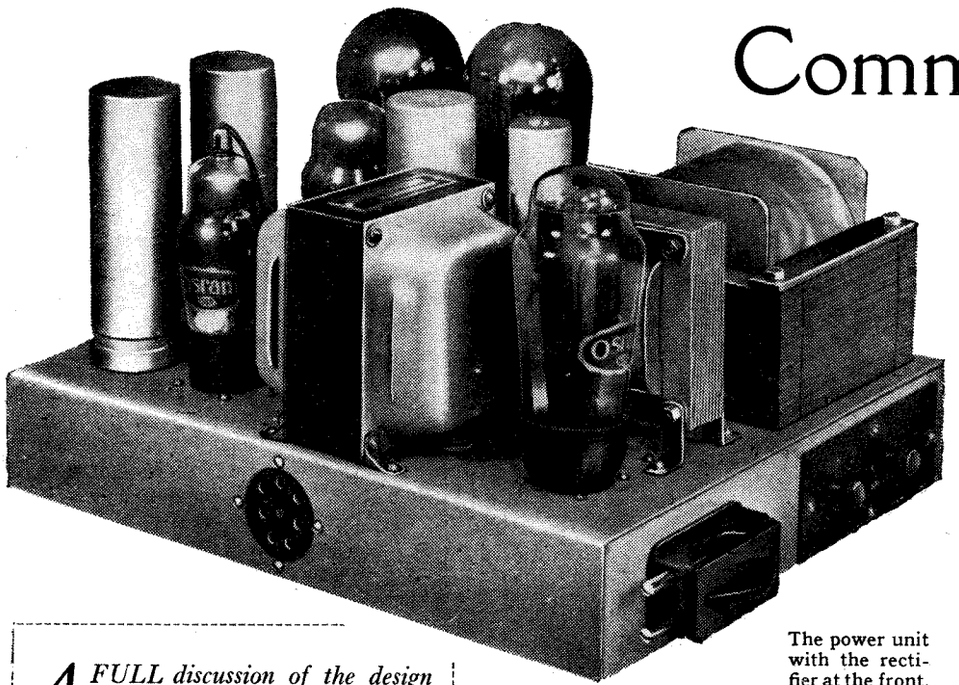
There is no question that this year you can buy at a reasonable price something very much better than your existing receiver, whatever your wireless tastes may be. There is, therefore, every inducement to replace the old set with something up to date, more efficient, easier to handle, less noisy, and generally closer to your idea of what the first-rate wireless set should be.

How a Receiver is Designed.—XXV.

The Wireless World

Communication Receiver

THE POWER UNIT, TESTING AND PERFORMANCE



The power unit with the rectifier at the front.

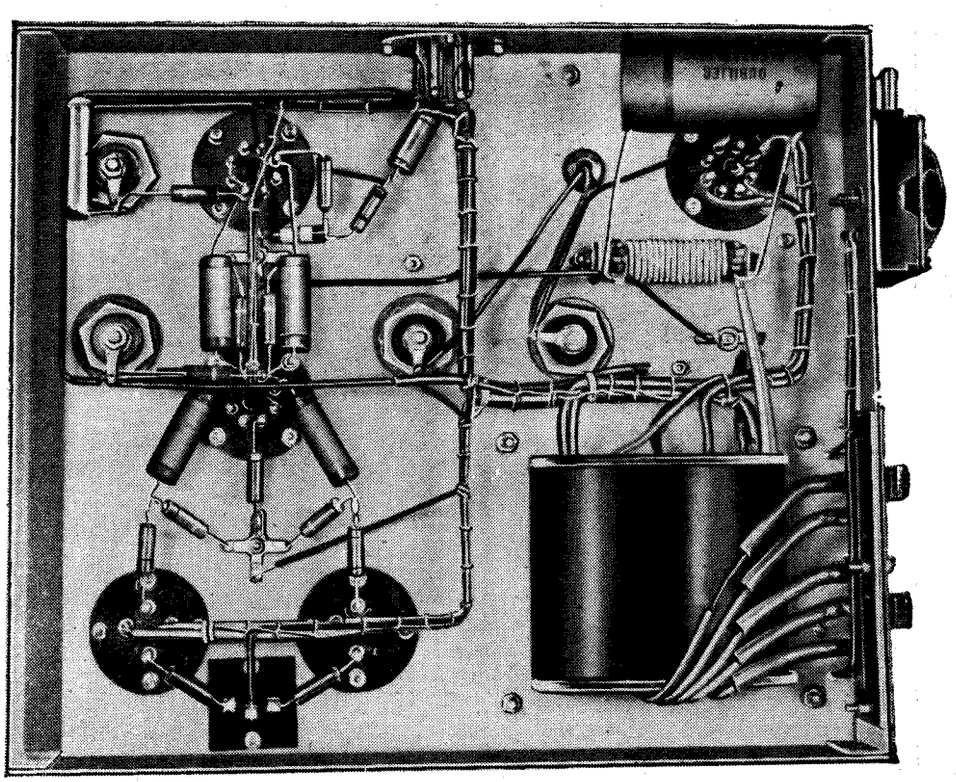
A FULL discussion of the design and construction of this receiver has appeared in past issues of "The Wireless World" and in this concluding article the construction of the power unit is dealt with. A description of the performance on test is also given.

IN this article constructional details of the equipment are completed with the details of the power unit. As explained last week, the wiring is also given for the case when it is desired to substitute two KTZ63 or 6J7G valves for the 6N7. Everything here is straightforward, and about the only constructional points which must be watched are the connection of the electrolytic condensers to the chassis. Contact between the condenser cans and the chassis is relied upon, but if the latter is of the painted type, do not forget to scrape off the paint beneath the cans and also round any earthing tags.

In general use and during the ganging, the adjacent aerial and earth terminals should be joined together and to earth, the aerial or the test oscillator output being connected to the other aerial terminal. If an aerial such as a dipole, with a two-wire feeder is used, however, then the two wires are joined to the two aerial terminals and neither is earthed.

When a receiver is to be used in conjunction with an amateur transmitter, it is usual to fit a switch to break the HT circuit of an early valve when transmitting so that the early stages are not badly overloaded. A special switch for this purpose is not fitted to this receiver since the radiogramophone switch can be used for the same purpose. When switched to gramophone the screen circuits of the early valves are broken and they are inoperative; this arrangement is, in fact, less hard on the valves than one which breaks the anode supply while leaving normal screen voltage. With either arrangement the first valve is not in a very enviable position however, for it is likely to be driven heavily into grid current. The remedy is an additional switch to short-circuit the RF valve grid circuit, but this is a complication which is unnecessary for most users of the equipment. Those who operate transmitters can easily introduce such modifications of this nature as they feel to be necessary.

On the medium- and long-waves the receiver will normally be operated with the beat-frequency oscillator off, and in general with an outdoor aerial the RF gain control should be set about halfway. Full RF gain is rarely, if ever, desirable on these bands unless the aerial is poor, for it is likely to result in whistle production through frequency-changer overloading. At the high-frequency end of the long waveband the RF stage will be found to oscillate with the RF gain control at maximum. This is normal and is due to the signal-frequency approaching the intermediate frequency combined with the high L/C ratio of the tuned circuits. It could be avoided only by spoiling the performance in some respect or by using considerably more screening. Neither seems



The wiring is quite straightforward, as can be seen from this photograph of the underside of the chassis.

The Wireless World **Communication Receiver—**

worth while as full RF gain is never needed at this part of the band.

For high-quality reproduction when interference permits it to be obtained, keep the selectivity switch at position 1, and adjust the frequency response with the tone controls. With a good speaker on a moderate size baffle, positions 4 for both switches, giving a rising bass and treble characteristics, are very suitable. A flat AF response is obtained in positions 3. On short waves when interference is bad, it is often desirable to cut off the higher frequencies and the treble switch can be in position 2 or even 1. Better intelligibility is then often obtained by cutting bass which can be done in position 1 or 2 of the bass control; this somewhat relieves the woolliness of reproduction with severe top-cut.

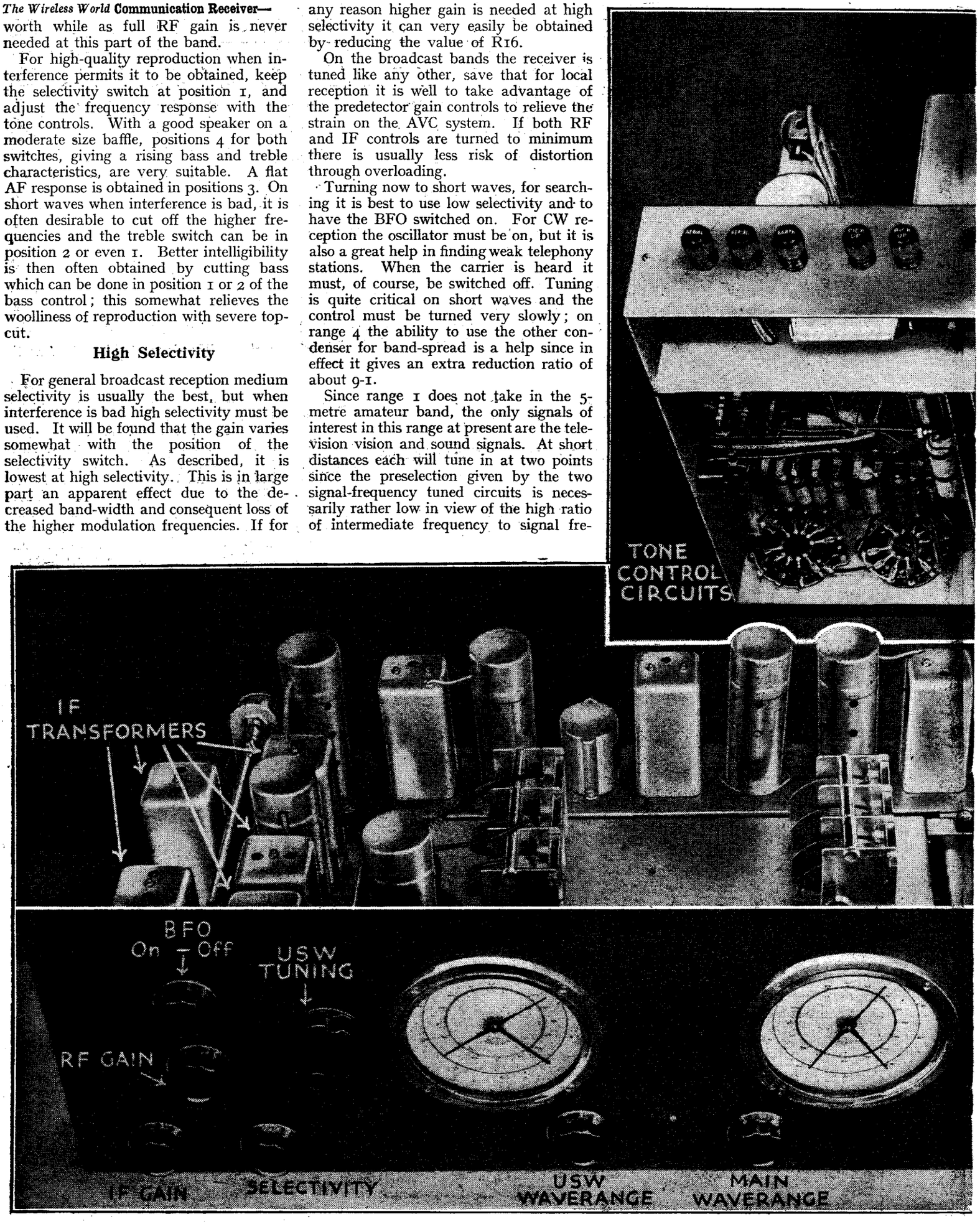
High Selectivity

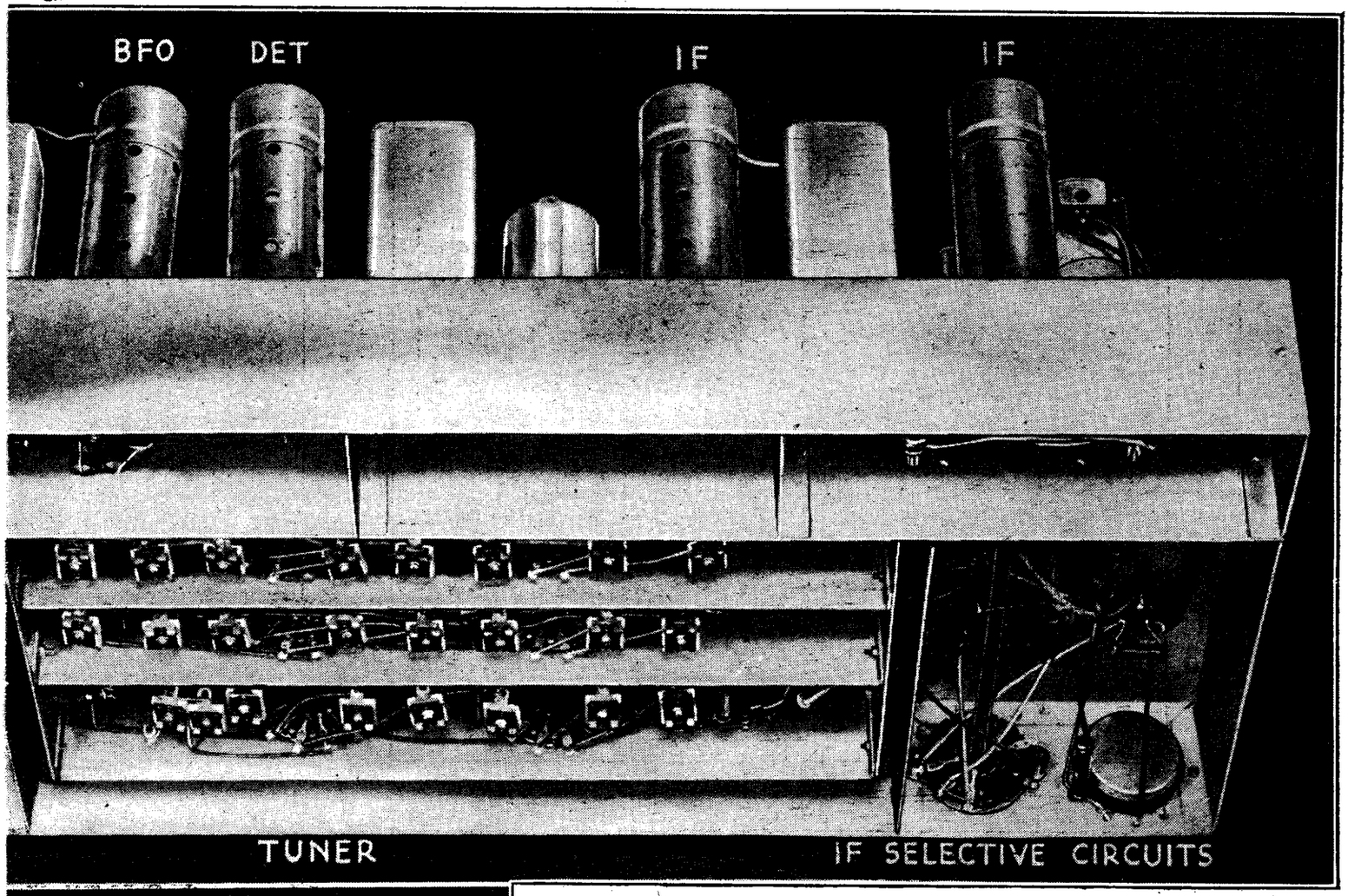
For general broadcast reception medium selectivity is usually the best, but when interference is bad high selectivity must be used. It will be found that the gain varies somewhat with the position of the selectivity switch. As described, it is lowest at high selectivity. This is in large part an apparent effect due to the decreased band-width and consequent loss of the higher modulation frequencies. If for any reason higher gain is needed at high selectivity it can very easily be obtained by reducing the value of R16.

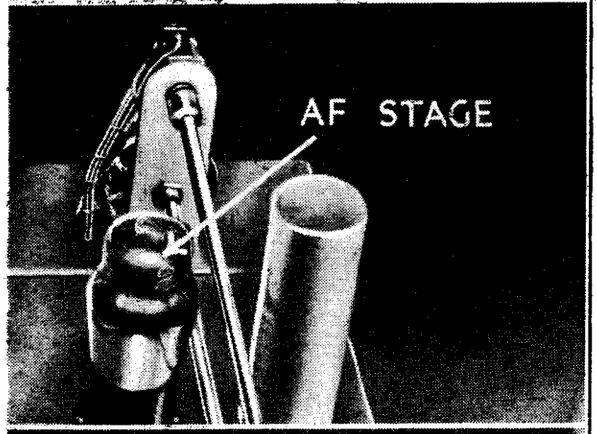
On the broadcast bands the receiver is tuned like any other, save that for local reception it is well to take advantage of the predetector gain controls to relieve the strain on the AVC system. If both RF and IF controls are turned to minimum there is usually less risk of distortion through overloading.

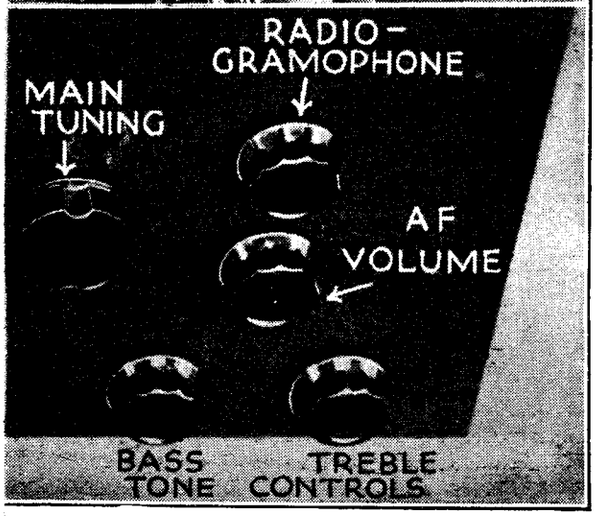
Turning now to short waves, for searching it is best to use low selectivity and to have the BFO switched on. For CW reception the oscillator must be on, but it is also a great help in finding weak telephony stations. When the carrier is heard it must, of course, be switched off. Tuning is quite critical on short waves and the control must be turned very slowly; on range 4 the ability to use the other condenser for band-spread is a help since in effect it gives an extra reduction ratio of about 9-1.

Since range 1 does not take in the 5-metre amateur band, the only signals of interest in this range at present are the television vision and sound signals. At short distances each will tune in at two points since the preselection given by the two signal-frequency tuned circuits is necessarily rather low in view of the high ratio of intermediate frequency to signal fre-









quency. There is, however, sufficient preselection to discriminate between weak signals, but owing to the great strength of the Alexandra Palace signals in the London area, two tuning points will be found and AVC will make them of nearly the same strength.

The 10-metre amateur band falls in range 2 and at suitable times American amateurs should be well received. This is usually summer afternoons. Range 3 covers the 13-metre broadcasting stations, but the greatest amount of general interest comes in range 4. This includes the 19-metre, 25-metre and 30-metre broadcast bands and the 20-metre and 40-metre amateur bands.

On test the receiver proved excellent in every respect, giving outstandingly good quality of reproduction in local reception on the medium, long and television wavebands, with ample volume for all domestic requirements. On all bands the sensitivity proved high enough to get well into the noise level; no greater sensitivity would be of use in any but the very quietest districts free from all trace of electrical interference. As certain types of interference can carry for long distances, there are very few districts indeed which are completely free from any trace of interference of any kind.

The signal-noise ratio proved unusually good, due in large measure to the RF

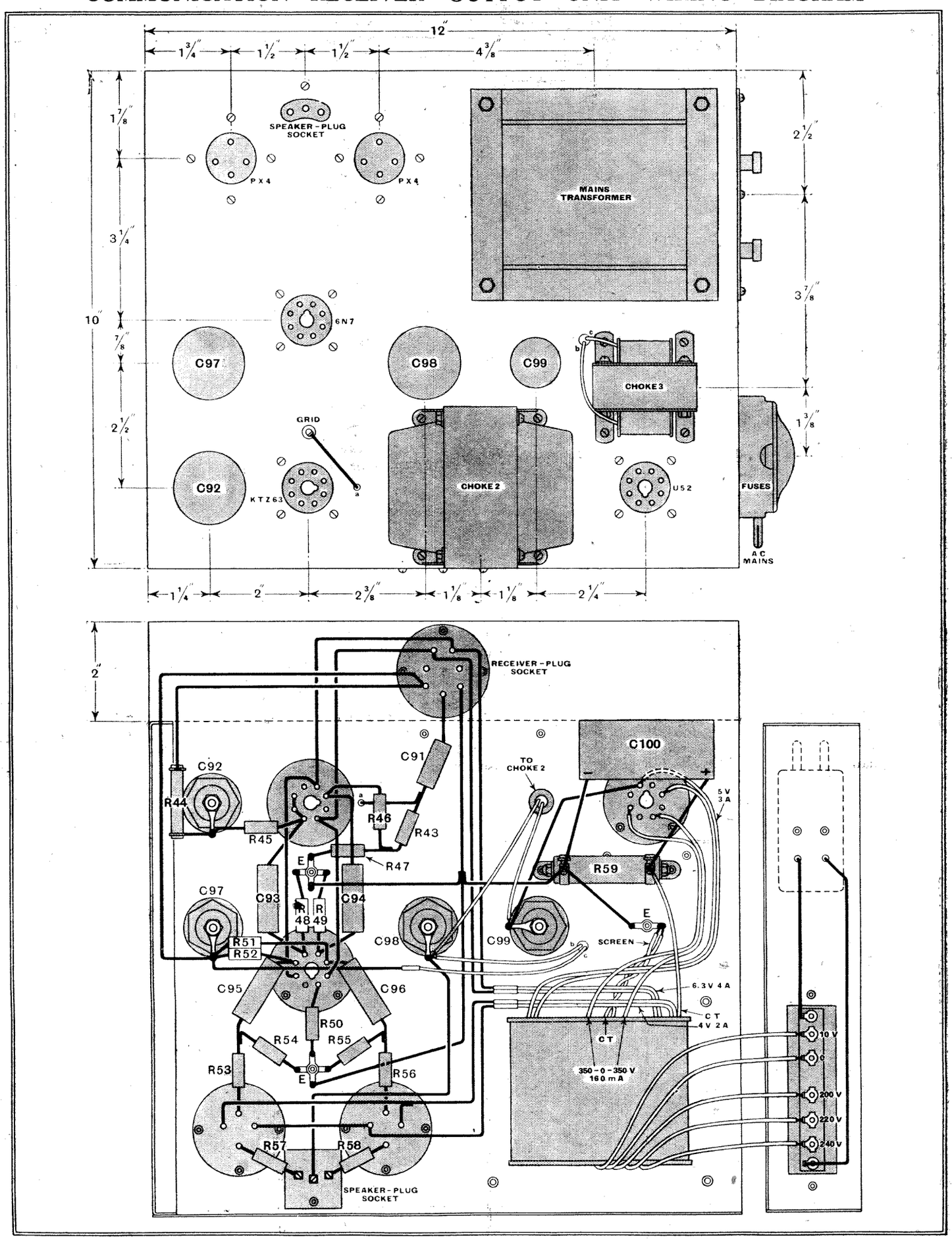
VALVES, VOLTAGES AND CURRENTS.

	Volts.		Cathode.	Currents.	
	Anode.	Screen.		Anode.	Screen.
RF EF8	250	250	2.05*	7.4	0.2
FC X65 Hex.	250	90	3.15*	1-2.5†	3.5
Osc.	75†	—			
IF KTW63 ...	250	90	7*	1.6	0.35
1st IF KTW63 ...	250	90	2.2*	6.5	1.6
2nd IF KTW63 ...	240	90	2.2*	6.7	1.55
Det. D63	0	—	0	0	—
BFO KTZ63	140*	135*	0	4.6	2
AF 6N7	105*	—	1.9*	1.9	—
Ph. Spl. KTZ63 ...	135*	—	35*	3.25	—
AF 6N7 {1	145*	—	2.7*	1.55	—
AF 6N7 {2	145*	—	2.7*	1.55	—
Output {PX4... ...	340	—	44	44	—
Output {PX4... ...	340	—	44	51	—

Total current: 158 mA.
Volts across C99: 360
Volts after 1st choke: 345
Volts after 2nd choke: 320

* Will vary appreciably according to the voltmeter resistance. True voltages are higher than the figures given.
† Will vary somewhat with tuning.

COMMUNICATION RECEIVER—OUTPUT UNIT WIRING DIAGRAM



Full details of the power unit are given in this drawing for the case when a 6N7 valve is used in the penultimate stage. Details of the modifications involved when two KTZ63 or 6J7G valves are used in its place are given elsewhere.

The Wireless World **Communication Receiver—**

valve and in part to the maintenance of good ganging accuracy on short waves. This latter is due in part to the excellence of the frequency-changer valve which is unusually free from unwanted internal couplings. Pulling between the signal and oscillator circuits is remarkably low and this is a great help in the attainment of good ganging.

Under normal conditions hum was inaudible and modulation hum completely absent. Microphony proved very low. When receiving very strong signals on ultra-short waves it is necessary to use low selectivity, but this would be done in any case to obtain the best quality, since little interference is found here. On the ordinary short-wave bands no trouble was experienced even at high selectivity except when the loud speaker was very near the receiver and the volume very great. Even then microphony was small, and no trouble should be experienced at normal volume levels.

A blueprint of the combined wiring diagrams of the receiver and tuner (less the power unit seen clearly on the opposite page) is available from the Publishers, Dorset House, Stamford Street, S.E.1. Price 1/6, post free

The AVC Circuit

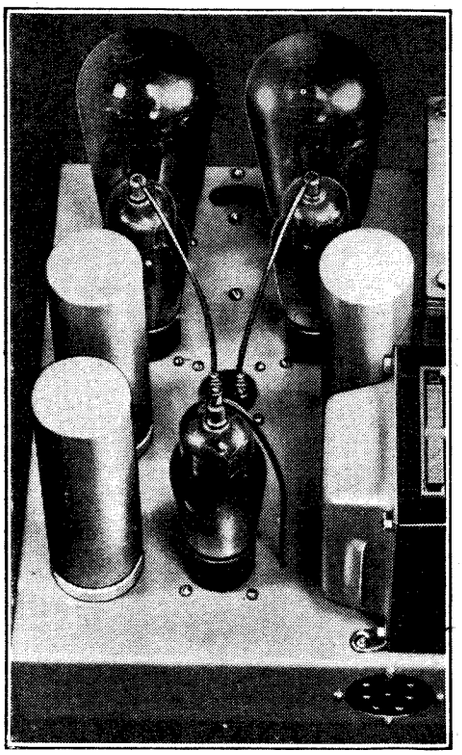
As had been expected, the variable selectivity system worked very well indeed. No shift in tuning was observed on varying the selectivity from high to low, but, naturally, if a signal is tuned in and the selectivity is increased some retuning may be necessary. This is because it is rarely possible to centre the flat resonance curve obtained at low selectivity exactly on a signal, for there is naturally a small movement of the condenser over which no change in output is observable. This is a natural state of affairs, and is responsible for the usual advice to tune in a signal at high selectivity and then to reduce the selectivity to the required degree. The maximum selectivity proved adequate for all normal requirements, and it is doubtful whether more would be of any advantage save, perhaps, for CW morse reception.

The AVC system proved satisfactory for the purpose for which it is intended—smoothing out fading. It does not hold all signals at the same level, and represents a compromise between no AVC and the extreme of AVC with which the strongest signal is held down to the strength of a weak one as far as the ear is concerned. At first sight attractive, the latter arrangement makes tuning more difficult and interstation noise becomes troublesome, so that a muting system is desirable. Muting systems are liable to cause distortion, however, and in general they are unsuitable for short waves where tuning becomes critical.

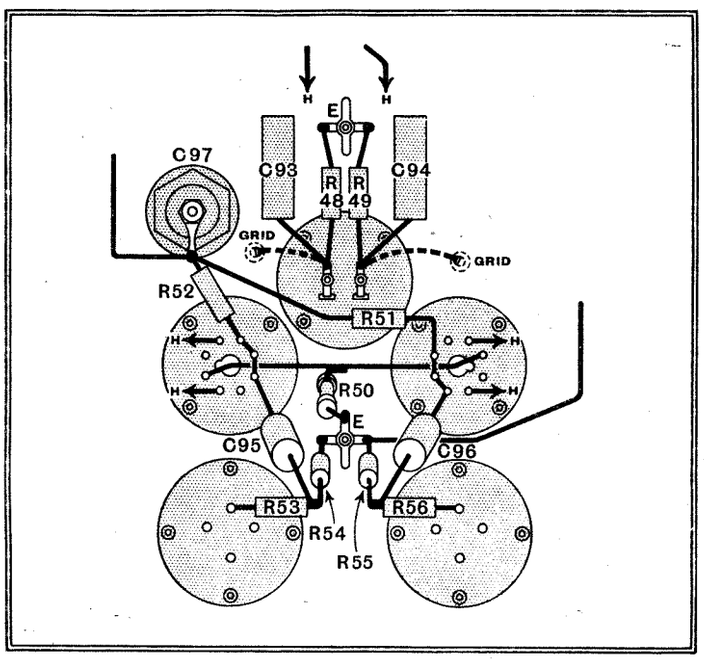
There is no doubt that for general "handleability" a receiver without AVC is the pleasantest, but equally AVC is necessary to reduce fading. A compromise has been adopted, therefore, which seems to meet the conditions admirably. The control is sufficient to reduce the volume variations of fading to a moderate level and yet it leaves the receiver free from the unpleasant effects of a violent control.

One result of this is that a tuning indicator is unnecessary and none is consequently fitted. In the writer's view such an indicator would serve no useful purpose, for it is easily possible to tune accurately by ear.

In conclusion, it should be pointed out that an error occurred in the circuit diagram on page 134 of *The Wireless World* for August 18th. The condenser C73 was shown as having a capacity of 0.002 μF, whereas its correct value is 0.0002 μF. The list of parts is not affected as this condenser is included in the coupling unit T7.



A view of the amplifier with two KTZ63 valves instead of the 6N7.



Wiring diagram of that portion of the power unit chassis that will be affected if two KTZ63 or 6J7G valves are used in place of the 6N7.

LIST OF PARTS

POWER UNIT

1 Mains transformer, Primary 200-250 volts, 50 c/s., screened. Secondaries: 4 volts, 2 amps. C.T.: 6.3 volts, 4 amps; 5 volts, 3 amps; 350-0-350 volts, 150-160mA. **Savage WW51**

1 Choke, 10H., 150 mA., 100 ohms, **CH2** **Sound Sales 10/250/H**

1 Choke, 20H., 50 mA., 400 ohms, **CH3** **Bulgin LF14S**

2 Valve holders, 4-pin (without terminals) **Clix Chassis Mounting Standard Type V1**

1 Valve holder, 7-pin (without terminals) **Clix Chassis Mounting Standard Type V2**

3 Valve holders, 8-pin, International octal type **Clix V4**

Fixed condensers:

1 0.01mfd., tubular, **C91** **T.C.C. 451**
4 0.1 mfd., tubular, **C93, C94, C95, C96** **T.C.C. 341**
3 8 mfds., 500 volts, electrolytic, **C92, C97, C 98** **Dubilier 0281**
1 4 mfds., 500 volts, electrolytic, **C99** **Dubilier 0283**
1 50 mfds., 50 volts, electrolytic, **C100** **Dubilier 3004**

Resistances:

2 50 ohms, ½ watt, **R57, R58** **Erie**
1 1,000 ohms, ½ watt, **R46** **Erie**
1 1,200 ohms, ½ watt, **R50** **Erie**
1 9,000 ohms, ½ watt, **R47** **Erie**
3 10,000 ohms, ½ watt, **R45, R53, R56** **Erie**
2 100,000 ohms, ½ watt, **R51, R52** **Erie**
4 250,000 ohms, ½ watt, **R48, R49, R54, R55** **Erie**
1 2 megohms, ½ watt, **R43** **Erie**
1 40,000 ohms, 1 watt, **R44** **Erie**
1 500 ohms, 20 watts, **R59** **Bulgin PR2**

1 Fused mains input connector with 2 amp. fuses **Belling-Lee 1114**

1 Plug and socket, 3-pin **Belling-Lee 1119**

1 Grid clip, octal type **Bulgin P96**

Chassis, complete with screws, etc. ... **B.T.S.**

Miscellaneous: **Peto-Scott**
3 lengths systoflex, 1 oz. No. 20 tinned copper wire, etc.

Valves:

2 PX4, 1 KTZ63, 1 U52 **Osram**
1 6N7 **Premier Supply Stores**

UNBIASED

By FREE GRID

Inquest on Radiolympia

THE great wireless show is over for another year, and I must say that on the whole I am not at all sorry, as it is always an exceedingly busy and temper-trying affair for me. I am at the moment thoroughly weary and footsore. I am, however, not in so sorry a plight as many of the ordinary visitors whom I saw leaving the show limping painfully along.

One leg longer than the other.

Their limping gait was by no means entirely due to the tiring tramping up and down the aisles, but was, I regret to say, due to their having one leg longer than the other owing to its having been so severely pulled by some of the "technical experts" on certain stands. There were so many people limping painfully out of the exits on the last day of the show that I suggest in all seriousness that the authorities would do worse than to consider changing the name of next year's show to Radio-limpia.

The truth is that although there was marked improvement this year in the matter of having people on the stands to deal with technical enquiries there is still a great deal to be done in this respect. Too many stands had, I found, a collection of hybrids who were neither salesmen nor technicians but a sort of cross between the two. They were full of high-falutin' technical jargon and little else; in fact, I heard so much of this lingolympia, which appeared to be a special type of technical jargon developed for the show, that I got thoroughly sick of it.

On the whole, however, the show was a great success, and I willingly pay my tribute to it. I hung about until long after the closing hour on the last evening but there was little being given away, and in the end I aroused the unjust suspicions of one of the innumerable uniformed officials who appear to be attached to this particular exhibition hall. However, in the subsequent interrogation I discovered that he was an ardent wireless enthusiast and a keen reader of *The Wireless World*. The result was that good came out of evil once more, as it so often does, as his unjust suspicions vanished into thin air and gave place to feelings of the utmost cameraderie and friendship.

His official position gives him an unrivalled opportunity of seeing what goes on behind the scenes, not only at the wireless show but at all other exhibitions. He was able to tell me many things about the organisation of the wireless exhibition of which I was previously ignorant, and I have arranged with him that next year, provided that all goes well and he still retains his official position, I shall be given opportunities of observing things which are usually hidden from the public eye.

σκοφονυ

I RECOLLECT that in my schooldays there was a tremendous upheaval in the educational world in the matter of Latin pronunciation. The so-called new method of pronunciation which was introduced at that time was claimed by its sponsors to be the correct one as used by Julius Cæsar, although, as I pointed out to my scholastic superiors at the time, this was no recommendation as it was well known that Cæsar was a provincial and his accent would undoubtedly be the Roman equivalent of broad Yorkshire.

There was, however, no such dispute, so far as I am aware, over the question of Greek pronunciation, as the ancient Hellenes had the good sense to use separate letters according to whether they wished their most important vowel sounds to be given a long or a short intonation. In view of this fact I am very distressed at the mispronunciation of the first syllable of the word "Scophony" which I hear on every hand. It is certainly no fault of the directors of the company which owns the word as they have proved their good faith by going to great pains to devise a word of pure Greek derivation instead of using a wretched hybrid, such, for instance, as "Television." I need scarcely tell my readers that the first vowel sound in "Scophony" should be short like HF connecting wires since the vital letter is an omicron and not an omega.

Hunstanton Hauteur

I SEE that the B.B.C. are to ask listeners with unusual surnames to let them know their correct pronunciation. It appears that the people at the Big House have been receiving complaints of mispronunciation of certain family names and this proposed enquiry is a laudable attempt to put matters right. Actually, of course, matters will not be put right at all as people with unusual surnames are by no means agreed as to their correct pronunciation.

There are, of course, many names other than family ones which are woefully mispronounced by the vulgar, as we people who go huntin' with the Pytchley and the Belvoir know only too well. It is not to these that I refer, for, after all, there is not the slightest doubt about their pronunciation among people who matter. It is, however, in connection with such names as Heckmondwike and Llanfairpwllgwwngyllgogerychwyrndrvb-wllllandisiliogogogoch and other places beyond the pale of decent society that the B.B.C. ought to worry.

In particular, I personally should like to know the correct pronunciation of Hunstanton as I have just had a most unfortunate experience there in connection with certain television experiments. I arrived at Liverpool Street Station in order to proceed there with my television gear for the purpose of testing reception conditions, and in asking for a ticket to the wretched place I omitted the middle syllable as I thought that this was correct. The result was that I promptly drew forth a few caustic comments from the booking clerk.

Accepting his rebuke with becoming meekness, I used the alternative pronunciation during the course of a conversation with the young lady presiding over the reception desk at the hotel at which I was endeavouring to register. It was quite evident from the way in which she elevated her eyebrows and from the tone of her voice that she regarded me as not being the type of visitor with whom the other guests of the hotel would care to

She elevated her eyebrows.

associate. When she suggested that there were other parts of the town where I might find accommodation in an environment more suited to me I promptly took my bag and my television gear and caught the next train back to London. It is solely due to this that Hunstanton is not "on the map" as far as television goes.

NEWS OF THE WEEK

"REDMOSS": Aberdeen's New Station

Some Technical Features

AFTER nearly fifteen years' service—it was actually opened on October 10th, 1923—the modest little one-kilowatt transmitter at Aberdeen is to be superseded to-morrow (September 9th) by a five-kilowatt station built on the most efficient lines and bearing the rather contradictory title of Redmoss (have you ever heard of "red' moss?) instead of Nigg, the name originally proposed. The old wavelength of 233.5 metres (1,285 kc/s) is being retained. A transmitter room, machine room, control room, and other accommodation are contained in a building approximately 68 feet long by 44 feet wide, and the power supply, from the Aberdeen Corporation mains, is brought to the site from a sub-station a mile away.

Reducing Distortion

The transmitter is anode modulated in the output stage, the necessary low-frequency power amplifier or modulator unit being designed for Class B operation. In order to minimise harmonic distortion in the modulator unit a portion of the output is tapped off and applied to the first stage in inverse phase. The amount of feedback is adjustable and is set during the final tests of the transmitter to give the best overall performance. By this means it is possible to obtain a figure for the total distortion introduced by the transmitter which is less than 4 per cent. at 90 per cent. modulation.

Safety Precautions

A novel feature of the station is the precaution taken to reduce the time necessary to clear an earth on the feeder system or aerial coupling circuit, such as might be caused by a lightning discharge in the neighbourhood of the aerial. The current which would flow to earth in this event is caused to operate a relay, which immediately removes the main high-tension supply and automatically re-applies it after a short period. An indicator is provided to warn the staff when the relay operates.

The type of aerial used is that in which the mast itself forms the radiator. The 250-foot steel lattice mast is insulated from earth at the base and has a capacity ring 40 feet in diameter at the top, surmounted by a red aircraft-warning light.

The principal improvement which listeners in Aberdeen itself should notice is in the quality of reception. Also the distance at which satisfactory reception can be obtained will be increased, particularly along the coast to the north and south of the city.

A CALL TO AMATEUR TRANSMITTERS

ELSEWHERE in this issue will be found details of the scheme inaugurated by the R.A.F. for the formation of a Civilian Wireless Reserve. The whole scheme was outlined by Air Commodore C. W. Nutting, O.B.E., D.S.C., Director of Signals, Air Ministry, at the Radio Society of Great Britain's Convention last Saturday when he appealed to amateurs to assist the R.A.F. and the nation by giving the scheme their support.

WHEN DO YOU LISTEN?

IF any clue were needed as to when people listen, or respecting the geographical distribution of listeners, it has been provided by the results of an inquiry conducted by the B.B.C. in connection with the thriller entitled "Send for Paul Temple." The eight episodes broadcast last spring were divided between Midland Regional (on Friday evenings) and the main Regional (on Saturday mornings), and 7,200 listeners were concerned in the B.B.C. inquiry.

About 4,400 heard the Friday evening episodes, 2,600 those on Saturday mornings, and the remaining 200 sometimes heard the programme in the evening and sometimes in the morning. An analysis showed that under the best conditions Friday evening is preferred to Saturday morning broadcasts, of this description at any rate, by about ten listeners to one.

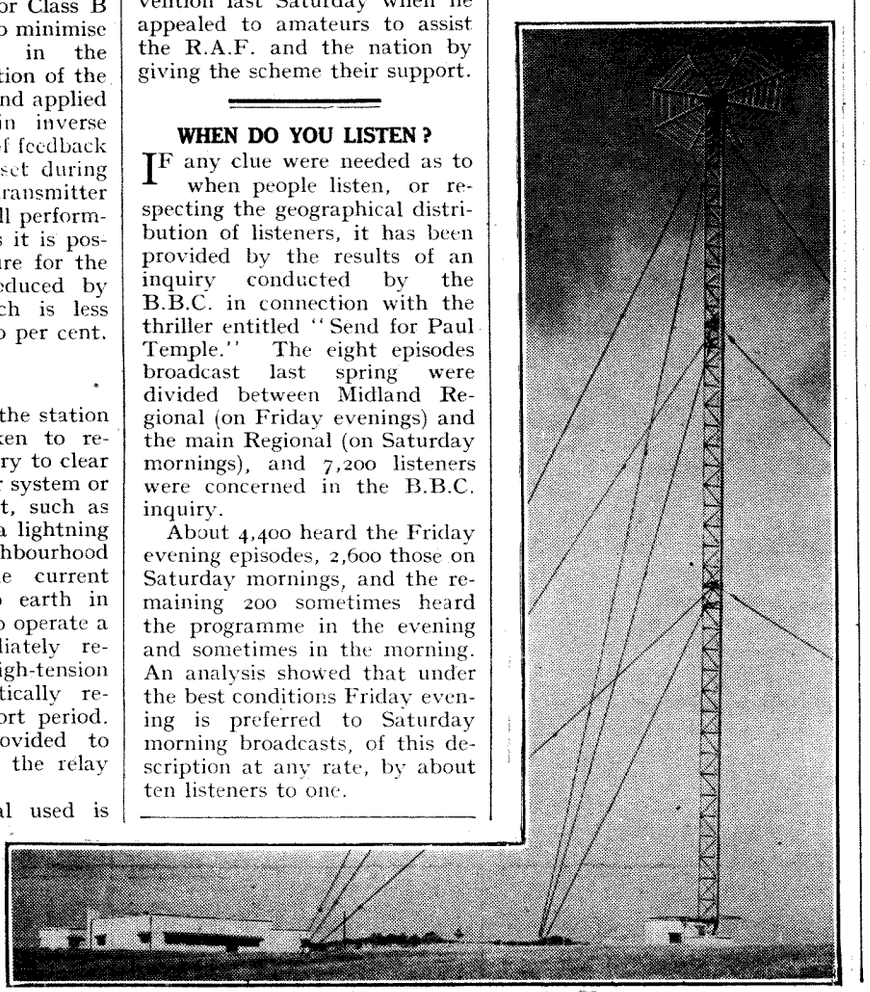
CO-OPERATIVE INTERNATIONAL RADIO RESEARCH

Plans for Solar Eclipse Experiments

PHYSICISTS and engineers of many countries have met in Italy for the sixth General Assembly of the International Scientific Radio Union which is being held from September 4th to the 11th. They will discuss wireless matters of mutual interest and formulate plans for co-operative international research. Plans for world-wide radio experiments during the solar eclipse of 1940 are also expected to be made.

The fiftieth anniversary of Heinrich Hertz's discovery of electric waves will be celebrated during the Assembly.

The British delegation to the Congress will consist of Prof. E. V. Appleton, Cambridge University, who is also President of the Union; Dr. E. H. Rayner and Dr. R. L. Smith-Rose, National Physical Laboratory; Mr. R. A. Watson-Watt, Air Ministry; and Prof. S. Chapman, London University.



REDMOSS. A general view of the station showing the 40-foot capacity ring which surmounts the 250-ft. steel mast radiator.

FREQUENCY RESPONSE

A Suggested Broadcast Test

THE recent broadcast in the National programme by Reginald Foort when he took listeners on a "tour of inspection" of the Theatre Organ, has caused considerable correspondence and comment. The *pièce de résistance* was when he ran up the scale from the lowest to the highest notes on the instrument. Many listeners failed to hear the last octave in the upper register and the last one or two notes at the other end of the scale. It was certainly a good test of receiver performance and perhaps it would not be asking too much for this response test to be repeated occasionally.

It will, doubtless, be of interest to readers to know the fundamental frequency of the highest and lowest notes on the organ, which we have obtained from the makers, the John Compton Organ Co. They are 8,000 and 32 cycles respectively.

SCHOOL HOUR IN INDIA

Tackling the Problem of Education for a Continent

THE All-India Radio authorities circularised educational authorities some six months ago in an attempt to secure their support in the matter of educational broadcasts. A definite daily programme schedule, suited to the needs of schools, is now in the process of being drawn up ready to be placed before the scholastic powers for their approval. It is expected to inaugurate the new service in October.

In the meantime it is noted with satisfaction that the average monthly increase in the number of wireless sets in India is 1,100.

"ROBBING PETER TO PAY PAUL"

TELEVISION is calling strongly for the exploitation of various means of saving on sound broadcasting what must, of necessity, be diverted to the sister service; and so it has been decided to make an interchange of London and Regional programme material more generally in the autumn. In fact, line relays are in for a hectic time. Listeners in London who look merely for some geographical significance in a relay from Scotland or Northern Ireland are likely to be disappointed.

Provincial listeners interested

News of the Week—

in the financial side of broadcasting may wonder why their local station officials should have to draw on their share of programme money to supply London with material which could be provided, in many cases, more effectively from the metropolis.

It is a tangled web that is being spun to help television forward in the provinces and it is becoming inevitable that Regional characteristics, while they will not be sacrificed entirely, should assume less importance in the eyes of Broadcasting House. After all, listeners should benefit generally in the ultimate result, by becoming mostly viewers. And in the meantime the B.B.C. has to take all of its money out of one till, having no other realisable assets.

MAKING THE NIGHT HIDEOUS

A Holiday Warning

NOISE detectives of the Danish Radio Noise Suppression Service recently traced the cause of a violent and unremitting howl as far as an unoccupied house in the provincial town of Middelfurt.

The neighbourhood considered it impossible that the oscillations could have come from the house in question as the owners were known to be away on holiday. Subsequent severing of the electric mains leading to the house arrested the howl in the middle of its song, and it was found that the family had departed for their holidays leaving their wireless set on which had broken into violent oscillation.

EDUCATIONAL OPPORTUNITIES

A FURTHER prospectus to those referred to under this heading last week has been received from the Polytechnic, 309, Regent Street, London, W.1. The radio and television engineering courses extend over a period of five years and provide a thorough training in the principles and technique of the subjects. The first three years of the courses are approved for the award of the "Ordinary" National Certificate granted by the I.E.E. A two-year course on radio and radio-gramophone service work is also available and is being conducted in co-operation with the Gramophone Company and E.M.I. Service. Enrolment week is September 19th to 23rd, from 6 to 9 p.m.

A RADIO HOWLER

IN the little Belgian town of Wavre the people were subjected to the unremitting strains from a too-noisy loud speaker. The owner refused to moderate the volume, he liked it loud. There is no law there to deal with such nuisances, but a lawyer came, like the Pied Piper to Hamelin, and freed the citizens from the plague of sound. He found the offender's Achilles' heel, and won a law case on the grounds that the loud speaker was operated at such a volume as to constitute public performances, and therefore authors' royalties were due on the works broadcast.

FROM ALL QUARTERS

Television in Paris

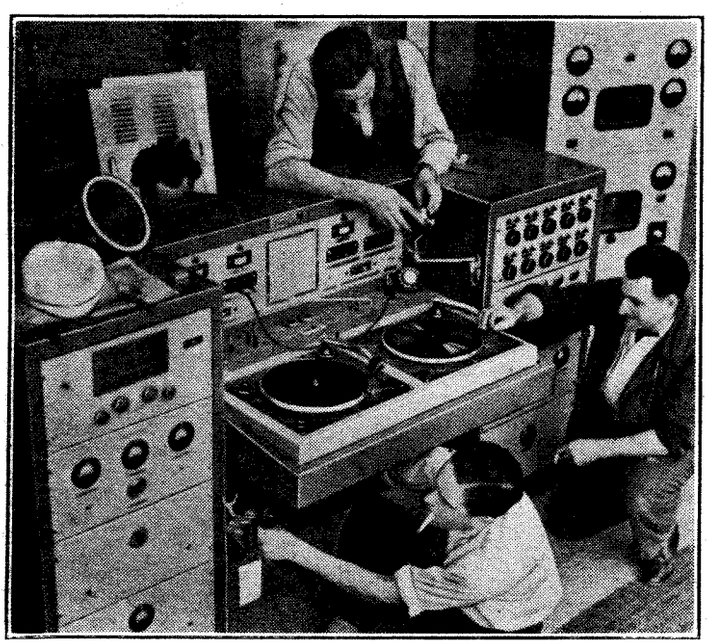
REGULAR television transmissions from the Eiffel Tower, on 6.52 metres, vision, and 7.14 metres, sound, are specially planned for reception at the Paris Radio Salon, where they are being demonstrated on commercial receivers as well as on a large screen in a "Vision Hall" which has accommodation for several hundreds of viewers. Transmissions will continue to take place daily from 4 to 7 p.m. and 9 to 10.30 p.m. until the close of the Exhibition on September 11th.

University Studies Short-wave Reception

A SURVEY of short-wave reception from stations all over the world has just been completed by the Ohio State University. In their report, the authorities remark that much remains to be done in the utilisation of the short waves for educational purposes. And if Ohio, why not Oxford and Cambridge? The time may come when all educational centres will possess a miniature Tatsfield linked up to the colleges.

Explanatory Booklets

Two useful booklets, priced at 1s. each, post free, have been issued by *The Wireless Trader*, Dorset House, Stamford Street, London, S.E.1. These publications are prepared primarily for dealers; the first, entitled "A.B.C. of Automatic Tuning," explains the principle and practice of all the usual systems of press button tuning. The other booklet, entitled "The Television Trader," contains much information on television receiver principles, but is particularly designed as an aid to service work. Oscillographs of the waveforms present at the various stages of a typical receiver constitute a valuable feature of the book.



INSTALLING apparatus for the centralised distribution system through which signals for demonstration purposes are fed to the stands at the Salon de la Radio, which opened in Paris on September 1st and continues until next Saturday.

5-Metre Contest

ALTHOUGH privately arranged, the contest for the G.W. Trophy, which is being held during this next week-end, September 10th and 11th, it has the full support of the Radio Society of Great Britain. Full particulars of the contest are included in the August issue of the *T. & R. Bulletin*.

Studio at Marseilles Fair

A BROADCAST studio will be installed in the Salon de T.S.F. at the Marseilles Fair, which will be open from September 17th to October 3rd. Programmes emanating from the studio will be broadcast from Marseilles on 400.5 metres.

Radio School in Persia

PRELUSIVE to establishing wireless stations in the principal towns of Persia, the Ministry for Posts and Telegraphs has founded a school of wireless telegraphy in Teheran. The course of instruction will last for two years, and entrants must agree to serve the Ministry for five years after passing their examination.

Research Work

THE Chelmsford Rural District Council has granted the Marconi Wireless Telegraph Company permission to erect four 80-foot lattice steel masts at their Research Station, West Hanningfield Road, Great Baddow, Essex.

Big-Fight Television Ban

THE promoter of the Doyle-Phillips boxing contest, to be staged on September 13th, has refused the B.B.C. permission to televise the fight with the comment: "Ordinary broadcasting (which he is permitting) is not so bad, but television will hit me, for there must be twenty thousand people ready to look in to the fight, and some of them might buy ring-side seats but for those sets." He was offered £75 to allow the fight to be televised.

Still Pictures to Illustrate Broadcast Programmes

THE Australian Broadcasting Commission is reported to be working on a scheme to provide schools, already equipped with broadcast receivers, with still-picture projectors and to hire out strips of film holding from 20 to 30 still-pictures. These pictures would be carefully prepared in order to illustrate talks in advance.

Amateurs Who Have Won

MR. MUSTILL, XZ2DY, of Burma, secured first place in the annual British Empire Radio Union transmitting contest. The contest is divided into two parts, the first for high-power amateur stations, and the second for stations using up to 25 watts. In this junior section, Mr. T. Martin, G2LB, retains the trophy for England.

Drastic Measures for Noise Makers

THE loud speaker nuisance is being seriously dealt with in the Scandinavian countries, where broadcast programmes are regularly interspersed with requests for moderation in volume. In Stockholm loud speaker reproduction of broadcast or gramophone music is banned during the hours from 11 p.m. to 7 a.m., and in Copenhagen new police regulations forbid noisy loud speaker music after 10 p.m.

Institute of Public Address Engineers

THE Annual General Meeting of the Institute of Public Address Engineers, the registered office of which is at 83, Cannon Street, London, E.C.4, took place at Radiolympia on August 29th, under the chairmanship of Mr. H. J. Fowlie, of the Maidenhead Radio Company. The business included the election of the Council, which consists of nine members.

PA for the Railway

THE public address installations at Paddington, Birmingham (Snow Hill), Cardiff and Newport stations have proved so successful in directing passengers to trains during rush periods that the Great Western Railway has decided to install similar equipment at Torquay. A portable loud speaker unit will also be available this winter for use at those stations where large football or racing crowds are anticipated.

British Televisors in U.S.A.

A NUMBER of British television receivers have been adapted to pick up experimental transmissions radiated from the Empire State Building, New York, and are being used in that city with great success.

More About Negative Feedback

Its Effects on a Quantitative Basis

By "CATHODE RAY"

IN a recent issue we examined the action of negative feedback in a fairly simple sort of way by considering an imaginary amplifier and finding out the results of applying a particular amount of feedback. To be able to extend this knowledge to cases in which one may be more practically interested, the best way is by means of simple formulæ. I don't very often inflict anything verging on algebra, and the following formulæ need not alarm anyone.

The summarised findings last week were:—

If a simple resistance feedback circuit is used—

(1) amplification is reduced,
(2) all forms of distortion are reduced,
(3) internally generated noise or hum is reduced,
(4) variability of amplification with change of valves or supply voltages is reduced.

If a circuit containing capacities or inductances is used, the feedback is applied unequally at different frequencies, and therefore—

(5) it may be used as a tone control.

Finally, if the feedback is tapped off in parallel with the output load—

(6a) the apparent internal resistance of the output valve is reduced.

And if it is tapped off in series—

(6b) the apparent resistance is increased.

By considering the simple calculations that were worked out it is not very difficult to arrive at general formulæ. But first of all let us be quite clear about the conditions. It is assumed that a certain fraction or percentage of the output voltage of the amplifier is taken back to the input and applied in series with it and exactly in opposition. This exactness of opposition, by the way, is the most difficult part of the bargain to fulfil in practice. If the full line in Fig. 1(a) represents one complete wave or cycle of the input signal, the dotted line shows another wave of different strength but exactly in opposition. By reversing the connections, of course, it is brought into exact reinforcement with the original, or in the same phase, as it is more usually called. Now in all actual amplifiers there is a tendency, due to stray capacities and inductances, for the phase to shift, so that we get something like Fig. 1(b), where the feedback wave lags behind exact opposition by about 45 degrees. (A whole wave, as shown, is divided into 360 degrees.) However, more of that presently; in the meantime we assume no phase shift.

Feedback Calculations

Let A stand for the amplification or gain of the amplifier itself, expressed as voltage multiplication. The amplification when feedback is included is normally smaller, so it may be appropriate to represent it by a. The fraction of the output voltage that is fed back can be called B. If 25 per cent. is fed back, then B is 0.25, and so on.

The first formula deals with the reduction in gain due to feedback. Remember that the amplifier itself is unchanged. If you were shut up in a box along with it you could not tell whether feedback were being used or not. The effect of feedback is, as it were, to make an entry on the opposite side of the ledger, reducing the balance to your credit. The balance after you have taken into account this debit entry is a.

$$a = \frac{A}{1 + AB}$$

That is a very simple formula, and is the vital one to know in connection with negative feedback. If you have the last article at hand perhaps you would like to apply the formula to the example there, in which the amplifier had a gain of 12, and 25 per cent. feedback was applied. So $a = \frac{12}{1 + (12 \times 0.25)} = \frac{12}{1+3} = 3$, which is just what we found then. Highbrows will complain that the formula really ought to be

$$\frac{A}{1 - AB},$$

and that B is negative and should be entered with a minus sign. That is quite right, but instead of bothering to remember to put in the two minus signs, which always destroy one another, it is perhaps allowable to remove them at the start because we are definitely confining our attention to *negative* feedback.

Next there is the reduction of frequency distortion or any other influence which acts to alter the gain. Suppose that something happens such as a change in mains volts, that alters the amplification from A to some other figure that can be called A′. Or suppose the frequency characteristic is not flat, but varies from A at one frequency to A′ at another. Then the corresponding ratio when feedback is used,

$$\frac{a}{a'} = \frac{\frac{A}{A'} + AB}{1 + AB}$$

In our example we supposed that A′ was 6, and found that a' was 2.4. Using the formula—

$$\frac{a}{a'} = \frac{2 + 3}{1 + 3} \text{ or } \frac{5}{4}, \text{ which is the same as } \frac{3}{2.4}.$$

An amplification ratio of 2 is reduced to 1.25, or, in other words, the percentage change in amplification is reduced to a quarter by the use of negative feedback, and this is the same extent, $\frac{1}{1 + AB}$, to which amplification itself was reduced.

Next, the more serious distortion—amplitude distortion, including harmonics and intermodulation. These are produced inside the amplifier and are assumed to be not present in the original signal at all, so with them may be lumped any other things, such as hum and valve noise produced in the amplifier, or, at any rate, that part of it included in the feedback loop. Any such undesired features generated at an earlier stage than the one where feedback is introduced are, of course, not distinguishable from the proper signal. In working out the example I was obliged to resort to a little algebra, and this is easily made into the general formula—

$$d = \frac{D}{1 + AB}$$

where D and d represent the distortion, etc., without and with feedback. Here once more the original is divided by 1 + AB to get the corresponding figure with feedback. So all the first four items are really covered by the same simple formula.

When dealing with tone-control effects the work centres around the calculation of B, which, instead of being a fixed fraction, is arranged to vary with frequency. What makes things much worse, mathematically, is that the phase changes, too, and A and B must be treated as vec-

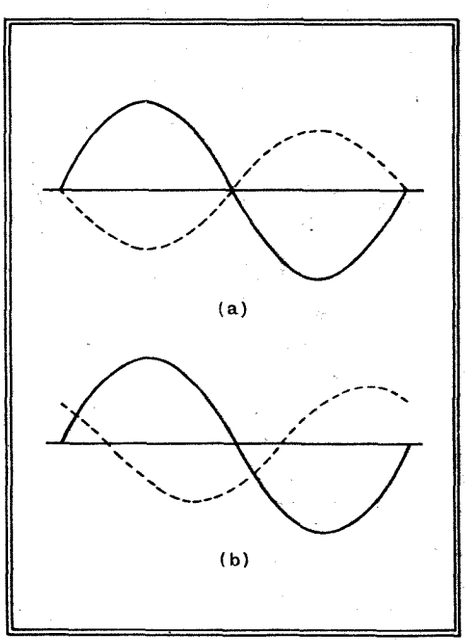


Fig. 1.—(a) If the full line is one complete signal wave, the dotted line represents feedback exactly in opposition, though unequal in amplitude. If a phase lag occurs (b), opposition is not exact and, if the phase change is large enough, feedback becomes positive, and is liable to cause oscillation.

More About Negative Feedback—

torial quantities, and that is a very long story. Nevertheless, common sense indicates the general methods to adopt. If a rise in gain is wanted, put in some component that reduces the feedback at that frequency. A capacity in shunt or an inductance in series does this at increasing frequencies and *vice versa*.

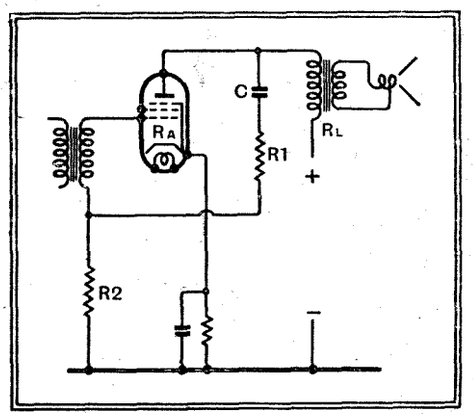


Fig. 2.—A practical way of applying negative feedback in such a way as to reduce the apparent resistance of the output valve. Transformer coupling is essential, however.

Lastly, there is the effect on apparent output valve resistance. *Apparent*, because the valve is just as before, but so far as the effects of any currents or voltages in the loud speaker or other load are concerned, it is as if the internal resistance of the valve were different. Here at last we come across something that is affected to a different extent from gain, distortion, etc. Assuming that the feedback is tapped off in *parallel* with the load, in order to *reduce* the valve resistance, the resistance is divided, not by 1 + AB, but by $1 + \frac{AB(R_L + R_A)}{R_L}$, where R_A is the original valve resistance and R_L is the load resistance. For example, suppose the output valve is a pentode of 40,000 ohms (R_A), the load resistance R_L is 8,000 ohms, and feedback includes only this one stage. If the mutual conductance of the valve is 5 mA/V, its amplification factor μ must be this multiplied by R_A in thousands of ohms, or 200. Now as A is $\frac{\mu R_L}{R_L + R_A}$, a simplified form of $1 + \frac{AB(R_L + R_A)}{R_L}$ is $1 + \mu B$. If 10 per cent. feedback is used, this is $1 + \frac{200}{10}$, or 21. So the original R_A is divided by 21 and is only 1,900 ohms, equivalent to a typical triode. Except for certain side issues, the correct load resistance is unchanged, but instead of being critical as ordinarily with a pentode, there is now plenty of latitude. This is particularly useful when the number of loud speakers in use is liable to vary. Owing to a tendency for the grid of the valve to be prematurely overdriven by the peaked feedback voltage that is likely to exist near full load, it is found in practice that when AB is not less than about 4 the optimum load resistance is about two-thirds normal.

The amplification (and distortion) is divided by $1 + \left(\frac{200 \times 8{,}000}{40{,}000 + 8{,}000} \times \frac{1}{10}\right)$ or 4.3, so is much less affected. It needs 4.3 times as big a signal to drive it at the grid, which means that the preceding valve has to supply so much more. Unless it had all this in hand in the first place, or unless the stage is enlarged, it is bound to be overloaded, and probably brings in more distortion than feedback removes. So this is a strong argument in favour of feeding back over more than one stage; in fact, over the whole amplifier if possible. The signal voltage at the beginning being relatively very small, there is plenty of scope for increase without any appreciable increase in distortion, and so practically the whole of the reduction of distortion due to feedback is actually obtained. Another advantage is that only a small voltage is required for feeding back, and so it can be taken from the secondary of the output transformer, which simplifies design considerably and extends the benefits of feedback to the transformer.

Phase Shift

All this is very good, but in practice there are some difficulties. The chief one is the phase shift that was mentioned earlier. Resistance-coupled stages, if reasonably well designed, are easy. The trouble comes when transformers are included. One transformer is generally quite feasible. Two transformers can be managed, but are very tricky. Three transformers are almost out of the question, but then one does not use three transformers these days. What happens is this: transformers pass on medium frequencies quite straightforwardly, but the extreme bass and treble frequencies are shifted back or forward in phase, and though feedback can cope with one phase shift—in fact, it pulls it in very considerably—the combined effect of two phase shifts may result in *positive* feedback at some frequency, which is likely to cause oscillation or at the very least a nasty resonance peak. So to avoid probable trouble of this nature, feedback should cover at most one transformer, and as this is preferably the output transformer it means that all stages should be resistance coupled. A resistance-coupled stage is cheap, so an extra one can be put in to compensate for loss of amplification due to feedback. To be on the safe side, it is wise not to make AB more than about 5.

The next thing to consider, especially if more than one stage is covered, is how to make sure that the feedback *is* negative. Here we come to actual circuits. Taking first an output stage only, there is generally a step-down output transformer of at least a 25 : 1 ratio, and the quantity AB is therefore probably too small to be worth having. The difficulty on the primary side is the + HT. Moreover, it is wise to feed back in *series* with the grid circuit to avoid lowering the grid input resistance. This is quite easy with transformer coupling, as shown in Fig. 2. C is simply to stop off the HT, and should be large enough to have negligible impedance compared with R1 and R2, which form the potential divider seen in most of last week's diagrams. B is $\frac{R2}{R2 + R1}$, of course. And A is $\frac{\mu R_L}{R_L + R_A}$, as we know. So all is set for working out the right R1 and R2 to give a desired amount of feedback. But, of course, R1 + R2 must be large enough not to draw off much power from the load R_L. If R_L is 5,000, R1 + R2 should be about 50,000 ohms or more; 100,000 and 10,000 are likely values, with 0.25 mfd. for C.

If the previous stage is resistance coupled, the above way can't be used. An alternative is to feed back into the cathode circuit, but as a positive voltage applied to the cathode is equivalent to a negative voltage to the grid, it is clear that the feedback would be in the wrong direction. In any case, there would be difficulties in adapting the circuit of Fig. 2 to feed back to the cathode. But with resistance coupling each stage reverses the phase, so if the feedback is taken to the cathode of the *previous* stage it comes out in the right direction. Another point is that, owing to the greater amplification of two stages, R2 can be got down to about 100 ohms or some such amount that can be inserted in the cathode circuit without provoking complications. Three stages cannot be worked in this way, because the feedback would be *positive* again; but with more than one stage the most convenient and useful method is to feed back from the secondary of the output transformer, because it can be connected either way

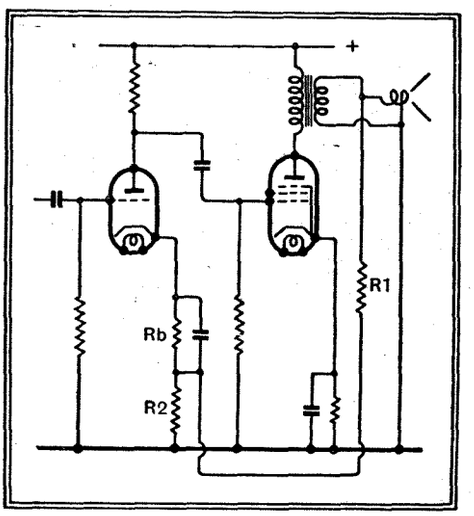


Fig. 3.—A recommended method of applying negative feedback. Two stages are covered.

round and so adapted to any number of stages, and, moreover, the transformer is allowed to share in the benefits obtained. Fig. 3 illustrates this practical method of application. R2 is assumed to be small compared with the bias resistance R*b*.

Just to make this clear, here is an example. The input to the driver valve necessary to obtain the full output of 3 watts in the load is known to be, say, 0.5 volt. Power in watts equals volts-squared

More About Negative Feedback—

divided by resistance, so if the loud speaker is a 5-ohm load the full voltage is $\sqrt{3 \times 5}$, or nearly 3.9, and A to this point is therefore 7.75. To cut distortion, etc., down to one-fifth (1 + AB) must equal 5, and B is therefore approximately 0.5. A shunt of 100 ohms across the 5-ohm load is quite harmless, so R1 and R2 are each 50 ohms.

Although this is beginning to look a very tough and uncathode-ray-like article, I

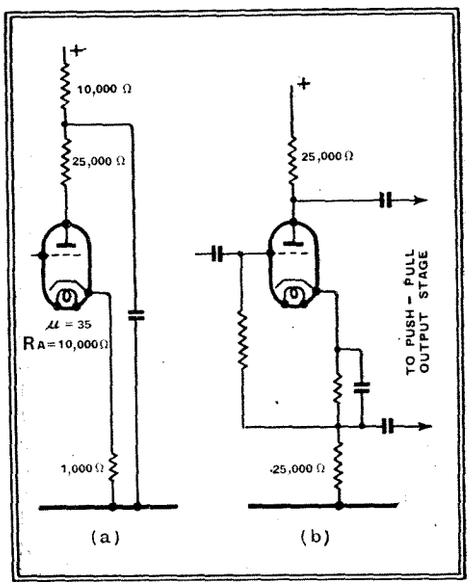


Fig. 4.—A simple form of negative feedback that is sometimes useful is shown in diagram (a). The phase-inverter circuit (b), for feeding a push-pull output stage, is an extreme form of (a).

must just include what is sometimes a useful way of employing negative feedback. Sometimes one wants a stage gain of only perhaps 5 or 10. Any resistance-coupled stage with a modern valve gives 25 or more, and it seems a shame just to throw the surplus away. By simply omitting the bias by-pass condenser one (*a*) reduces the gain, (*b*) improves the quality of amplification, and (*c*) saves the cost of one electrolytic condenser. Take Fig. 4(a) as an example. In the ordinary way its gain would be $\frac{35 \times 25{,}000}{35{,}000}$, or 25. But with the unbypassed auto-bias resistor there is a B of $\frac{1{,}000}{25{,}000 + 1{,}000}$, and neglecting the odd thousand the gain is cut down to $\frac{25}{1 + \frac{25}{25}}$, or 12½. The decoupling resistance does not come into the calculation at all, of course. An extreme form of this sort of feedback occurs in the phase inverter circuit Fig. 4(b), where half of the total load resistance is in the cathode side, and the total gain (including anode and cathode sides) is cut down to less than 2. As the resistance in the cathode side is vastly too much for bias purposes, the bias arrangements must be separate as shown.

One last thing; although I have not dared to include detailed information about feedback tone control circuits, if you use some other sort of tone control incorporated in the amplifier do not for any sake feed back across it, because the feedback will do its best to level the tone out again!

R.A.F. Wireless Reserve

Experienced Amateurs Asked to Enrol

A SCHEME has been formulated and will be put into operation immediately for the enrolment of a Civilian Wireless Reserve consisting of wireless amateurs who would be prepared to offer their services to the Royal Air Force in the event of a national emergency. The object of this new organisation is to provide an adequate reserve of efficiently trained wireless personnel on which the Signals Branch of the R.A.F. could call should the need arise.

Wireless amateurs in this country, and particularly those holding a transmitting licence, will undoubtedly give this scheme their whole-hearted support as it is on this class of experimenter that the Secretary of State for Air relies for its early success.

Enrolment in the new Reserve will not necessarily mean any curtailment in the amateur's wireless activities on his own particular frequencies, as training will largely be carried out at the volunteers' homes and on their own sets. Regular transmissions from either the Air Ministry or from the Electrical and Wireless School at Cranwell will constitute the main form of training, and special receiving equipment will not be required. Occasional attendance at reserve centres for lectures and training exercises will be required, and opportunities will be available also to visit R.A.F. Stations.

On such occasions a small training allowance and reasonable travelling expenses will be paid and all members will receive an appropriate badge.

To qualify for enrolment candidates must have a reasonably good knowledge of wireless telegraphy and be between the age limits of 18 and 54 years. Exceptional consideration will be given to applicants of special qualifications who are above the age limit.

Enrolment in the first instance will be for a period of five years with the option of an extension for further periods of the same duration if officially approved.

Members holding a transmitting licence and who have attained the required standard of proficiency will receive an allowance of £2 per annum towards the cost of maintaining their equipment and in addition crystals will be issued free.

Applications for enrolment in the Civilian Wireless Reserve should be addressed to the Under Secretary of State, Air Ministry (Signals C.W.R.), Adastral House, Kingsway, London, W.C.2.

The Wireless Industry

THREE newly introduced Mullard measuring instruments, comprising a Modulated Oscillator Type GM.2881, a Cathode Ray Oscillograph Type GM.3152, and a Calibrated AF Oscillator Type GM.2304, are described in leaflets just issued and available from The Mullard Wireless Service Company, Limited, 225, Tottenham Court Road, London, W.1.

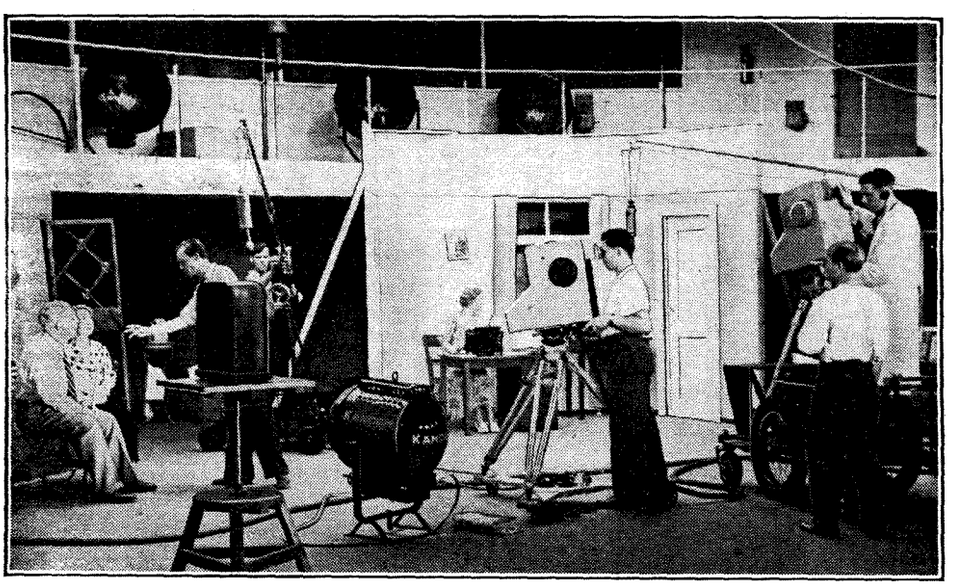
A new company, Holsun Batteries, Ltd., Neville House, Page Street, London, S.W.1, has been formed to sell accumulators and dry batteries hitherto marketed individually by Britannia Batteries, Peto and Radford, and the Fuller Accumulator Company.

The new edition of that ever-useful publication, the Osram Valve Guide, is now "out." In addition to giving complete data on all Osram valves, it includes information on base connections and also a number of useful circuit diagrams. Copies are obtainable free from the General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.

What is claimed to be the largest television order by an individual retail firm was placed during the recent Olympia Exhibition, when Alfred Imhof, Ltd., well-known New Oxford Street dealers, signed a contract to take 50 of the new Pye television radiograms.

The address of the British McMurdo Silver Co., Ltd., is now 17, Hertford Street, Park Lane, London, W.1. McMurdo Silver 1939 models and Amperite ribbon velocity microphones, etc., are available for demonstration.

The address of the Milnes Unit Service Co. is 272, Camden Road, London, N.W.1; telephone Gulliver 4628.



A CIRCULAR TELEVISION STUDIO, part of which is seen here, so designed that a number of sets and scenes can be arranged round the cameras, has been built at the temporary television headquarters in the Deutschlandhaus in the Adolf Hitler Platz in Berlin.

Random Radiations

By "DIALLIST"

Puzzling

IT'S difficult to know quite what to make of this year's Radiolympia, which is still in full swing as I write. In the technical organisation, no trouble or expense was spared to make it a complete success. But the attendance figures are down, though television proved to be an even greater attraction than was expected. The Exhibition deserved to attract far greater numbers of people than it did: it was well organised, it was well arranged, and there were plenty of interesting things to be seen on the stands. But somehow people seemed to know far less about it than was the case in previous years; in fact, I was asked several times both before and after August 24th whether or not there was going to be an Exhibition this year! Londoners, no doubt, knew all about it, for announcements were well in evidence there; but if the little country town in which I live is typical, not so much as usual was done to bring it to the notice of people in the outlying districts within easy reach of London. To give one instance, the wireless shops here didn't display the Exhibition poster, though they have done so in previous years. In those where I made enquiries I was told that they hadn't received it.

They Meant Business

If the crowds at Olympia were smaller than usual, there was no doubt that they had come with more serious intentions. They had come to see whether television was worth while, or whether the new receivers were so much better than their old ones that there were real reasons for making a change. The fact that a large proportion of them found convincing affirmative answers to both questions is shown by the good business that was done. Television rather tended to put ordinary wireless into the shade, but for all that there was wide interest in the new developments.

New Tuning Systems

PRESS-BUTTON tuning is going to be a success, though I doubt whether it will have such a spectacular career here as it has had in the United States. Listening conditions in the two countries are rather different. There must be few American towns of importance in which there are not two or three local broadcasting stations that are received at about the same strength. Hence once the manual volume control has been adjusted to produce the required sound level, a variety of entertainment can be received by touching buttons and doing nothing else. With us, the field strength of even the best foreign stations is in most places considerably below that of the locals, so that we have to adjust the volume control as well as touch a button when we change from one to the other. It's only a minor objection of course, and there are ways of overcoming it. I have used a good many push-button sets, and I must say that this method of tuning in quickly and cleanly any of a selection of stations is one that grows on you.

The D-X Aspect

Some have complained that less and less is being done by manufacturers for the listener who likes to be able to indulge when he feels so minded in the reception of distant stations both on the medium and on the short waves. Those who take this view are inclined to think that the introduction of press-button systems will eventually lead to listeners confining themselves to a mere handful of stations and never bothering their heads about others. I don't agree a bit. There were one or two sets fitted with buttons only and unprovided with tuning dials or tuning knobs; but in the majority of the button-tuned receivers you will notice that the manual tuning arrangements are distinctly good; often, in fact, they represent a marked improvement in their smoothness and in the absence of backlash. The long-distance man, too, has been well catered for by the introduction by many firms of large and sensitive receiving sets with specially good performance on the short waves. There were quite a number of sets on view which made one long to handle their controls on the medium-wave band in the small hours and at various times and seasons on the short waves. I am much looking forward to putting a selection of these through their paces on my own aerial.

A Big Improvement

ONE thing that impressed me very favourably at Olympia was that it wasn't half so hard as in some of the years gone by to get the technical information that you wanted about the products displayed. I had some rather biting things to say, I remember, this time last year about the off-handed ignorant and lackadaisical youngsters who populated some of the stands; this year I didn't come across one who stood with his hands in his pockets, puffing cigarette smoke into my face and letting loose a flow of patter that had been mugged up by heart. Instead, I found on every stand that I visited men who know all about the products of their firms, and were most willing to supply all the information that one wanted. On the E.M.I. Service stand there was a complete team of specialists, every one of whom was an expert in his own particular line. I had similar pleasant experiences at the stands devoted to valves, as well as at those displaying sets and component parts. I have

Broadcast Programmes—FEATURES OF THE WEEK

THURSDAY, SEPTEMBER 8th.

Nat., 7.30, Students' Songs: the B.B.C. Men's Chorus. 8, "George Edwardes"—The Guv'nor of Daly's biography. 9, Jack Payne and his Band.

Reg., 7, "The Dog's Chance"—Talk on the origin of breeds. 8, Promenade Concert. 9.5, "Jane Austen in the West." 9.40, Variety from Bristol.

Abroad.

Turin Group, 9.30, The International Festival of Contemporary Music from Venice.

FRIDAY, SEPTEMBER 9th.

Nat., 6.30, "The Amateur Handyman Out-of-doors"—Laying a Garden Path. 6.45, "Virginia," a musical comedy. 7.45, B.B.C. Ballroom with Alvin Saxon and his Band. 8.20, Promenade Concert, with the Grinke Trio. 10.5, "Up Against It."

Reg., 7, The Story of Flodden, talk by Col. G. F. T. Leather. 8, The Snake Charmers of Egypt—talk. 8.50, The Café Colette Orchestra. 9.30, "Tobermory Treasure"—the legend of the Spanish Galleon sunk near the Isle of Mull.

Abroad.

Strasbourg, 9.15, "I Pagliacci"—Opera (Leoncavallo).

SATURDAY, SEPTEMBER 10th.

Nat., 5, Henry Hall and his Orchestra. 8, "Money! Money! Money!" a horror play. 8.30, Sing-Song, including Bertha Willmott, Turner Layton and Ernest Butcher.

Reg., 6, "George Edwardes." 8 and 9.50, Promenade Concert, with Cyril Smith solo piano.

Abroad.

Paris (Eiffel Tower), 8, "Faust"—Opera (Gounod), conducted by Fourestier.

SUNDAY, SEPTEMBER 11th.

Nat., 1, Band of 2nd Bn. The Manchester Regiment. 3, Eugene Pini and his Tango Orchestra. 5, Digging up the Past, archaeological talk. 9.5, "Table Under the Tree," new musical series.

Reg., 6.15, Nina Milkina, pianoforte. 6.50, Medvedeff's Balalaika Orchestra. 7.15, "Home Again," Reginald Foort at the B.B.C. Theatre Organ. 9.5, Nova Pilbeam in Barrie's play "Mary Rose."

Abroad.

Rome Group, 9, "Nerone," tragic opera (Bioto).

Kalundborg, 10, Contemporary Swedish music.

MONDAY, SEPTEMBER 12th.

Nat., 7, Mr. and Mrs. Neemo "Still Here." 7.45, Arthur Sandford, pianoforte. 8, "Birth of a Hurricane"—talk. 8.15, Wagner Promenade Concert. 10.5, The Past Week.

Reg., 7, "Close to Earth"—talk. 8, Dave Frost and his Band. 8.30, Jeanne de Casalis in "Uncle Arthur," a moral fantasy for organ and voices. 9.45, Louis Levy presents "You Shall Have Music."

Abroad.

Radio Eireann, 7, Indian Music, with descriptive narrative.

Luxembourg, 10.5, Operetta music, including works by Gershwin and Strauss.

TUESDAY, SEPTEMBER 13th.

Nat., 6.30, Nova Pilbeam in "Mary Rose." 7.55, Ben Frankel and his Orchestra. 8.30, Seaside Nights—Llandudno.

Reg., 6.30, Reginald Foort at the B.B.C. Theatre Organ, with Alfredo Campoli, violin, in a special programme for hospitals. 8, Handel Promenade Concert. 9.45, Boxing Commentary—Doyle *v.* Phillips.

Abroad.

Strasbourg and Rennes, 8.30, From the Opéra-Comique.

Luxembourg, 9, Music-Hall from Paris.

WEDNESDAY, SEPTEMBER 14th.

Nat., 6.25, The Organ, the Dance Band, and Me. 7, Talk by Lynn Ungoed-Thomas on "The Young Persons' Employment Act, 1938." 7.20, Novelty Numbers by the B.B.C. Variety Orchestra. 8, Brahms Promenade Concert with Egon Petri, solo piano.

Reg., 8, Roy Fox and his Band from the Empire Exhibition. 8.30, "The Pig and Whistle," a truly rural episode with Charles Penrose. 9, "Advance in the Air," first of a series of aviation talks.

Abroad.

Paris PTT and Strasbourg, 8.30, Symphony Concert from the Vichy Casino.

Warsaw, 9.10, Twelve Chopin Preludes played by Turczinski.

been to every Exhibition since No. 1, and this is the first time that I have been able to pay this kind of compliment. May it be a good augury for the future!

It's a Long Way!

SOMETIMES I have wondered just how far one walks in the course of a comprehensive visit to the Exhibition. It must be a goodish number of miles. I always try to get a conspectus first of all by viewing the Show from the gallery, and then going downstairs and taking a path shaped like the windings of a frame aerial as shown in a circuit diagram. That is to say, I go first right round the outermost gangway; after that I take the one next inside and so on until I come to the middle. Then I walk round the National Hall, and this year there was the Television Studio to be taken in as well. That first rather rapid tour finished I go to the various stands I have noted from the catalogue as worth special attention, and finally I go to most of the others to make sure that I haven't missed anything. On the opening day I spent the best part of six hours on my feet, and I shouldn't be surprised if I covered ten miles or so! It would be interesting to take a pedometer and see what it has to say about it.

Will Television Catch On?

AFTER hanging fire as a hobby for a couple of years, television received a marvellous push in the right direction at Radiolympia. Is it now going to come into its own as a popular pastime? The signs seem to show that the corner has now been turned, and that the man in the street is ready to take television to his heart, and to give the televisor a place in his home. Possibly he held back in the past because television was then so new; he was afraid that, like so many new things, the original televisors would become obsolete almost as soon as they were installed. He has now seen that this didn't happen, and he has received the strongest possible assurances that it is not going to happen for a long time to come. He feels now that he can buy safely, and that whatever instrument he chooses will give him long service.

Were They There?

ONE hopes that some of the Americans who have had hard things to say about British television were present at this year's Exhibition. If they were they must have found plenty of reasons for revising some of the opinions that they have expressed. They couldn't help being struck by the excellence of the reproduction both of the images and of the accompanying sound, by the numbers of different instruments on view, or by the interest and by the enthusiasm shown by the throngs around the stands. I hope none of them ran away with the idea that the television transmissions were being received from the Alexandra Palace over a wire. I mention the point because I came across one or two people who thought they were. The co-axial cable was there right enough, but its use wasn't to bring impulses from A.P. to Olympia. What it did was to convey them from the studio in the National Hall to A.P., whence they were radiated and picked up in the normal way.

Overdoing It

One did hope that as the receiving sets on the stands were really working this time every care would be taken to see that they were giving of their best. Unfortunately not a few of them were simply being allowed to blow their heads off. You came across quite small sets with their volume control turned hard over, which were producing *with* distortion about ten times the volume of which they were capable without. Never have I heard more ghastly wireless noises than some of these poor overloaded receivers produced. Luckily there weren't a vast number that were being so badly treated; but those that were didn't exactly furnish the best of advertisements for that perfect reproduction of which their makers had a good deal to say in their catalogues. It wouldn't be a bad idea if the authorities imposed a hefty fine on any exhibitor who was caught overloading like that.

Body Capacity

FEW of us who used to cuss body capacity effects when we were attempting short-wave reception in the queer old days (you remember how your slightest movement would sometimes lose a signal altogether) realised then that the phenomenon which we found so annoying might have useful applications. It certainly has, and they seem to be growing. Some time ago we heard of a burglar alarm device which was operated, not by an infra-red ray beam and a photo-electric cell, but by the effects produced on an oscillating valve by the capacity of an approaching human body. Just the other day I heard that the principle was being applied successfully to automatic change-giving machines. The coin which the machine is testing before parting with the change passes through the anode coil of an oscillating valve. The adjustments are such that a coin of the wrong metal is instantly rejected. The principle is also being used, I believe, for counting objects at a very rapid rate in factories.

A Moving Question

SOON I shall have to give up my present house and find another. On one thing I am quite decided, though in most matters of this sort I give way to my better-half. I am jolly well going to have a house that isn't near a main road on which there is a constant stream of motor traffic. I want to be able to do my short-wave reception in peace, and to have television without snowstorms on the screen and crashes from the loud speaker. Unless we get that promised legislation soon you will probably find house-agents advertising freedom from radio interference as one of the attractions of those desirable residences in which they deal!

Spanning Distances

WHAT stupendous affairs the big American broadcast networks are nowadays. I have just been reading in *Radio News* an account of the N.B.C. chain, which, with its supplementary networks, extends right across the continent from New York to San Francisco. Not only that, but it goes on the east coast from Portland, Maine, in the north to Miami, Florida, in the south; in the Central regions from New Orleans on the Gulf of Mexico to Duluth near the Canadian border, and on the west from San Diego in California to Seattle and Spokane, which are just south of British Columbia. How many miles of land line are involved when it is doing a full relay I can't even guess, but the number must run into many thousands. There is also a radio link between San Francisco and Honolulu, 2,100 miles away. Think of the work involved in keeping these lines up to the mark for relaying purposes!

An Interesting Volume Control

MY recent paragraph on the lack of reliability which is a feature of so many volume controls prompted Messrs. Rocke International, Limited, to send me some interesting data about one of their volume controls and a sample, which I was invited to take to pieces. It is of American origin and is undoubtedly a very sound piece of work, although I haven't yet had a chance of putting it through its paces.

Television Programmes

An hour's special film transmission, intended for the industry only, will be given from 11 a.m. to 12 noon each week-day.

Sound	Vision
41.5 Mc/s	45 Mc/s

THURSDAY, SEPTEMBER 8th.

3, Stanelli's Bachelor Party. **3.30,** British Movietonews. **3.40,** 171st edition of Picture Page.

8, Promenade Concert (sound only). **9,** Cabaret. **9.30,** Gaumont-British News. **9.40,** 172nd edition of Picture Page. **10,** Interval Music. **10.25,** News.

FRIDAY, SEPTEMBER 9th.

3-4.15, "Winter Sunshine," the play by G. A. Thomas; cast includes Athene Seyler and Nicholas Hannen.

8, Promenade Concert (sound only). **9,** Speaking Personally: Raymond Gram Swing. **9.10,** British Movietonews. **9.20,** A review of songs from "The Mizzen Cross-Trees," "Powder and Pipeclay," and "Rogues' Gallery." **10,** Interval Music. **10.25,** News.

SATURDAY, SEPTEMBER 10th.

2.40, O.B. from Wapping of some of the activities of the River Police. **3-4,** "Gianni Schicchi," one-act opera (Puccini) with English text by Percy Pitt.

8, Promenade Concert (sound only). **9.5,** Cabaret. **9.35,** Gaumont-British News. **9.45,** "The Cab." A one-act comedy by John Taylor. **10.5,** Interval Music. **10.25,** News.

SUNDAY, SEPTEMBER 11th.

8.50, News. **9.5,** "The Bear," a jest in one act by Anton Tchekov. **9.25,** Film—"A Trip to the Villa d'Este." **9.35,** Pouishnoff, pianoforte. **9.50,** Cartoon film. **9.55-10.15,** Definition Bee; in which sides will compete for the accurate definition of words proposed by the "Bee" master.

MONDAY, SEPTEMBER 12th.

3-4.15, Feature Film: Maurice Chevalier in "Man of the Moment."

8, Promenade Concert (sound only). **9,** "The Romantic Young Lady," a comedy by Martinez Sierra. **10,** Interval Music. **10.25,** News.

TUESDAY, SEPTEMBER 13th.

3-4.15, "These Our Daughters," a comedy by Charles Terrot.

8, Promenade Concert (sound only). **9,** Revue. **9.15,** Feature Film: Maurice Chevalier in "Man of the Moment." **10.50,** News.

WEDNESDAY, SEPTEMBER 14th.

3, British Movietonews. **3.10,** Cabaret. **3.55,** Cartoon Film.

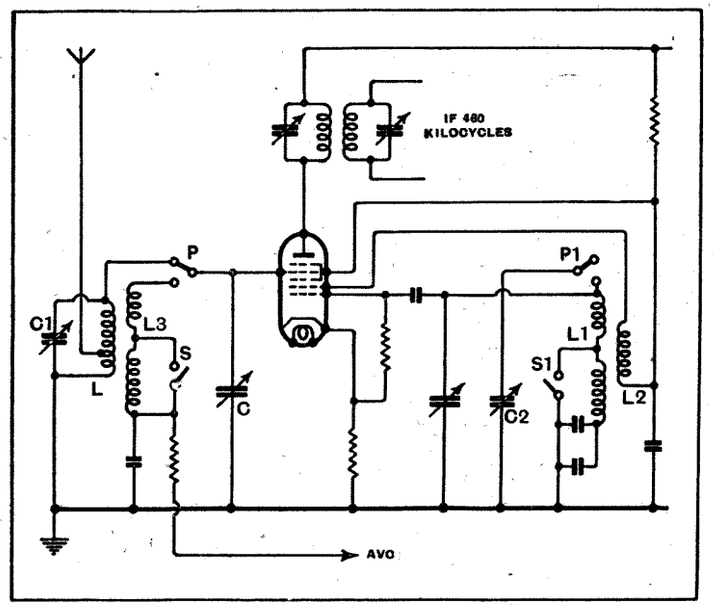
8, Promenade Concert (sound only). **9,** "La Serva Padrona," opera by Pergolesi, arranged by Hyam Greenbaum. **9.35,** Gaumont-British News. **9.45,** Talk. **9.55,** Cartoon Film. **10,** John Carr's Jacquard Puppets. **10.10,** Interval Music. **10.25,** News.

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

PUSH-BUTTON TUNING

THE invention provides a simple push-button selection of the two most-frequently-used stations in any given locality. In the London district, for instance, the obvious choice would be between the National and Regional programmes. The simplified control depends upon the fact that the sum of the carrier and local-oscillator frequencies is arranged to produce the fixed intermediate frequency in one case, whilst the difference between the carrier and local oscillator is used in the other case.



Method of employing push-button tuning for two local stations.

As shown in the Figure, the push-button switches P and P1 are interlocked so that both must be either up or down. In the position shown, the Regional programme is tuned in by the coil L and condenser C. This signal frequency when added to the local oscillations produced by the back-coupled coils L1, L2, produce the fixed IF of 460 kc/s. When P and P1 are pushed downwards, the long-wave station is tuned in by the pre-set condenser C1 in combination with the coils L, L3. Simultaneously a pre-set condenser C2 is inserted across the local-oscillator coils L1, so that a "difference" frequency of 460 kc/s is produced and fed to the fixed IF circuits. Ganged switches S, S1 introduce the loading coils for the long-wave setting.

E. K. Cole, Ltd., and A. W. Martin. Application date February 17th, 1937. No. 485890.

o o o o

TELEVISION RECEIVERS

TO reduce the number of valves in circuit, the one usually employed for separating the synchronising impulses from the picture signals is omitted, so that the output from the demodulator D, in the figure (a) is fed directly to the time-base circuits TB for generating the line and frame scanning voltages respectively.

One of the time-base circuits is shown separately in the figure (b). The grid G of the discharging valve V is normally biased to cut-off by a battery B, whilst the condenser C is being charged up through a resistance R. The output from the demodulator D is applied to the grid of the valve V in such phase that the synchronising impulses are positive and the picture-signals negative. The latter therefore have no effect, though the arrival of a positive synchronising impulse allows the valve V to conduct and so discharge the condenser C. The resulting saw-toothed oscillation is fed to the deflecting plates P of the cathode-ray tube.

W. E. Benham. Application date October 21st, 1936. No. 485653.

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HIGH FREQUENCY "LINES"

A "DIELECTRIC GUIDE" capable of transmitting centimetre waves, without attenuation, consists of a hollow metal jacket or tube which may contain free air or gas, the internal diameter of the tube being approximately equal to the transmitted wavelength. The tube may be filled with solid insulating material instead of air, or with stranded cords of non-conducting material.

The RF energy is transmitted along the length of the "guide" as a displacement wave, and not as a go-and-return current, the waves being polarized axially or radially along the guide.

Siemens and Halske, Ltd. Convention date (Germany), December 24th, 1935. No. 485948.

o o o o

ELECTRON MULTIPLIERS

THE electron multiplier is widely used for generating oscillations of medium frequency. For very high frequencies, however, the internal capacity of the "target" or secondary emission electrodes is found to be a handicap. In addition, the "transit time" of the electrons, that is, the time taken for them to pass from one electrode to the next, must be kept within allowable limits, having regard to the frequency to be generated.

According to the invention, both difficulties are overcome by using a valve of the split-anode magnetron type, and arranging the secondary-emission or target electrodes so that the primary electron stream strikes against them at an acute angle. The electrons emitted from the cathode of the valve are forced by an external magnetic field to travel in a spiral path, inside a pair of semi-cylindrical anodes. The "target" electrodes are placed at each end of the semi-cylindrical anodes, at right angles to the axis of the spiral path along which the primary electrons move, so that the impact is tangential.

Marconi's Wireless Telegraph Co., Ltd. (assignees of E. G. Linder). Convention date (U.S.A.), November 30th, 1935. No. 485672.

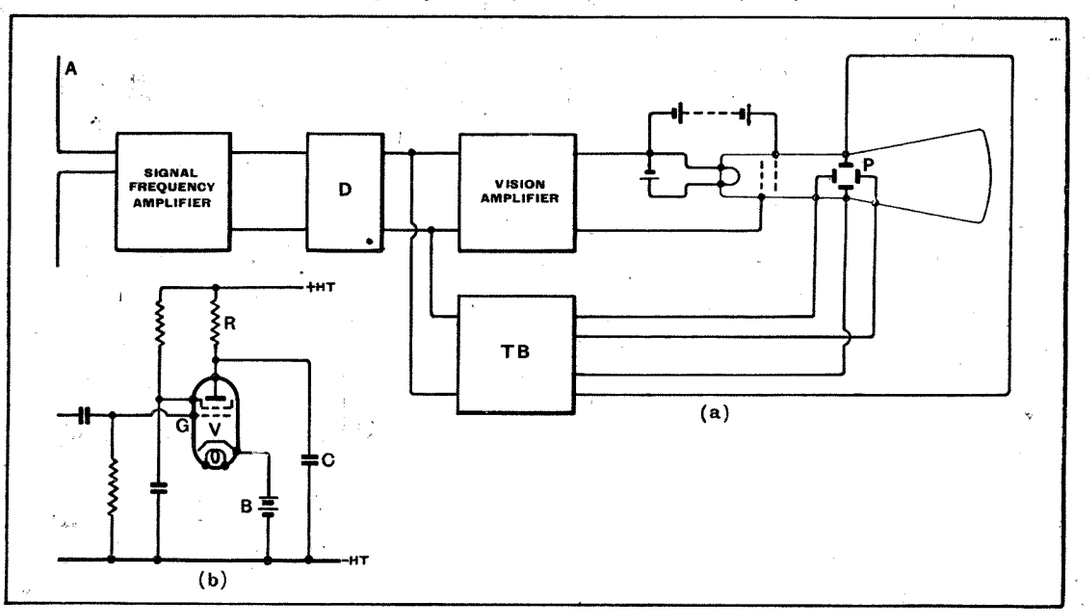
o o o o

AIRCRAFT WIRELESS

DIFFICULTIES arise in fitting an all-metal aeroplane with the usual frame aerial used for direction-finding. It is undesirable to mount the aerial outside, because of the extra air-resistance, whilst the interior of the cabin is almost completely screened by the metal walls.

According to the invention, the windings of a frame aerial are arranged inside the cabin, but fairly close to, and parallel with the sides of the glass or celluloid window of the cabin, where the screening or damping effect of the metal walls is at a minimum. When used with a radio compass, for "homing," the "drift" effect caused by a side-wind is compensated by inserting a reactance at one end of the frame winding. This produces the same effect as rotating the aerial through a small angle "into the wind."

V. I. Bashenoff. Application date November 25th, 1936. No. 486084.



Schematic arrangement of television receiver in which sync separating stage is omitted is shown at (a) while (b) gives details of the time-base circuit employed.

The Wireless World

THE PRACTICAL RADIO JOURNAL

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EDITORIAL COMMENT

Television Finance

A Problem Not Yet Solved

B.B.C. revenue to meet the cost of stations, staff and programmes is derived from two sources—a share of the Post Office receipts as fees for receiving licences and the profit from the programme and other publications of the Corporation. Ever since broadcasting started in this country there has been a very substantial increase in these sources of revenue year by year, but at last there are signs that the number of licences taken out has nearly reached a maximum, so that, looking to the future, we must not expect an increase of revenue from this source, and it is even possible that if interest in broadcasting should decline the revenue may actually show a reduction. With regard to the revenue from publications, the B.B.C. stated in the current issue of their annual Handbook that, "Owing to a general rise in the price of paper and other costs it may not in future be possible, in spite of increasing circulations, to secure an equally favourable result from publications."

Revenue Stationary

There would be no occasion for real anxiety in the matter of financing the B.B.C. organisation if we could feel satisfied that stability in expenditure was being reached at the same time as stability in revenue ; but, just as the time is approaching when sources of revenue seem more likely to show signs of curtailment than expansion, television has come along to demand a very heavy additional drain on B.B.C. financial resources. How heavy the demand of television in this respect may be it is difficult to foresee at this stage, but it does not require much imagination to realise that television programme costs are likely to be considerably greater than those of sound broadcasting programmes for an equivalent number of broadcasting hours. The distribution of television when many stations are eventually set up to cover the country on a national scale will be, undoubtedly, much more costly than the distribution of sound programmes where simultaneous broadcasting is employed ; and to conduct separate television programmes at each television station or even at groups of television stations, must prove vastly more expensive than in the case of sound distribution, if only by reason of the fact that to cover the whole country a much larger number of short-wave stations for television will have to be set up.

Rejected Proposals

All kinds of suggestions have from time to time been put up as possible solutions for this problem of financing television. Sponsored television programmes have been proposed, but firmly rejected by a Government Committee, and so also has the alternative suggestion of an additional licence for television ; which, in any case, would produce only a comparatively small revenue for some time to come. It has even been suggested that the ratepayer should contribute.

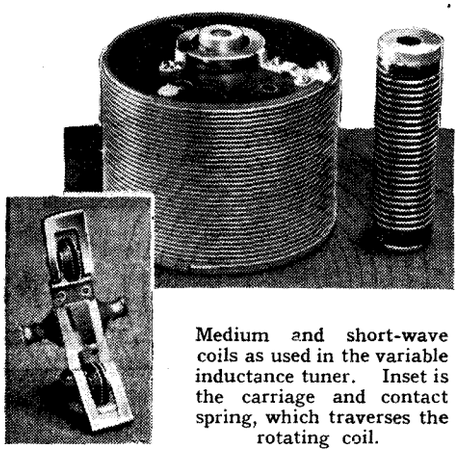
Already it would seem that expenditure on television has necessitated some fairly drastic economies on sound broadcasting programmes. This form of economy is hardly likely to be well received by the majority of listeners, especially those who at present have no prospect of benefiting from a television service.

The more this problem is studied the more difficult it seems to be of a satisfactory solution. Yet every day finds the B.B.C. and the radio industry more deeply committed to seeing television through. This determination is no doubt evidence of a healthy optimism, but we should, ourselves, feel far more satisfied with the outlook if the growth of television brought with it a growth in revenue sufficient to cope with the financial demands of the new service, without impairing the existing service of sound broadcasting.

Variable Inductance Tuning

A SUCCESSOR TO THE VARIOMETER

By WILLIAM N. WEEDEN



Medium and short-wave coils as used in the variable inductance tuner. Inset is the carriage and contact spring, which traverses the rotating coil.

TUNING by means of a continuously variable inductance (as opposed to a variable condenser) is not new; a device of this nature was described in "The Wireless World" over ten years ago. However, it is of interest that a modernised version has now been developed in America to comply with present-day requirements for broadcast reception and other purposes.

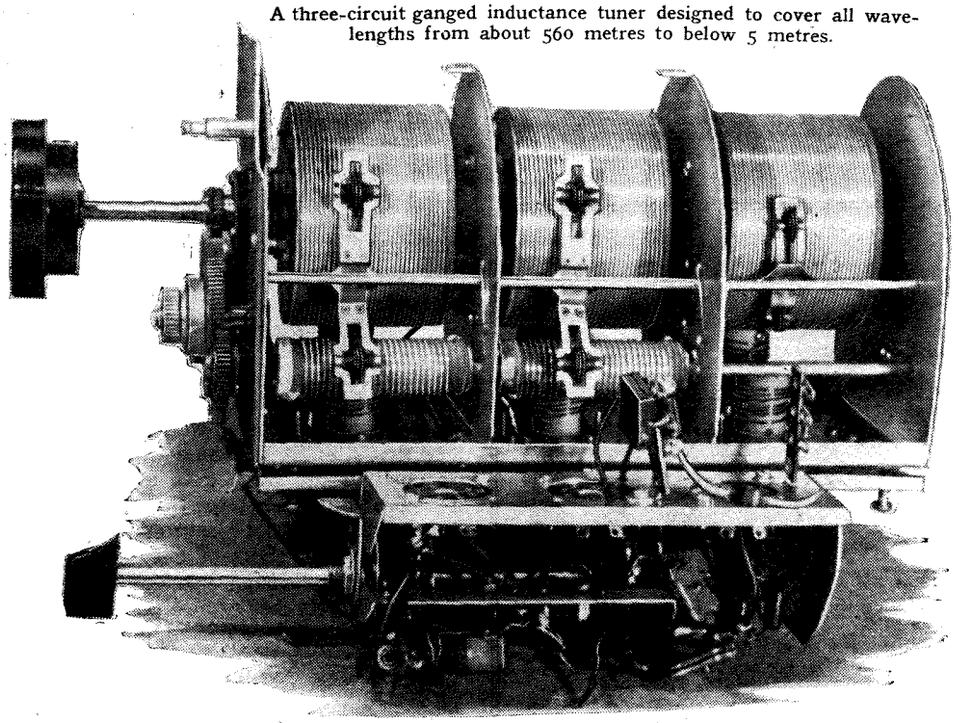
FEW of us have been entirely satisfied with the conventional tuned circuit in which variations in frequency are brought about by changes in capacity. In such circuits changes in gain and selectivity with variation in frequency render the task of the receiver designer very difficult, while the user of these receivers does not enjoy the necessity for hair-line tuning at the high and ultra-high frequencies. Also, the fact that with condenser-tuned circuits tuning becomes increasingly critical with decreasing wavelength limits the use of push-button selectors to the broadcast band—even with the use of AFC. The limitation of the frequency ratio to three to one with condenser-tuned circuits requires the use of a number of bands in all-wave receivers, with increased cost of manufacture, difficulty of alignment and added complication to the user. One last indictment against our old friend the variable condenser lies in its tendency to cause microphonic oscillations when employed in the oscillator circuit of a selective high-frequency superheterodyne.

Early Attempts

While a great deal of ingenuity has been exercised in the development of complex circuits to minimise changes in gain and selectivity, and in the design of ingenious mechanical and electrical "band spread" tuning systems to simplify tuning at the higher frequencies, few engineers have seriously attempted to solve *all* of these problems by the elimination of the variable condenser as the tuning element. Although a few abortive attempts have been made to use the variometer, tuning coil with sliders, or even the winding of bare wire from an insulating to a metallic drum or roller in an effort to reap the many advantages coincident with the use of variable inductance as the frequency changing element, little success was achieved until Mr. Paul Ware, one of America's most resourceful radio engineers, recently demonstrated a thoroughly successful and practical inductive tuner.

Shortly after conceiving the idea of this tuner, Mr. Ware realised that its success would depend in large measure on the metallurgist's ability to furnish wire, contact shoes and collector rings which would neither oxidise nor wear unduly during a normal life. Of perhaps even greater importance was the necessity for freedom from corrosion during lengthy periods of idleness. For these reasons, Mr. Ware took his embryonic tuner to P. R. Mallory and Co., Inc. (an American firm specialising in the design and manufacture of all sorts of contacts in rare metals and alloys).

A three-circuit ganged inductance tuner designed to cover all wavelengths from about 560 metres to below 5 metres.



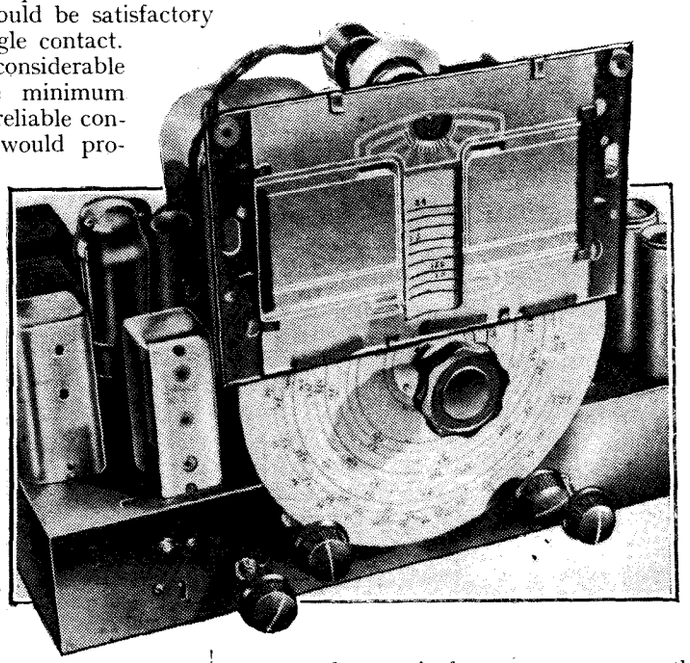
In describing the Ware Inductive Tuner, its mechanical design will first be described. This variable inductance is formed by winding a threaded bakelite former with bare hard-silver-plated, hard-drawn copper wire on which a phosphor bronze contactor slides in much the manner of the stylus on an old-style phonograph.

Traversing the Winding

This springy contactor is mounted on a carriage or trolley arranged to slide along the side of the coil in a direction or plane parallel to the coil axis. On this carriage is mounted the split bronze contact spring, mounted directly between the two grooved bakelite trolley wheels which "ride" the turns of the inductance as it is rotated, drawing the carriage along so that the bronze spring remains in firm contact with the inductance from end to end. The carriage assembly is compressed between the overhead guide rod and the coil former, the spring taking up any eccentricities. The design of this trolley assembly reduces to a minimum the

Variable Inductance Tuning—

wear on both wire and contact, while the bifurcated contact spring permits the use of much lower contact pressure for a reliable contact than would be satisfactory with any form of single contact. This design provides considerable latitude between the minimum pressure required for reliable contact and that which would produce excessive wear. Life tests indicate a mechanical life for these variable inductances of at least 30,000 complete round trips. Of great importance was the test for noise when the inductances had been out of service for a protracted period. Observations made at intervals of two months over a period of a year indicate that there is no reason to expect noise to develop.



Chassis of a receiver employing inductance tuning. Note the spiral indicating scales.

It will be evident that, for each turn of wire on the coil former, 360 degrees of rotation will be required, which with 30 to 50 turns gives from 60 to 100 times the angular movement available with the variable condenser. Thus tuning at high frequencies is accomplished more easily than on the broadcast band operation with many of our present receivers, and without the backlash, "slip" or "stickiness" present in some slow-motion dial drives. In view of the rapidly increasing use of, and interest in, the ultra-high frequency band in connection with television, *real* high quality broadcasting, etc., the ease of tuning at these frequencies afforded by the Ware tuner should be of great value in popularising these new services. Also, the application of motor-driven push-button control to the inductive tuner is both possible and practicable, and affords on the ultra-high frequencies at least the accuracy obtainable from our present-day tuners on the broadcast bands.

No Condenser-Vane Microphony

The last of the mechanical advantages afforded by the new tuner is its complete freedom from microphonics, even at the highest frequencies and under the most difficult acoustic conditions. This advantage alone will save the set designer from many untimely grey hairs!

The writer has spent much space and time in describing the properties of the new tuner at high frequencies, as he feels that increasing use of the higher frequencies will direct attention towards the many advantages offered exclusively by the inductive tuner.

While the conventional circuit tuned by a variable condenser provides a maximum range of 3 to 1 in frequency coverage, the Ware tuner affords a range of 10 to 1. The increased frequency coverage of the inductive tuner over that of the condenser tuned circuit is due to two factors. First, that it is possible to reduce the LC product of the inductance tuned circuit to a lower value than that inherent in the condensed tuned circuit, where the LC product minimum is limited by the minimum capacity of the variable condenser plus the stray circuit capacities. Secondly, the lower frequency end may be extended by increasing the number of turns comprising the variable inductance, provided that the natural frequency of the unused part remains outside the operating range. With this three-to-one improvement in frequency coverage, the problem of band switching should be greatly simplified.

Ganged Multi-Range Units

An accompanying illustration shows a tuner covering all frequencies from 540 kc/s to 65 Mc/s. It will be seen that two sets of rotating coils are employed, each being driven by a separate gear train (visible at the left) in such a manner that their relative speeds are inversely proportional to their winding pitches. While both the first and second compartments (from the left or front of the tuner) contain broadcast and high-frequency coils, the third compartment contains only the broadcast coil as no radio-frequency amplification is employed in this particular model at the high frequencies.

The long primary motion of this inductive tuner enables the use of "spread out" dial scales, and another photograph shows the dial with its three parallel *spiral* scales, each about five feet in effective length with a dial of 10in. diameter. The proper scale only is illuminated by the switching of dial lights by the wave-band switch, the dial light being raised or lowered by the operation of the drive shaft so that the light behind the dial travels from end to end of the spiral scale as the trolley contactor travels from one end of the coil to the other.

Electrical Features

Having discussed both mechanical and operating features of the tuner at some length, its electrical description will now follow. Electrically, a simple variable coil with a suitable maximum inductance and a fixed value of associated capacity will operate from a low radio-frequency limit determined only by what is considered an acceptable average impedance up to a frequency near the natural period of the unused portion (dead end) of the coil. With cylindrical coils of acceptable broadcast gain, this natural frequency may lie between 20 and 50 megacycles, depending largely on its diameter. The broadcast band gain and step-up increase with inductance and decreasing fixed capacity. Fig. 1 gives the relation between natural frequency and used-unused turns for a 2.5in. diameter coil of 24.5 turns.

While working on the circuit applications of his new tuner, Mr. Ware soon found that the use of a separate coil of low inductance and high Q connected in series with, but not coupled to, the variable inductance, greatly improved the high frequency performance of the tuning system as compared to the use of an equivalent mechanically "stopped off" portion of the variable inductance. Of course, considerable absorption takes place if the circuit is tuned through the natural frequency of the unused portion of the variable coil, due to the coupling between the used and unused portions. The mutual inductance between even a fraction of a turn and the remainder of the coil is sufficient to cause absorption. Earthing the unused end of the coil raises

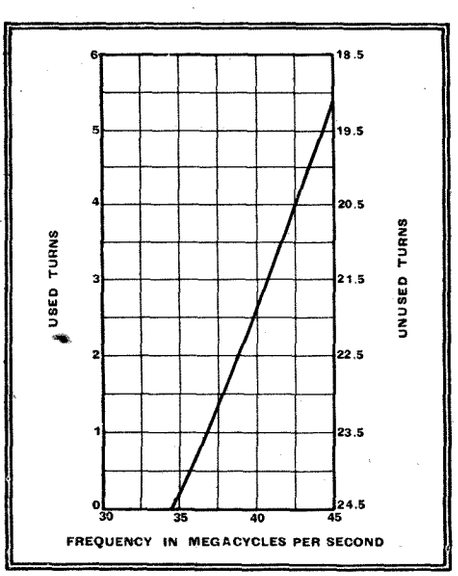


Fig. 1. The natural frequency of a coil for various numbers of turns in the "live" and "dead end" portions.

Variable Inductance Tuning—

its natural frequency, and in practice these coils are constructed with their unused ends earthed to the shaft. The broadcast band performance is slightly better with the "unused" end free, but in multi-range receivers it is necessary to ground this unused end as the high-frequency ranges are otherwise inoperative.

Improving "Q"

The importance of the "end" inductance is shown graphically in Fig. 2, wherein the variable inductance is a 2in. coil of 53 turns of No. 22 wire, 3.4in. in length, which is made to cover a frequency range of 540 kc/s to 18 Mc/s in two bands by switching both the end inductance and fixed capacity. This figure gives Q as a function of frequency with and without the fixed end inductance. The improvement in Q due to the use of the end inductance tends to produce uniform impedance over a relatively wide frequency range in each band. This feature is particularly valuable in superheterodyne input circuits as the increased Q tends to maintain a good image ratio at the high-frequency end of each range, where with condenser-tuned circuits it would normally be poor.

The inherent high-Q, low impedance characteristic of the Ware circuits in the broadcast band suggests their use in high quality local TRF receivers, as their tuned impedance of 10,000 to 20,000 ohms should not be seriously impaired when shunted by the low input resistance of a diode detector. The stability of such a receiver should be considerably greater than that of a condenser-tuned circuit of equivalent gain.

While the new tuner has a great deal to offer the designer of TRF receivers, its principal application will, of course, be to the superheterodyne, so a few words on inductively tuned oscillator circuits and their tracking problems should not be amiss. Fig. 3(a) represents the conventional RF tuning circuit (*b*) is the usual condenser tuned oscillator circuit normally used with (*a*). Circuits (*c*) and (*d*) respectively are the inductively tuned equivalents of (*a*) and (*b*). It will be noted that the series padding condenser C*p* of (*b*) is replaced by the shunt inductance L*s* in (*d*); while the high-frequency adjustment for circuit (*b*) is the condenser C*t* shunted across the tuning condenser, circuit (*d*) employs the variable end-coil L*x*. Circuits (*c*) and (*d*) will produce a similar three-point tracking characteristic to that commonly achieved by circuits (*a*) and (*b*).

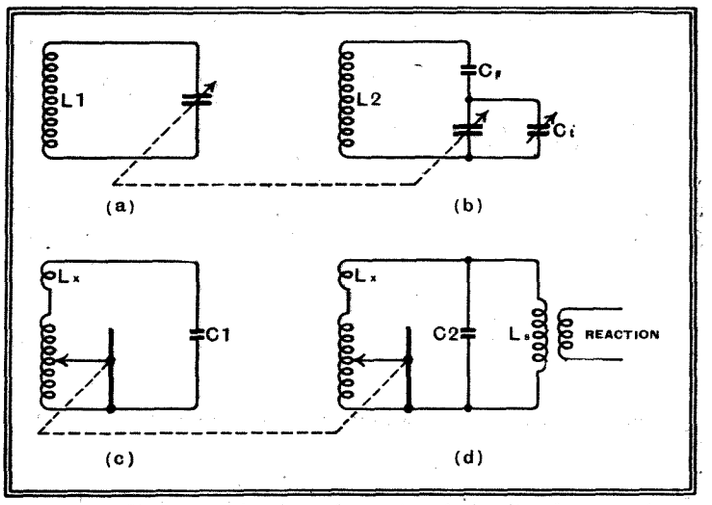


Fig. 3. The conventional condenser-tuned circuits of a superhet frequency changer (a — b) compared with the variable inductance method (c — d).

The actual oscillator circuit differs but little from that used with condenser-tuned circuits, magnetically coupled feedback proving very satisfactory. The reaction coil may be coupled to the end coil, variable coil or shunt coil; or it may be distributed between two or three of these components as desired. Such an oscillator employing the inductance tuner will perform very smoothly at high frequencies, due both to the impedance/frequency characteristic of this tuner, and to the change of coupling or mutual inductance between reaction coil and variable coil affected by changing its inductance, if the reaction coil is coupled in part, at least, to the main inductance. These effects tend to insure a reasonably constant output voltage over a frequency range of ten to one.

The Ware tuner has also been successfully applied in an all-wave signal generator covering a frequency range from 90 kc/s to 35 Mc/s in three bands only. It would seem that inductance tuning may be of great value in the laboratory on account of its uniformity of output, length of dial scale and simplified band switching.

To return to the problem of tracking in the superheterodyne, it should be pointed out that the deviations encountered between the usual three exact tracking points will increase with frequency coverage—in both inductive and capacitive tuned circuits systems. Also, for equal tuning ranges, the error in tracking will increase as the frequency range is moved toward the intermediate frequency. However, means have been devised whereby the tracking of inductance-tuned circuits covering a large frequency range may be greatly improved.

In conclusion, the writer wishes to thank Mr. Ware for his courtesy and co-operation in the preparation of this paper, and the Institute of Radio Engineers for permission to use photographs and drawings.

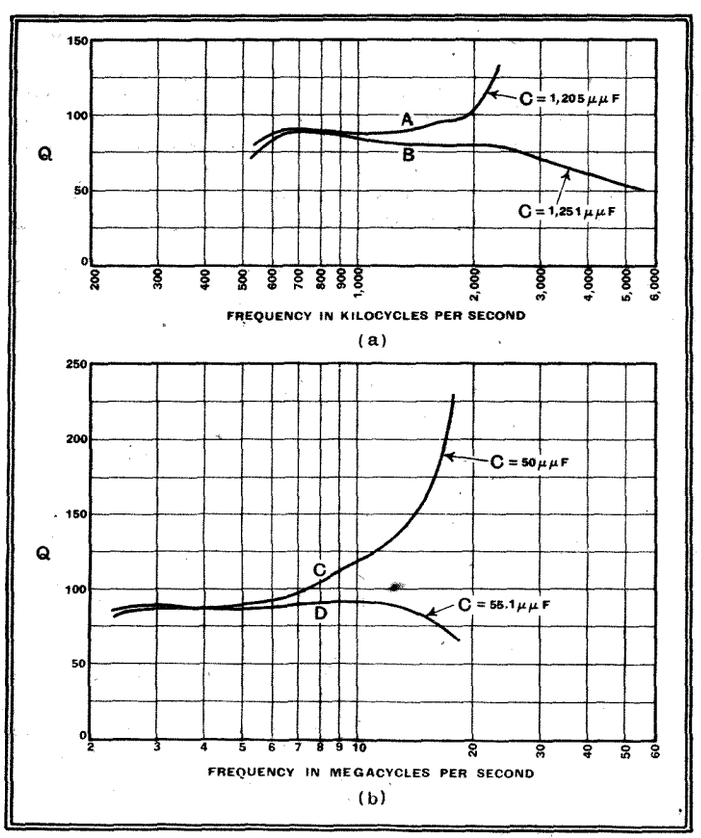


Fig. 2. Showing the improvement in "Q" at various frequencies resulting from the insertion of a fixed coil in series with the variable inductance. Curves A and C relate to circuits with loading inductances on medium and short waves respectively; curves B and D to unloaded coils. Parallel tuning capacity values are shown.

Books Received

A Simple Guide to Television, by Sydney A. Moseley and H. J. Barton Chapple. An outline of the history and general principles of transmission and reception of television, followed by a description of modern equipment and methods. Pp. 43 with 13 photographs and explanatory drawings. Sir Isaac Pitman and Sons, Parker Street, Kingsway, London, W.C.2. Price 1s. net.

Questions and Answers in Telegraphy and Telephony, by W. S. Procter, A.M.I.E.E. Written for students in preliminary, intermediate and final grades. The questions cover both practical and theoretical subjects; automatic telephony is also treated. Pp. 205, with many illustrations and diagrams. Sir Isaac Pitman and Sons (address above). Price 6s. net.

Tone Control—IS NOT MERELY A QUACK REMEDY FOR POOR QUALITY

ATTEMPTS to provide oneself with a really comprehensive tone control are often disappointing. This article explains why.

By "CATHODE RAY"

HAVING, as I thought, had something to say about all the controls that are likely or unlikely to be found in modern sets, I was quite surprised on turning over my last four years' pages to find nothing with the above title. This is merely an oversight, now to be remedied; not evidence that I don't believe in tone control.

There are some who would deal as tersely with the subject as the celebrated advice to those about to marry: "Don't!" So perhaps it is necessary first of all to give reasons why tone ever should be controlled. "*My* aim is to reproduce the original faithfully, so all my amplifiers and things are as nearly as possible 'straight line' and there is never any need for tone control," says one school of quality enthusiasts. That is all right, if one assumes a whole lot of things that actually belong mainly to the realms of pure imagination. The "straight line" policy breaks down when:

1. *The balance of tone of the original, due perhaps to the acoustics of the situation, is unpleasing.* Tone control then improves on what the direct listener can hear.

2. *There is imperfection in the apparatus outside the enthusiast's control*—the effects of bad telephone lines, interference, noise, record scratch, can all be mitigated by tone control. The enthusiast's own equipment, especially the loud speaker, is *of course* perfect!

3. *Listening is done in a room or any place having acoustics of its own.* It is seldom realised how the listening room plays "ducks and drakes" with the "straight line" reproduction. The enthusiast who is horrified by a 1-db. irregularity in his graph cheerfully tolerates a 10-db. lump or hollow due to his room, just because, like the ostrich with its head in the sand, he can't *see* it.

4. *The intensity of sound at the ear of the listener is not exactly the same as it would be if he were present at the original performance* ("Scale Distortion"). In practice, to ensure that it *is* always the same is difficult, inconvenient, or even impossible. In the home it necessitates constant attention to the volume control. And in public address applications the essence of the thing is reproduction of the voice at an intensity which, if it could be achieved at all by the unaided human throat, would demand a considerable rise in pitch. Even perfect apparatus makes magnified speech sound too low and quietened music sound too thin.

5. *Gramophone records are played.* Owing to well-known limitations of the recording process, a note of 50 c/s frequency is recorded at only one-fifth of the proper strength, or a loss of 15-db.

Another Possibility

And, if the enthusiast is broadminded enough to admit that, after all, his apparatus *may* depart just a *leetle* from the path of perfect rectitude, there is further scope for tone control. Granted, then, that tone control is not a quack nostrum, what is the best way to do it?

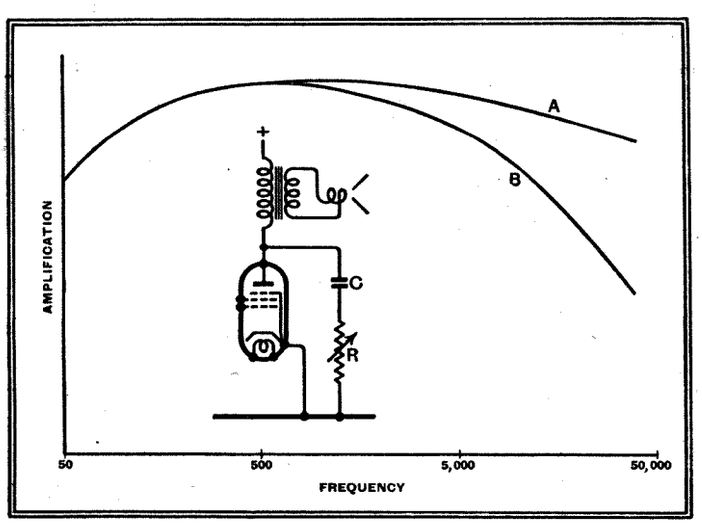


Fig. 1.—The common commercial "tone control." Reducing R cuts down the high tones from A to B.

It has been said that the common or commercial tone control operates on the principle of adding to a scanty helping of meat by throwing away some of the potato. It consists of a condenser in the anode circuit of the output valve, usually varied by means of a rheostat in series with it, whereby the top notes are progressively whittled away (Fig. 1). And so it sounds nice and "mellow" (really woolly) and lets the general public say, "Just listen to the bass!"

The listener who is intelligently aiming at good reproduction soon realises that this doesn't increase true bass one iota; it is no good for correcting gramophone recordings, for example. Something is wanted that really boosts the bass to a substantial degree—15-db., or a five-fold increase is needed for restoring it to levelness, let alone for making good any deficiencies in the loud speaker or elsewhere. Then in a selective radio receiver a certain amount of top boost is wanted to level that end up. At the same time the very highest frequencies may have to be reduced in order to remove heterodyne whistle. For rendering speech easily intelligible when it is reproduced perhaps more than life-size by a selective and therefore bass-heavy receiver it is a great advantage to be able to cut the bass. And for removing the worst of scratches, crackles, hisses, and whistles, though at some sacrifice of quality, top cut is useful. A combination of bass cut and treble cut is helpful for clearing up speech received from very weak stations, and for special purposes, such as correcting loud-speaker resonances, appropriate tone correctors can be arranged. Fig. 2 shows a selection of the most useful characteristics. It is seen then that the tone control of commerce hardly begins the job.

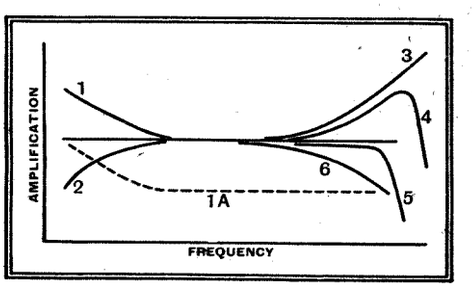


Fig. 2.—Examples of useful tone control characteristics: (1) bass boost, (2) bass cut, (3) top boost, (4) ditto with cut-off to remove whistles, etc., (5) whistle (or scratch) cut-off, (6) top cut. Unless there is amplification in hand for boosting, it can only be obtained at the expense of general volume, as at (1A).

Extra Amplification Needed

The first point that strikes one on looking at Fig. 2 is that considerable hidden reserves of amplification must be provided. If one were to try to get a characteristic such as (1) by carving away all except the extreme bass, and in (1A), it would be more of a volume control than a tone control. For a five-fold boost at any particular frequency (taking that as an example for the sake of argument) it is necessary to provide at least five times the normal amplification. Actually, as we shall soon see, it is necessary to provide a good deal more than that.

Now there are innumerable possible ways of tone controlling, but the most generally effective and easy to work out

Tone Control—

to give the desired results is the one that depends on using an intervalve coupling with an impedance that varies with frequency. The merit of *resistance* coupling in the eyes (or ears) of the quality merchant is that resistance is practically the same at all frequencies concerned. Hence the "straight line," and so forth. But if a condenser is used in place of the resistance (some special arrangements have to be made to pass the HT current to the valve), the impedance—and hence the amplification—increases as the frequency decreases, giving a bass lift. To prevent it from keeping on reducing in the opposite direction—the treble end—a resistance is put in series, so that when the impedance of the condenser becomes negligible the resistance takes charge and keeps the curve level from there to the upper end of the frequency scale. Fig. 3 illustrates this.

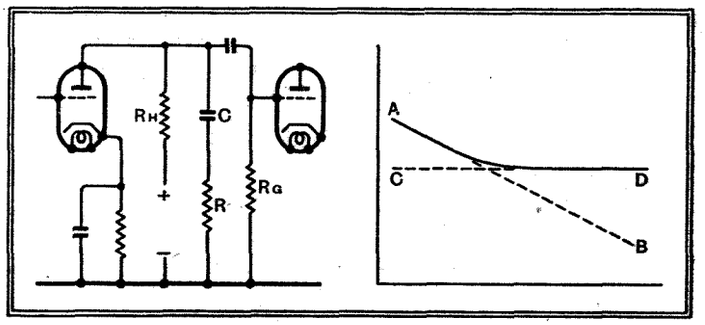


Fig. 3.—**An ordinary resistance-coupled stage with the addition of C and R having between them a much lower impedance than RH and RG, which are required merely to keep the valve anode and grid at the correct voltages. At very low frequencies, C has most of the impedance, and the amplification is relatively high. It is prevented from falling off continuously at the high frequencies by R, which gives the same impedance at all frequencies. AB is the characteristic with C alone ; CD with R alone ; and AD with both as shown. The other condenser in the circuit diagram is supposed to have such a large capacity that its impedance is too low to affect the results.**

In a sequel I shall give a practical example or two that will (I hope) make clear how to choose values of components for getting specified results ; but accepting the general principle of varying the amplification at different frequencies by using a varying-impedance intervalve coupling, another important point occurs

Coupling Impedance Values

There is a limit to the amplification that can be got out of a valve by increasing the coupling impedance. Suppose the valve has an amplification factor (μ) of 30 and a resistance of 10,000 ohms. Then, if the coupling impedance is also 10,000 ohms, half the μ is wasted in the valve, leaving a net amplification of 15. Now suppose you increase the coupling impedance five-fold, to 50,000 ohms, do you get an amplication of 75? Obviously not, for the valve has only 30 to give. Actually you get $\frac{30 \times 50,000}{50,000 + 10,000}$, or 25 ; less than double. If you started off with a much lower impedance, say 1,000 ohms, your initial amplification would be only $\frac{30 \times 1,000}{1,000 + 10,000}$, which is about $2\frac{3}{4}$; but increasing the impedance five-fold gives 10, or nearly a four-fold rise. It follows that to get effective tone control by this method the coupling impedance must be much less than the valve's own impedance. This is contrary to the well-known rule that to avoid amplitude distortion due to the curvedness of the valve's characteristics the anode circuit should have a resistance several times as great as the valve's own resistance. Worse still, owing to the very low amplification of a valve with a small coupling impedance, one is tempted to increase the input signal in order to keep up the required volume, so greatly increasing the likelihood of distortion. One can't even use negative feedback to fight this distortion, because negative feedback tries to iron out the boosts and cuts that one has just taken great trouble to get!

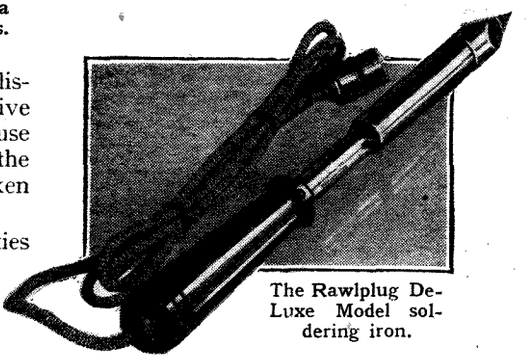
The only solution to these difficulties is to do the tone controlling at a very low signal strength, and not to count on the tone control stage to amplify very much but rather just to pass on the general level more or less unchanged, and to amplify only those frequencies that need special correction. All this assumes a considerable amount of tone correction ; if only minor adjustments are needed the design can be more like an ordinary stage of amplification.

Having agreed that even the quality enthusiast can do with tone control if it is the genuine article, and having got out of one's head the idea that a genuine tone control can be made by tacking a few condensers and things on to existing stages of amplification, we are ready to look at some practical circuits in the next article.

Rawlplug Soldering Iron

A NEW electric soldering iron has been produced by The Rawlplug Co., Ltd., of Rawlplug House, London, S.W.7. It is known as the De-Luxe Model and is priced at 9s. 6d.

It has a copper bit some 2in. long and measuring an inch in diameter at its widest point. It is, therefore, large enough to retain the heat necessary for the soldering of more than small parts and there should be few ordinary jobs which cannot be successfully tackled with its aid.



The Rawlplug De-Luxe Model soldering iron.

The model submitted for test was rated at 220-230 volts, but the iron can be obtained in a variety of ratings. On test the iron proved in every way satisfactory.

Television Programmes

An hour's special film transmission, intended for the industry only, will be given from 11 a.m. to 12 noon each week-day except Monday.

Sound	Vision
41.5 Mc/s	45 Mc/s

THURSDAY, SEPTEMBER 15th.

3, Cabaret. **3.30,** Gaumont-British News. **3.40,** 173rd edition of Picture Page.

8, Promenade Concert (sound only). **9,** Cabaret. **9.30,** British Movietonews. **9.40,** 174th edition of Picture Page. **10,** Interval Music. **10.25,** News.

FRIDAY, SEPTEMBER 16th.

3, "La Serva Padrona," one-act opera by Pergolesi, arranged by Hyam Greenbaum. **3.35,** British Movietonews. **3.45-4.5,** "The Bear," a one-act jest by Anton Chekhov.

8, Promenade Concert (sound only). **9,** Cabaret. **9.45,** Gaumont-British News. **9.55,** Demonstration of Cat's Cradle, by T. T. Paterson. **10.5,** Interval Music. **10.25,** News.

SATURDAY, SEPTEMBER 17th.

3, The John Carr Jacquard Puppets. **3.15,** Gaumont-British News. **3.25,** Cartoon Film. **3.30,** Cabaret.

8, Promenade Concert (sound only). **9,** Starlight. **9.10,** British Movietonews. **9.20,** "Felicity's First Season," play by Charles Terrot. **10.20,** Interval Music. **10.25,** News.

SUNDAY, SEPTEMBER 18th.

3-3.50, O.B. from Euston Station, in commemoration of the L.M.S. Centenary, 1838-1938.

8.50, News. **9.5-10.20,** "The Ascent of F6," a revival of the play by W. H. Auden and Christopher Isherwood.

MONDAY, SEPTEMBER 19th.

11-11.30 a.m., O.B. from Euston Station, a hundred years of railways.

3-4.15, "Youth at the Helm," a comedy by Hubert Griffith, from the German by Paul Vulpius.

8, Promenade Concert (sound only). **9,** Speaking Personally. **9.10,** Cartoon Film. **9.15,** Talk. **9.25,** British Movietonews. **9.35,** Cabaret. **10,** Interval Music. **10.25,** News.

TUESDAY, SEPTEMBER 20th.

3, Charles Heslop in Cabaret. **3.25,** British Movietonews. **3.35,** "The Cab," a one-act North Country comedy by John Taylor.

8, Promenade Concert (sound only). **9,** Gaumont-British News. **9.10,** "Youth at the Helm," as on Monday at 3 p.m. **10.25,** News.

WEDNESDAY, SEPTEMBER 21st.

3-4, "The Romantic Young Lady," a play by Martinez Sierra.

8, Promenade Concert (sound only). **9,** West End Cabaret. **9.30,** British Movietonews. **9.40,** Cartoon Film. **9.45,** Tennis Demonstration. **10,** Interval Music. **10.25,** News.

Television Topics

GHOST IMAGES

A GHOST image is the name given to a faint secondary picture appearing on the television screen a little distance away from the main picture. Sometimes more than one secondary picture can be seen, although in the majority of cases the successive images become fainter and fainter.

The cause of the ghost image is the arrival of a second signal reflected from an adjacent metal structure, the distance between the structure and the receiving aerial being sufficient to cause an appreciable time delay between the arrival of the true signal and the reflection.

The time delay is related to the position of the ghost image and can be approximately estimated in the following way: Suppose the ghost is spaced ½in. away from the main image. On a 12in. tube with a 10in. picture side the time taken for the spot to move ½in. is 1/20th of the line period or 1/200,000th sec., which is the time lag between the true signal and the reflection. If the reflecting surface happened to be immediately behind the receiving aerial in the direction of the transmitting station the distance in miles could be estimated by multiplying the time lag by 186,000 giving in the example above 0.93 miles. This is the "go and return" distance and the actual distance of the reflector is half this, or approximately half-mile.

The location of the reflector cannot always be estimated with certainty, as it is possible for the signal to be reflected obliquely from a building which is not in direct line with the aerial and transmitter. The estimated distance is therefore the minimum radial distance of the reflector, and will serve as an indication only of the source of the trouble.

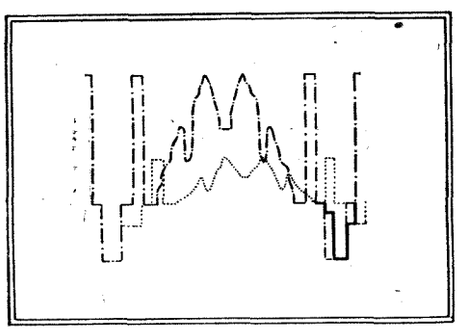


Fig. 1.—A signal for a scene with a white surround is shown by the chain line and its echo by the dotted line. The heavy line indicates the deformation of the sync. pulse.

The effect of the reflected signal on the picture varies both with its intensity and the time lag. If the spacing is wide and the signal is of high intensity the picture is spoilt for viewing, as the whites of the ghost may coincide with blacks of the true picture, giving varying shades of grey. The fact that the ghost signal is displaced in time from that of the main signal will also lead to a superposition of the ghost signal on the synchronising pulse, which is a more serious trouble and which will lead to displacement of the lines or complete loss of synchronism.

The effect of the ghost on the synchronising pulse is shown in the two diagrams of Figs. 1 and 2. In Fig. 1 the chain-dotted line shows a signal corresponding to a scene with a white surround, the signal rising to full white at the beginning and end of each line, with a small black portion preceding and following it. The dotted line shows the fainter signal arriving approximately 10 microsecs. later, and it will be seen that the white portion of the ghost signal cancels out a portion of the sync. pulse. The resulting sync. pulse is shown by the heavy line. Unless the sync. circuit is adjusted to fire on the leading edge of the pulse (and this means critical adjustment), the step will delay synchronising and the line will be displaced.

If the amount of white at the edge of the picture varies from line to line, as would be the case with no margin, the picture may be broken up, due to the displacement of those lines which terminate in full white.

Fig. 2 shows this condition with a line terminating in a wide band of white, and it is seen that the ghost signal has almost entirely eliminated the sync. pulse—in fact, with a longer delay and a stronger ghost signal the pulse would be entirely neutralised.

In practice such extreme cases are rare, but the presence of a ghost signal will usually make synchronising too critical to be reliable.

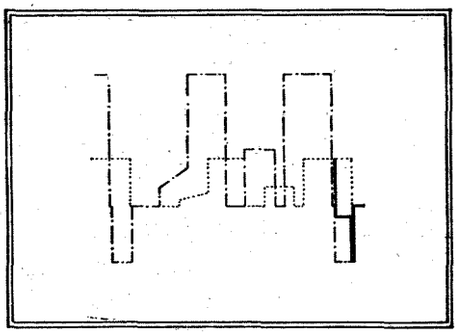


Fig. 2.—In a case when there is a wide band of white at the end of the line, the echo can almost eliminate the sync. pulse.

Unfortunately there is no simple remedy for ghost images, and it may be necessary to re-erect the aerial in another position.

If the reflection is produced by a surface behind the plane of the aerial it can generally be eliminated by using a sufficiently directive aerial array, and this can only be a matter for experiment.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

Ignition Interference

MAY I add my bit to "Diallist's" "Hill Problem"? There is a very simple reason why ignition noise is often greater from a climbing car than from a descending one.

The ignition voltage is much higher, as it depends, of course, on the gas pressure between the plug points.

When the throttle is closed, as when descending a hill, the engine is driven by the vehicle, and pressure is low. The spark gap then offers little resistance and the voltage across it is quite low.

If, however, the throttle is opened the cylinders fill on the induction stroke, and when compression occurs the pressure between plug points is high, and the electrical breakdown voltage of the gap is correspondingly increased.

My own aerial is just sufficiently far enough back from the main road to avoid interference from most vehicles, but every double-deck bus climbing the hill produces interference, though nothing is heard from those descending.

Leicester. HAROLD E. DYSON.

Pitcairn Island

WITH reference to "Diallist's" comments on Pitcairn Island, at the time of my last visit to this island around 1927, all the inhabitants were members of the "Seventh Day Adventists" church of Los Angeles, which provided most of their special requirements, including radio by special collection or subscription. Obviously, their situation would make communication with the U.S.A. easier than with England, but in spite of this and their religious inclinations, the islanders are all staunchly British. At the time of my visit, the operator (receiver only) was Floyd McCoy, a direct descendant of one of the original "Bounty Mutineers" and he afterwards visited England on a world tour.

The visits of ships are not nearly so rare as suggested, as unlike Tristan da Cunha, Pitcairn is almost on the direct trade route from the Panama Canal to New Zealand, and serves as break in the monotony of long ocean voyages to the passengers, who have the pleasure of seeing the long-boats pull out accompanied by lusty hymn singing.

London, S.W.9. J. P. PAGE.

I WAS rather astonished to read the paragraph in "Diallist's" "Random Radiations" entitled "Pitcairn Island." My astonishment comes from the fact that it seems a little late now to talk about British intervention in radio matters in British possessions such as Pitcairn. For many years Andrew Young, on Pitcairn Island, worked wonders by way of keeping in communication with the outside world with next to no gear at all and, what there was, ages

Letters to the Editor—

old. A reference to "Q.S.T." for October, 1937, will refresh the memory of "Diallist" as to how it came about that American manufacturers jumped into the breach and provided, for no remuneration whatever, the modern and up to date transmitting and receiving equipment described in "Q.S.T.," January, 1938. I am of the opinion that Andrew Young, on Pitcairn, could scarcely have been provided with more suitable gear, and if Britain, whether amateurs or Government, feel that something should be done, I suggest that there are plenty of other British possessions which are equally deserving of the gift of similar apparatus.

Stirlingshire. GM8TT.

I WAS in communication with Miss Dorothy Hall, W21XY, on August 21st, and obtained the following information about Pitcairn.

The island is not out of touch with the outside world, but is at present working with reduced power. Miss Hall had herself spoken to Pitcairn some fifteen hours earlier.

The wind generator has broken down and certain other damage has been sustained, due to a severe electrical storm lasting 2½ hours.

A subscription in America has resulted in the presentation of a gasolene Delco generator and 90 gallons of gasolene. These supplies have left by steamer from Panama and are due at Pitcairn on August 31st.

Bromley, Kent. A. D. MILNE, G2MI.

Nation-wide Television Service : the Use of Film

IN view of the difficulties of establishing a national as distinct from a purely local system of television, the time seems opportune to consider an alternative method of approach.

Disregarding reception difficulties as being the less pressing, and considering entirely the obstacles in the way of transmission throughout the whole country, the principal and, in fact, the sole one now remaining is that of bringing the material to be televised to the door of the station. In the belief that in the reproduction of an "actuality" on the viewer's screen, the quality of instantaneous transference was vital, television technicians have found necessary an amount of preparation and a cost out of all proportion to the interest value of the picture so reproduced. Is this costly instantaneousness necessary? Is it necessary that a scene or performance be directly scanned at all? Is the policy of television to be that of making visible performances which as public entertainment are basically imperfect and "actualities" whose interest moments during the time of scanning are few or non-existent, and whose sole virtue is that their instantaneousness is calculated to inspire awe and wonder? There is a simple and inexpensive way of achieving at once the dual purpose of providing the transmitting station with material and ensuring that such material is of proven entertainment or interest value. The scene might be simply filmed, thence taken to the studio, developed, "cut," arranged and transmitted with the certain knowledge that whatever the scattered interest of the original, the transmitted version contained the essence of its merit. Film transmission is, of course, no new thing in television, but what is suggested is that the film be adopted as the sole link between actuality and viewer and that the expensive and unwieldy direct method be abandoned except for such special cases as the finish of a Derby.

The adoption of visual recording would solve very many problems. The cost of recording would be far less than that of relaying from a distant scene. The cost of copies of the recording would be negligible. The cost of running provincial stations from such records would likewise be very small. Consequently, the provision of television on a nation-wide scale would be possible. Space does not permit the enumeration of the advantages, both technically and æsthetically, of such a system, but they are many and far-reaching.

With regard to the actual method of recording, the film one seems the most promising. Standard film alone gives good results —equally as good as those from direct scanning. A lot might further be done in the way of designing a film-like strip of such dimensions and of such nature as would be amenable to television scanning as distinct from ordinary projection. It might be a foot or ten feet wide if that would the better suit—it might be transparent or opaque.

Finally, the adoption of the film link in television would make entertainment available to the million and not the few—to those more in need of it than the entertainment-surfeited population of London. It is up to television to find out if there is, after all, any demand for that instantaneousness which is so costly, and, further, to find out whether life-likeness might not be the better conveyed to the viewer's screen by means of the film link. L. STAPLETON.

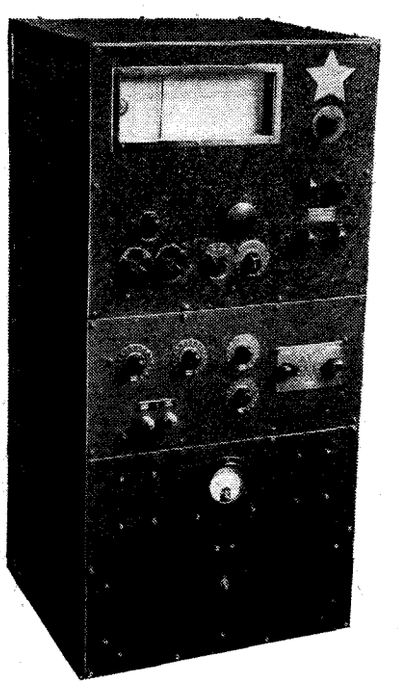
Greenford, Middlesex.

A Versatile Quality Receiver

DEMONSTRATIONS of the Voigt loud speaker during the period of the Show were made in conjunction with an interesting receiver-amplifier produced by the Lowther Manufacturing Co., Ltd., St. Mark's Road, Bromley, Kent.

The instrument is housed in a black-finished steel cabinet, and the various component chassis can be removed independently. At the top is a combined superhet or 2RF straight receiver covering short-, medium- and long-wave broadcast bands and a separate 7-metre tuner for the Alexandra Palace sound channel. The middle panel carries independent bass and treble correction circuits and four pre-amplifiers with separate volume controls for gramophone, radio and microphone inputs with provision for "mixing." At the bottom is the power amplifier, giving 9 watts for 2 per cent. total harmonic distortion. This unit is fitted with an output meter calibrated in watts.

On radio the overall response, aerial to output transformer secondary, is level to 10,000 c/s with a 4 db drop at 16,000 c/s.



Designed for recording work this receiver-amplifier has four separately controlled input circuits and is adapted for reception of 7-metre high-quality transmissions in addition to the usual broadcast bands.

With the tone controls at zero the amplifier alone is level from 50 to 18,000 c/s.

The equipment has been produced to the order of Star Sound Studios, 13, Kenton Road, Kenton, Middlesex, who specialise in quality recordings of B.B.C. transmissions. The service is used by many of the leading broadcasting personalities, who are thus able to "hear themselves as others hear them" and can often make slight modifications in their microphone technique.

News from the Clubs

Bradford Radio Society

Headquarters: Cambridge House, 66, Little Horton Lane, Bradford.
Hon. Sec.: Mr. S. Hartley, 7, Blakehill Avenue, Fagley, Bradford.

The following programme has been arranged for the first half of the winter session:—

October 11th.—(Opening night) Marconiphone lecture on the latest developments in television.
October 26th.—Lecture on short-wave workings, by Mr. Garnett (G6XL.).
November 8th.—(Provisional date) Lissen lecture on short waves.
November 23rd.—Lecture on "High-efficiency Indoor Aerials," by Mr. Heaviside (G2QM).
December 6th.—Lecture on "High-quality Reproduction," by Mr. G. A. Briggs, of Wharfedale Wireless.
December 20th.—Lecture on "AC Practice and Theory," by Mr. Bateman (G6BX).

Each lecture will be accompanied by a demonstration. The annual subscription is now 2s. 6d.

Worthing Scientific Association

Headquarters: The Literary Institute, Montague Street, Worthing.
Meetings: Second Tuesday in each month.
Act. Hon. Sec.: Mr. C. J. Ainsworth, 31, Belvedere Avenue, Lancing, Sussex.

The Association held a successful meeting on Tuesday evening last, when a paper on "Television" was read by a member. *Wireless World* readers are cordially invited to attend further meetings of the Association.

The Robert Blair Radio Society

Headquarters: The Islington Men's Institute, Blundell Street, London, N.7.
Meetings: Wednesdays at 8 p.m. (practical); Thursdays at 8 p.m. (theoretical).
Hon. Sec.: Mr. A. R. Richardson, 24, Mercers Road, London, N.19.

A hearty welcome is extended to non-members wishing to attend meetings this season. The first will be held on September 21st, at 8 p.m. The Society looks forward to the new season with confidence, and the technical adviser, 2DYK, is expecting to receive a full transmitting licence in the near future.

Dollis Hill Radio Communication Society

Headquarters: Braintcroft School, Warren Road, Cricklewood, N.W.2.
Meetings: Alternate Tuesdays at 8.15 p.m.
Hon. Sec.: Mr. E. Eldridge, 79, Oxgate Gardens, Cricklewood, N.W.2.

A demonstration of home recording was given at a recent meeting by Messrs. Ash and Mackenzie. The play-back of a speech made by the President during the evening showed the high quality obtainable.

Crystal Band-Pass Filters

A NEW FILTER EMPLOYING QUARTZ CRYSTALS

THROUGHOUT the history of communication, both by wireless and by wire, efforts have continually been made to improve the selection of the wanted signal. These efforts have been directed towards picking out the wanted signal from all the unwanted in such a way that it is not distorted while the discrimination in its favour is virtually complete. In one form or another resonant circuits are invariably adopted for this purpose, and development has lain in applying them in better ways.

No difficulty would be found if it were possible to transmit on a single frequency only, for any desired degree of selectivity could easily be obtained by employing a number of highly efficient resonant circuits tuned to the signal. All signals, however, occupy a band of frequencies. This is well known in the case of telephony, for with the usual double-sideband system the band of frequencies occupied is equal to twice the highest modulation frequency—some 20,000 c/s for really high quality. There is, however, a definite band-width associated with all methods of signalling; it is narrowest with continuous-wave morse transmission, where it may reach only a few hundred cycles per second, and it is greatest with television, where it reaches some 5,000,000 c/s. The actual factor upon which the band-width depends is the rate of change of carrier amplitude, and this depends on the amount of information sent in a given time. With slow-speed morse signals, the band-width is extremely small, but although it is still narrow compared with telephony standards, it is wide enough to be very important when modern high-speed signalling systems are used.

The first essential for interference-free reception is that the various carrier frequencies for the different signals are spaced so that the sidebands do not overlap. Ideally, it is then possible to separate the signals without distortion by using a receiver having a rectangular resonance curve, such as that of Fig. 1(a). In practice, however, this curve is not obtainable. The nearest approach to it is the form shown in Fig. 1(b); the top is no longer flat, so that there is some distortion of the wanted signals; the rejection of unwanted signals is not complete, and the sides of the curve are not vertical. Consequently, the carrier spacing must be increased so that there are spaces between the sidebands of the wanted and adjacent unwanted signals.

THE use of quartz crystals for obtaining high selectivity has been known for some years, but they have not achieved any great popularity for broadcast purposes because the selectivity is too high. In this article is described a new method of using quartz crystals to obtain band-pass circuits of almost ideal characteristics.

If a highly selective circuit of the non-band-pass type is used, the resonance curve takes the form shown at (c). There is no difficulty about selectivity, but the higher sidebands of the wanted signal are greatly attenuated. In the case of speech and music this makes the reproduction lifeless, with increasing selectivity it becomes boomy, and with still higher selectivity unintelligible. The same happens with morse, but the selectivity needed is higher; with sufficiently high selectivity the dots and dashes run together and cannot be distinguished.

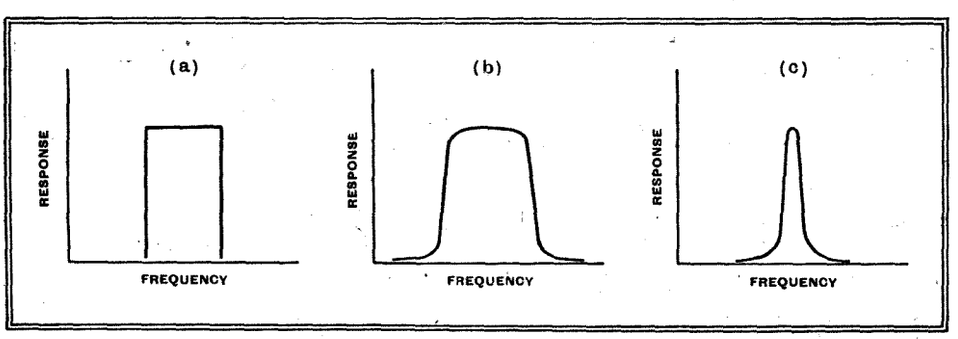


Fig. 1.—The ideal theoretical band-pass resonance curve is shown at (a) and a practical form at (b), while a non-band-pass curve appears at (c).

Some years ago, however, it was realised by Dr. J. Robinson that the bad effects of sideband cutting could be corrected in a subsequent stage of the receiver. No resonant circuit ever reduces a signal completely to zero; consequently, when a highly selective circuit is used and the sideband cutting is severe, modulation frequency currents are still present in the output of the detector. The higher modulation frequency currents are so small in comparison with those of low modulation frequency, however, that an intelligible signal may not be obtained.

Now if they are applied to an amplifier which amplifies the high frequencies more than the low and in the correct degree, the signals in its output will be restored to their correct relative strength. If the frequency response curve of the amplifier is the inverse of the modulation frequency response of the selective circuits, high-quality reproduction is possible and the discriminating action of the selective circuits against signals on adjacent channels is retained.

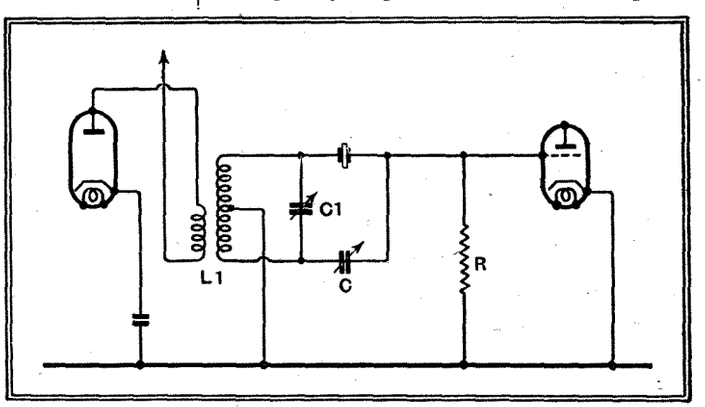


Fig. 2.—The usual quartz crystal bridge circuit is shown here. The crystal capacity is balanced by the condenser C.

It is easy to show mathematically that the correct shape of AF amplifier characteristic is most easily secured when the selectivity is obtained all in one resonant circuit. The correction curve then follows a simple law, and moreover, if the selectivity exceeds a certain figure, which depends upon the *lowest* modulation frequency, the correction curve is independent of the actual degree of selectivity.

In order to obtain these desirable conditions, Dr. Robinson adopted a quartz crystal for the selective circuit, for it is not possible to obtain sufficient selectivity from any single resonant circuit of the coil and condenser type unless critical reaction is used. This is undesirable, however, because it is too difficult to maintain the correct conditions.

The quartz crystal behaves as a coil, condenser, and resistance in series, the

Crystal Band-Pass Filters—

whole being shunted by a condenser. The series elements behave as a tuned circuit of extremely high Q ($=\omega L/R$), and consequently form the elements of a very highly selective circuit. The shunt capacity is undesirable, but its effects can be balanced out by using the crystal in a bridge as shown in Fig. 2.

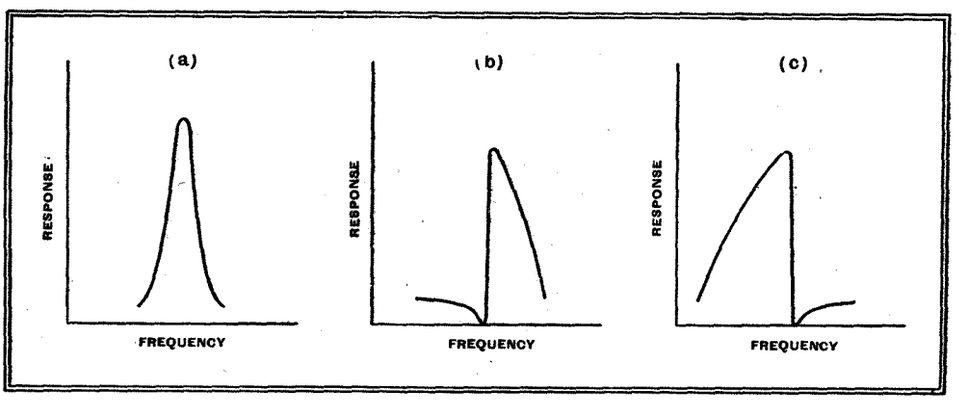


Fig. 3.—A single quartz crystal properly balanced gives a curve such as (a), while the forms (b) and (c) are secured by slight unbalancing.

Here one-half the voltage developed across the tuned circuit L1 C1 is applied through the quartz crystal to the output circuit, which can be a resistance R as shown, or a tuned circuit. The other half of the voltage across L1 C1 is applied in opposite phase to R through the balancing condenser C. When this capacity is equal to that of the crystal the voltages passed to R by the two paths are equal and opposite and so cancel out. This is at frequencies considerably different from that of the crystal resonance; the essential *capacity* balance remains true at all frequencies, however.

Now at resonance the crystal behaves as a resistance of moderate value and the output of L1 C1 passes to R through it. At frequencies near resonance it behaves as a reactance and resistance in series, but the resistance term soon becomes negligible. At frequencies higher than resonance the crystal behaves as an inductance, and at frequencies lower than resonance as a capacity. The phase of the sidebands is thus changed, for with the carrier at the crystal resonance the upper sideband currents are advanced in phase by some 90 degrees, and the lower sideband currents are retarded by a like amount.

With the crystal capacity correctly balanced a symmetrical resonance curve is obtained of the type shown in Fig. 3 (a). If the balancing capacity is increased or reduced, however, the curve becomes asymmetrical; on one side of resonance the curve falls off much less steeply, and on the other side much more steeply. On this latter side the output falls to zero at some frequency and rises again for frequencies further removed from resonance. This is shown in (b) and (c) of Fig. 3.

This arrangement is widely used in American communication receivers and provides the so-called single-signal feature. Correction in the AF circuits is not used, since the system is employed chiefly for morse reception and the crystal is largely used in a slightly unbalanced condition. The resonance curves of Fig. 3 (b) or (c) are obtained and the signal is tuned to the peak. The position of the point of infinite attenuation is then shifted to fall on an interfering signal by means of the balancing condenser.

Such highly selective circuits are not without their drawbacks, however, the chief of which is the need for an extremely stable oscillator in the frequency - changer. The effective bandwidth of a quartz circuit may be only 50-100 c/s, so that the greatest tolerable oscillator drift is, perhaps, ± 40 c/s. In short-wave reception the carrier frequency may be 4-60 Mc/s, so that the oscillator frequency must be stable to one part in 100,000 at the low-frequency end of the band and one part in 1,500,000 at the other. This is extremely difficult to achieve and necessitates the use of automatic frequency control.

The use of a band-pass type of resonance curve is thus highly desirable. Normal methods using coils and condensers have the drawbacks of needing either many circuit elements or of giving only a gradual cut-off outside the pass-band. Dr. Robinson, however, has found that it is possible to secure extremely good band-pass characteristics from an arrangement similar to that of Fig. 2, but using two crystals instead of one. The two crystals have different resonance frequencies, roughly corresponding to the edges of the pass-band, and the action of the circuit depends on the phase reversal obtained on either side of the crystal resonance and described earlier.

Consider the circuit of Fig. 4, which is the same as that of Fig. 3, but with the balancing condenser replaced by another crystal. Both crystals have substantially the same shunt capacity, so that the capacity of the one is effective in balancing that of the other, and a special condenser for this purpose is unnecessary. Now one crystal has its lowest impedance, and hence passes the greatest current, at one frequency f1, and the other at another, higher, frequency, f2. For frequencies lower than f1, both crystals attenuate and behave as condensers, causing the output currents to lag by some 90 degrees behind the input voltages. The inputs to the two crystals are in opposite phase, however, since they are obtained from the opposite ends of L1 C1. With respect to the input to one crystal, therefore, the output of the other is leading by 90 degrees and that of the other is lagging by 90 degrees. In the output circuit, therefore, the two currents are subtractive.

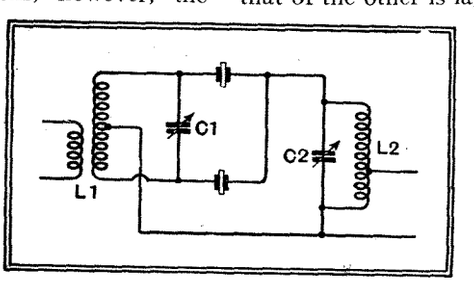


Fig. 4.—A band-pass characteristic can be secured by using two crystals in a bridge circuit.

For frequencies higher than f2, both crystals behave as inductances, and the output currents lead by some 90 degrees over the applied voltages. Again, the voltage applied to one crystal is 180 degrees out of phase with the voltage applied to the other. The outputs of the two crystals are consequently in opposite phase and the currents are subtractive. The output of the circuit as a whole is in the same phase for frequencies lower than f1 and higher than f2, and the currents passed by each crystal are subtractive.

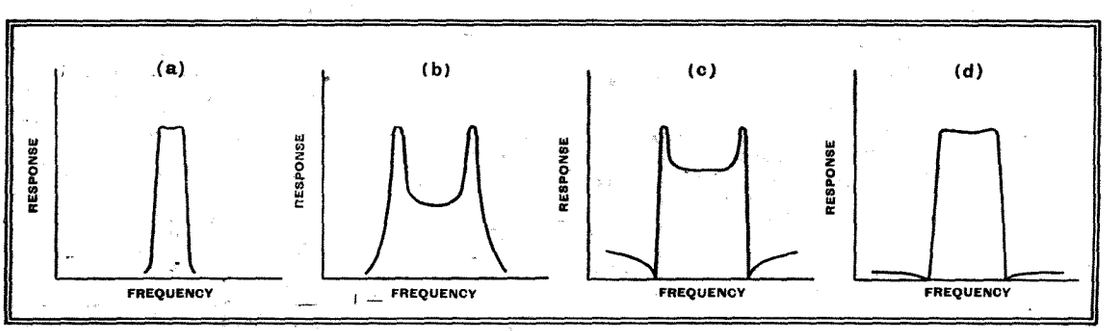


Fig. 5.—For narrow pass-bands the circuit of Fig. 4 gives the form of resonance curve shown at (a), but for a wide pass-band the form changes to (b). By shunting one crystal by a condenser the curve is modified to (c) and with the other tuned circuits the overall form of (d) can be secured.

Now for frequencies between f1 and f2, the crystal resonant to f1 behaves as an inductance and gives a 90 degrees lead to the current, while that resonant at f2 be-

Crystal Band-Pass Filters—

haves as a condenser and gives a 90 degrees lag. Again, however, the inputs are in opposite phase, so that the output currents are in the same phase and are consequently additive.

In this simple way the elements of a band-pass filter are obtained. Between f1 and f2 the currents passed by the crystals are in the same phase and add together, while outside this band they are in opposite phase and subtract; if they had the same magnitude they would cancel one another.

Immediately adjacent to the resonance frequencies the action is modified by the effective resistance of the crystals and the currents lead or lag by less than 90 degrees. The effect of this is to reduce the abruptness of the transition from the pass to the stop regions. Where only a narrow pass-band is needed satisfactory results are secured with this simple circuit and a curve of the type shown in Fig. 5 (a) is secured. With a wide pass-band, however, two marked peaks with a deep trough between them are found as in Fig. 5 (b).

Using A Balancing Condenser

A considerable improvement can be effected by shunting one crystal by a condenser of suitable value. If the higher frequency crystal is so shunted it passes a greater current in the pass-band and in the same phase as the crystal current. The total output is thus increased and the height of the trough is raised. Outside the pass-band the condenser continues to pass current in the same phase, but the outputs of the crystals are in opposite phase. At two frequencies, one lower than f1 and the other higher than f2, the condenser current is equal to the outputs of the crystals and the total output is zero. At frequencies still further from the pass-band, however, the condenser passes more current than the crystals and the output increases and is greater than if no condenser were used.

The resonance curve thus takes the form of Fig. 5 (c). As compared with the case when no balancing condenser is used, the selectivity is reduced for frequencies considerably removed from the pass-band. The peaks are less pronounced, however, and the trough is higher, showing better efficiency in the pass-band. Moreover, the sides of the curve are steeper and there is infinite attenuation at two frequencies very close to the edges of the pass-band.

The precise shape of the resonance curve depends on the output load circuit. The results already described are obtained with a resistive load such as that of Fig. 2 rather than with the tuned circuit L_2 C_2 of Fig. 4. When such a tuned circuit is used, its own resonance characteristics come into play and it tends, in conjunction with the input circuit L_1 C_1, to fill up the trough of Fig. 5 (c) and to reduce the rise in response away from the pass-band. Taking the tuned circuits into account, therefore, the overall performance approximates to that of Fig. 5 (d).

This is an almost ideal resonance curve and many requirements other than those of broadcasting can be met. The wider the pass-band the more difficult it is to secure a flat characteristic within that band and high attenuation outside it, but the difficulties are by no means insuperable. Filters have already been constructed with a pass-band of 5 kc/s and flat within 1 db. and yet having an attenuation of 60 db. only 500 c/s outside the pass-band; this attenuation being not a maximum at the so-called frequencies of infinite attenuation, but a minimum outside the 500 c/s region over which cut-off occurs.

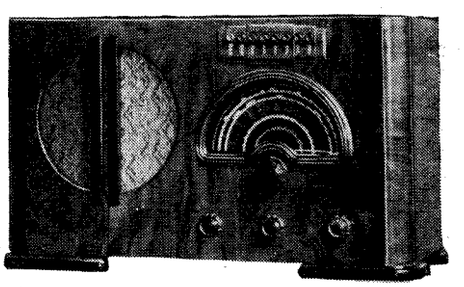
Filters of this type would seem to have wide application in carrier telephony and with a pass-band of about 8-9 kc/s would be ideal for general broadcast use. Filters with a narrower band of about 1 kc would be ideal for CW morse reception. The statement that a band-width of 8-9 kc/s would be suitable for broadcasting may require some explanation, for at first sight it would appear better to choose a band twice as wide in the interests of quality of reproduction. This would, however, entail greater difficulty in filter design, construction and adjustment, and the band-width would be too great for the interference - free reception of many stations.

It seems better, therefore, to choose a narrower pass-band which will be considerably better from the selectivity point of view and which will yet yield quality of normal standards. Owing to the simplicity of the circuit it is quite possible to arrange a switch to dispense with the crystals when first-class quality is required from local stations.

Readers may look forward to more information on this new development in the near future.

Ambassador "Mototune" Receiver

PRESS-BUTTON tuning of nine stations with motor-driven control is a feature of the latest version of the Model 6778 receiver made by Ambassador Radio Gramophones, Hutchinson Lane, Brighouse, Yorks. This receiver is obtainable as a table model



at 15 guineas, a console at 17½ guineas and a radio-gramophone at 22½ guineas. A remote control unit is also available and special export models are made with kilocycle calibrations and with the long-wave range omitted. In all models there are two short-wave ranges covering 12 to 99 metres.

Broadcast Programmes — FEATURES OF THE WEEK

THURSDAY, SEPTEMBER 15th.

Nat., 7.45, Brian Lawrance and his Sextet. 8.30, From the Promenade Concert. 9.25, A.R.P. Talk.

Reg., 6, Reginald Dixon at the organ of the Tower Ballroom, Blackpool. 8, "Compton Wynyates," the story of a house. 8.40, "Give me Air"—A search for new talent. 9.40, From the Promenade Concert.

Abroad.

Paris (Eiffel Tower), Lyons, 8.30, "The Invisible City of Kitezh," opera (Rimsky-Korsakov).

Milan Group, 9, "A Masked Ball," opera (Verdi).

FRIDAY, SEPTEMBER 16th.

Nat. 6.45, Eddie Carroll and his Orchestra. 7.30, "Give Me Air." 8.30, From the Promenade Concert. 10.5, "Up Against It."

Reg., 8, "Heloise and Abelard," a programme based on their letters. 8.30, Variety from Morecambe. 9.50, From the Promenade Concert.

Abroad.

Naples Group, 8.30, Syncopated American and Italian Music.

Rome Group, 9, "Falstaff," opera (Verdi).

SATURDAY, SEPTEMBER 17th.

Nat., 5, Mantovani and his Dance Orchestra. 7.30, "Foort-Issimo," with Reginald Foort, Anne Ziegler and Webster Booth. 8, The Two Leslies present "Radio Pie."

Reg., 6.45, 'Horner's Corner." 8, From the Promenade Concert. 9.40, "Money with Menaces," a thriller for broadcasting.

Abroad.

Radio Normandie, 9, "The Damnation of Faust," opera (Berlioz).

SUNDAY, SEPTEMBER 18th.

Nat., 12.40, Mario de Pietro and his Estudiantina. 5, Digging Up the Past—Talk on How it is Done. 6.30, Relay from the Negro Church, Washington. 9.5, Songs of the British Isles.

Reg., 5, Recital by Olive Groves, soprano. 7, Mantovani and his Tipica Orchestra. 9.30, "Hotel Splendide," twenty-four hours in the life of a big hotel.

Abroad.

Beromunster, 4.45, "Titus," opera (Mozart).

Berlin, 8.10, Concert version of Verdi's opera, "Falstaff."

MONDAY, SEPTEMBER 19th.

Nat., 7, "Mr. and Mrs. Neemo." 8, A.R.P. Talk. 9, "Dolores," musical comedy. 10.20, Experimental Hour, 13, "Pippa Passes," by Robert Browning.

Reg., 6.25, Band of Queen Victoria's Rifles. 8.20 and 9.35, Wagner Promenade Concert. 9.20, I Knew Melba—Talk by Ivor Newton.

Abroad.

Radio-Paris, 8.30, "Joseph," biblical opera (Méhul).

TUESDAY, SEPTEMBER 20th.

Nat., 6.30, Frank Titterton, tenor, with Reginald Foort. 8, "Alexander's Ragtime Band," radio version of the new film. 9, Sydney Lipton and his Band.

Reg., 8, Promenade Concert, with Telmányi, violin. 9, "River of Ships," a feature from the Clyde. 10, Russian Songs, sung by Vladimir Rosing, tenor.

Abroad.

Eiffel Tower, Lyons, 8.30, "The Strausses," a review of their music.

Milan Group, 9, "La Passione," oratorio (Malipiero).

WEDNESDAY, SEPTEMBER 21st.

Nat., 7, Talk by the Rt. Hon. Earl Stanhope, on Technical and Evening Institutes. 8, Bach Promenade Concert. 10.5, Schubert Recital, by Reginald Foort.

Reg., 6.45, Students' Songs. 8, Louis Levy Presents "You Shall Have Music." 8.45, Jessie Matthews in Dance Cabaret from Bournemouth, with Billy Thorburn and his Music. 9.25, "Cold Coal," a play of unemployment.

Abroad.

Brussels I, 8, "Paganini," operetta (Lehár).

Berlin, 9, Mozart and Haydn Concert, by the Dobrindt Orchestra.

UNBIASED

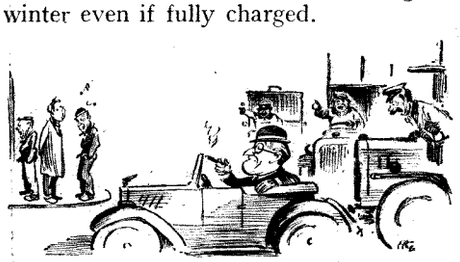
By FREE GRID

A Car Radio Problem

I SUPPOSE that amongst my readers there must be quite a number who have had considerable experience with car radio, and are in a position to help me with a little advice as to which is the most suitable type for me to obtain for use in rather special circumstances.

It might be thought, of course, that with my unique wireless facilities I ought to be in a position to know more about this than any of my readers. Actually this is not so. I have not, in fact, got any radio fixed in my car, the reason being that I strongly object to paying the extra licence fee. I did have such a set, but when the P.M.G. gave a definite ruling about this matter some time ago I disposed of it for a mere song, this being literally true in this case and not a mere figure of speech, as I gave it away to a little group of Welsh street singers whose rendering of "Yes, sir, she's my baby," in the Welsh language, particularly pleased me. You will, therefore, understand that by reason of my enforced abstinence from car radio I am rather out of touch with it, and that is why I am seeking your assistance.

The reason why I now wish to buy a car radio set, and moreover, the very best that money can buy, dates back to mid-summer, when you may recollect my describing to you a super-silent electric outboard motor designed for use on river-side craft. Much against my inclinations, I was compelled by Mrs. Free Grid to buy one of these devices, and, of course, I had to get also a car battery of large ampere-hour capacity to drive it. Now that the end of September is in sight, I have naturally begun to think about laying the boat up for the winter, and I have suddenly found that I have a totally unexpected battery problem on my hands as the makers of it tell me that I must on no account allow it to stand idle during the winter even if fully charged.



For a mere song.

Now I cannot use the battery on my car, for its physical dimensions are too great, and, apart from this, I, of course, already possess a car battery. I am aware that I could discharge the battery through some sort of resistance and then recharge it from time to time during the winter months in order to keep it in trim. This, however, involves sheer wanton and ruthless dissipation of good electro-chemical energy, and as waste of any kind is entirely against my principles, I refuse to entertain the idea.

The only way in which I can usefully employ the battery during the winter is to use it for driving a car radio set, and this means, of course, that I must dispose of my existing domestic receiver and instal car radio in the house in its stead. There is nothing against this idea so far as I can see; in fact, there is everything to recommend it as I can obtain several extra Bowden cables and control panels and so make the set tunable from any room in the house.

Science or Sentiment

THERE has been, I fear, an unfortunate development as the result of the attempt, of which I told you a few weeks ago, to use rats and ferrets in order to tunnel a passage under neighbouring gardens for my low impedance aerial transmission line. The fact that rats and ferrets both escaped caused, to say the least of it, a feeling of extreme tension in the neighbourhood, but there was an even more unfortunate result. The man who supplied me with the sackload of rats was not as honest in his dealings as he might have been, and had adulterated them with a considerable quantity of mice as a make-weight.

Unfortunately, mice do not care for the free and open life of the countryside but, like myself, prefer the comfort of the domestic fireside. The ones that escaped, I regret to say, found a home in my bedroom and caused me considerable annoyance at night, apart from the fact that they consumed several valuable MSS which I had prepared for publication in the columns of this journal. If it had not been for the use of wireless principles I should by now have been completely overrun with the pests.

No doubt some of you may possibly call to mind that some time ago I described in these columns a simple but effective mouse-trap which I had invented. It consisted merely of strips of metal, such as Meccano, attached to a baseboard with a small separation between each strip. Alternate strips were attached to either terminal of the 500-volt winding of an ordinary mains transformer from an old wireless set, the result being extremely effective. Needless to say, when I first discovered that the escaped mice had taken refuge in my bedroom, I at once thought of my old trap, but unfortunately I am now on DC, and 240 volts is definitely not enough for the purpose. It merely acts as a reminder to the mice to be more careful in future.

Although I possess both a cat and a dog which sleep in my room, they proved very ineffective, both seeming to think that a bedroom is intended solely for sleeping purposes. Eventually, however, I rigged the trap up in their sleeping basket and arranged matters so that a mouse running over an electrode concealed under the carpet, upset, by means of "hand capacity" effects, the constants of a delicately balanced oscillator circuit, thereby switching on the trap on which both cat and dog were sleeping, and administering to them a gentle reminder that duty called.

Unfortunately, this scheme was unsuccessful at first as the whole of the first night was nothing but a prolonged cat and dog fight, as every time the two animals were roused by a mouse operating the relay each suspected the other of being the cause of the annoyance, and eventually I had to banish one of them and arrange for each to take alternate nights of duty. This arrangement was then entirely successful,

A prolonged cat and dog fight.

but unfortunately I now find myself in trouble with Mrs. Free Grid, whose life seems ordered more by caprice and sentimentality than by logic and the spirit of scientific detachment. She has seen fit to bring the matter up at the committee meeting of one of the animal societies of which she is a prominent member, and I look like facing a charge of cruelty to both cat and dog.

Auf Wiedersehen

BECAUSE of my Radiolympic revelations I learn that I am to be refused admission to the Manchester Exhibition. I intend, therefore, to grow a little face fungus, and this means that my notes will not be appearing for a week or two. Anybody who has had the painful experience of getting his beard caught in the mechanism of a typewriter will know the reason why.

NEWS OF THE WEEK

LETTER RECORDS

Personal Recording at Berlin P.O

THE head post office in Berlin has recently been equipped with sound-recording apparatus to enable "spoken letters" to be made by members of the public. These automatic recorders are fitted in sound-proof cabinets to ensure privacy. The cost for recording one side of a 5-in. blank is about 2s. 6d., and for an extra 1s. 3d. the reverse side may also be "filled." For those requiring a longer speaking time 7½-in. discs are available. Each disc is supplied with a reinforced envelope, for posting, together with a few needles for playback. If this scheme is well received it is intended to install these cabinets in all the major post offices in the Reich.

Whilst this idea is being hailed as an innovation in Germany, it is interesting to recall that a similar machine, known as the Voice Recording Automat, was first demonstrated publicly at the 1935 Radio Exhibition at Olympia. This instrument automatically recorded one's voice on a 5-in. aluminium blank upon the insertion of 6d. in a slot. For an additional two pennies an envelope for postage and a packet of fibre needles were supplied. The ingenious mechanism of this machine is described in British Patent No. 412,509.

The avowed intention of the original company exploiting this machine was to install these Voice Recording Automats in every big railway station, hotel and chain store in the country, but for some reason these machines were not sufficiently patronised after the novelty had worn off. However, these Automats are still in use at amusement arcades in the West End of London and at seaside holiday resorts.

WHERE GERMANY LEADS

RETURNS recently supplied by the International Broadcasting Union show that there were approximately fifty million licensed listeners, including subscribers to relay exchanges, in the world up to the end of July, the latest period for which figures are available. Germany now leads with 9,514,000 licences, but no fewer than 638,000 of these were issued free. Great Britain, second in the list, has over 8,600,000 licences, plus 50,000 issued free to the blind. France, a long way down, comes next in order with 4,500,000 licences.

SETS FOR SCHOOLS

Help in the Choice of Receivers

TWICE a year the B.B.C. issues fresh details, in the form of a pamphlet, of types of receiving apparatus suitable for use in schools. A new pamphlet is now ready and it contains much useful information about installations which have been tested by the Central Council for School Broadcasting on premises acoustically approximating to those of classroom.

The main purposes of the selection is to suggest sets which give faithful reproduction of the actual voice of a speaker in the classroom. The installations described have outputs of 6 watts and over, and are suitable, in cases where extension wiring is fitted, for operating a number of loud speakers simultaneously in different rooms or for use in large halls. Whilst installations of this type are essential where a large output of sound is, on occasions, required, they can, of course, be used for ordinary classroom work as well.

NO LICENCE—NO SET

Sidelights on the Case of the Confiscated Radiogram

ORDER for the forfeiture of a £60 radiogram which was made at the Ipswich Police Court last week, as part of the penalty for operating the instrument without a licence, has aroused widespread interest, especially among hire-purchase traders, who foresee in this a possible source of trouble to themselves.

In many contentious quarters, speculation runs high on further possibilities in the case, should the Ipswich offender decide to claim back the gramophone components of the confiscated radiogram. Are such components necessary parts of a receiving station or are they merely independent accessories?

CANADA'S NEW STATION

Completing the Chain of C.B.C. Transmitters

WORK has started on the third of Canada's 50-kW transmitters, CBA at Sackville, New Brunswick. This station, which is to cover the three Atlantic coast provinces of New Brunswick, Nova Scotia, and Prince Edward Island, will operate on 1,050 kc/s (285.7 metres).

A fourth 50-kW station is to be built this autumn in the vicinity of Saskatoon, Saskatchewan, the site not yet having been definitely decided upon. This transmitter will be similar to CBA and will operate on 540 kc/s (556 metres) covering the three prairie provinces of Manitoba, Saskatchewan and Alberta.

No date has yet been fixed for the opening of either of these stations, but it is expected that they will be in operation by the summer of next year. The two transmitters will be companion stations to CBL, Toronto, and CBF, Montreal, which were opened last year. A fifth station is planned to be built next year in British Columbia, after which a high-powered short-wave transmitter is to be added to the chain of Government stations operated by the Canadian Broadcasting Corporation.

WIRELESS TELEPHONE IN THE HEBRIDES

EXPERIMENTAL transmissions from the first beam radio stations in the Hebrides are expected to be carried out this month. A station 1,000ft. up on the mountains near Castlebay, Barra, will work with a second station at Tobermory, Mull, and a third near Oban. The radio link will replace the submarine cables, which have frequently suffered damage during winter storms.

BIG AMATEUR STATION OPENED

It Has Five Separate Transmitters

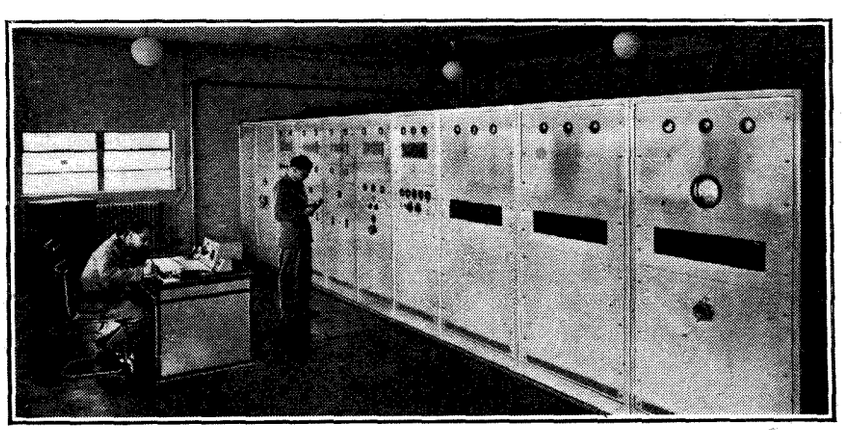
IN memory of the late Hiram Percy Maxim, first President of the American Radio Relay League, an amateur station bearing his name was inaugurated at Newington, Connecticut, U.S.A., on September 2nd. A complete network of Connecticut amateur stations dealt with messages of acknowledgment relayed from amateurs all over the world.

The $18,000 memorial station is the most complete of its kind in the world. The performance of five separate powerful transmitters is improved by special aerial systems designed for the most efficient coverage of North America. The purpose of this memorial station is to communicate with members throughout the country.

TELEVISION MOBILE UNIT

Yeoman Service at Radiolympia

FOLLOWING its use at Radiolympia, where it gave a service of consistent excellence, the television mobile unit is going back to Hayes, Middlesex, for minor adjustments by E.M.I. It is a tribute to the careful workmanship of the engineers that in spite of the jolting that this enormous van suffers in its journey to and from the scene of its operations, very little goes wrong with the apparatus. This is because the hundreds of valves and other delicate components are mounted on or enclosed in rubber, so that they are not affected by the rough roads which the van has to negotiate. On some occasions the mobile unit has travelled fifteen miles to the scene of action, and has been brought into use after the short period of time—about twenty



A DEPARTURE from the normal practice at most B.B.C. stations is to be found in the transmitting hall of Aberdeen's new 5-kW station at Redmoss. Usually the programme control desk is in the control room, whereas at Redmoss this is included in the transmitter hall and is placed in front of the transmitter itself, as can be seen in this photograph.

News of the Week—

minutes—required merely for "baking" the valves.

Its first visit after the overhaul will be to Euston Station on Sunday and Monday next (September 18th and 19th) to show viewers the exhibition and celebrations with which the L.M.S. is commemorating the centenary of the opening of the London to Birmingham Railway.

NEW BEROMUNSTER STATION

Aerial One Mile from Transmitter

A FEATURE of the new Swiss broadcasting station at Beromunster which, it is expected, will be inaugurated during this autumn, is the great distance, 1.5 kilometres, that the aerial is situated from the transmitter.

This 100-kW station, which will work on the present station's frequency of 556 kc/s (539.6 metres), will be equipped with 700ft. aerial masts to overcome the difficulties of propagation experienced in this mountainous country.

A TIP TO CAMERAMEN

Criticisms of Production Methods at Alexandra Palace

TELEVISION methods at Alexandra Palace do not find favour in the eyes of Mr. Thomas H. Hutchinson, television programme director of the National Broadcasting Company of America, who has returned to his native heath after a visit to London and other European television projects. After a week in the B.B.C. television studios he formed the impression that camera movement is too restricted. A singer, for instance, is assumed to be more or less static; the camera is focused on him and "stays put."

American television, on the other hand, believes in using as many cameras as possible on a single subject, and picking up different angles to give variety to the image, in the same way as the cinema does. The instantaneous switching system adopted in the American experiments enables the operators to cut from one camera to another without the loss of a split second's viewing. The B.B.C. uses a superimposed fade, which often gives nothing but a blurred view and takes considerably more time for the first image to be replaced by a new picture.

While one is in censorious mood, it may be said that another ground of criticism, not confined to any American expert, is that fadeovers are not always carried out with intelligence. Where an orchestra is being televised it sometimes happens that a section of the players is shown on the screen at a moment when those players have nothing to do; or the back view or face of a pianist is shown when the hands and the keyboard are, at that moment, the main objects of interest.

LOUD SPEAKER LULLABY

THE loud speaker nuisance, like the poor, is always with us. And with our Continental contemporaries also. The ingenious excuse offered by a Berlin listener who was summoned for "excessively loud operation of wireless apparatus," was that he felt it his duty to render State announcements as audible as possible to the neighbourhood through the open window. This was a tacit admission of guilt and he was fined a substantial amount. A South Wales listener who offended similarly would no doubt have a sounder defence. His neighbour has written as follows:

"The other night, about 11.15, my husband went to ask our neighbours if they would turn their wireless down, as he wished to get to sleep. They had gone to bed!"

Limit of B.B.C.'s Power

A number of county and borough councils have, however, introduced a by-law under Section 249 of the local Government Act, 1933, making this an offence for which the penalty is up to £5. The B.B.C., on its side, considers that it has perhaps a moral obligation to restrain the perpetrators of the loud speaker nuisance and therefore broadcasts from time to time the following appeal:

"Here is a reminder for which we get many requests each week and in which we are particularly interested. It concerns the loud speaker nuisance, If you are listening out of doors, or by an open window, please keep your set as quiet as possible, so that the comfort of others may not be disturbed."

THE INDUSTRY IN YUGOSLAVIA

THE thirtieth Zagreb Trade Fair, which was held at the beginning of this month, showed that the wireless industry in Yugoslavia, where less than one per cent. of the population of 15,000,000 has receivers, has stagnated. The price of sets remains high, the cheapest being about 3,000 dinars (approximately £14), which includes the 20 per cent. luxury tax, while the licence costs approximately 25s. a year.

At the Fair only one English firm was represented, that being Kolster-Brandes, while German manufacturers were well to the fore, although a number of their stands exhibited placards only, the remainder featuring last season's sets. The only new German receivers were on the stands of the former Austrian manufacturers.

Other countries represented were France, Sweden, Holland and Switzerland.

Although there are so few listeners in Yugoslavia, it is the first Balkan State to have television demonstrations. These are being given by a Dutch manufacturer during the period of the Belgrade Autumn Fair, which closes on September 19th.

FROM ALL QUARTERS

Broadcasting in New Zealand

LAST year's revenue from broadcast advertising was £98,000, which meant that the State commercial broadcasting service suffered a loss of £7,800. One of the four stations operated for the full year, and it is reported that the expenditure included non-recurring establishment charges.

Radio in Australia

Two hundred and fifty thousand pounds has been set aside by the Australian Federal Government for the construction and equipment of a high-powered broadcasting station at Canberra, which, it is claimed, will be the most powerful in the Empire. Nearly £500,000 is also to be spent on the erection of twenty-five stations for communication and navigational purposes on the principal Australian air routes. The erection of a further twelve such stations is also under consideration.

Success of Paris Radio Salon

As the result of numerous requests from firms showing at the Paris Exhibition, it was extended for an extra day, not closing until Monday (September 12th) at 7 p.m.

Marconi-Branly Memorial

A monument to the memory of Marconi and Branly has recently been dedicated in the little French town of Wimereux, where wireless signals transmitted by Marconi at Dover were picked up by Branly in 1899.

Kettering Radio Exhibition

KETTERING Radio Society's sixth annual three-day Radio Exhibition is to be opened by Ann Ziegler at the Central Hall, Kettering, on Thursday, September 22nd. Daily demonstrations of television will be given and contests for amateur artistes will be run, with a B.B.C. talent spotter in attendance.

Milan's Radio Palace

THE Italian broadcasting organisation, E.I.A.R., has secured a site of 4,500 square metres in Milan on which to build a Palace of Radio.

Pitcairn Reception

APPARENTLY the new petrol generator provided by American subscribers for Pitcairn Island, and referred to by a correspondent in his letter on page 250 of this issue, is now in use, for a reader, Mr. C. Freaison, of Sutton-on-Sea, Lincs, reports reception of VR6AY, on 20 metres, on September 9th.

Servicing Instruction

A COURSE of instruction in radio servicing is being given at the Borough Polytechnic, London, S.E.1, during the coming winter session. Students will be prepared for the City and Guilds certificate examination. Practical repair work will be carried out and the lecturer will be Mr. J. de Gruchy, the originator and the first secretary of the National Radio Engineers' Association.

Exports Up

THE G.E.C. reports that British radio exports during the first six months of this year have exceeded by 50 per cent. those during the corresponding period of any other year.

Repairs While You Wait

A TRAVELLING radio repair shop has been put on the roads by Radio-Belgrade, and in a recent tour of Yugoslavia fifty towns were visited and 300 sets put in order.

For Prospective "Hams"

COMMENCING yesterday, a weekly evening radio class is being held at the Goldsmiths College, New Cross, London, S.E.14. Principles are explained by simple lectures and demonstrations, while on the practical side a short-wave transmitter (G6OW) will be in operation. Further information may be obtained from the Office of the College, or from Mr. A. L. Beedle, the lecturer, on Wednesday evenings.

Short Wave Report

VK2ME, the 20-kW station at Sydney, Australia, is to be heard in this country on 31.28 metres during the early afternoon. Its transmissions draw to a close with the song of the Kookaburra, or Laughing Bird, and this is followed patriotically by a rendering of the National Anthem. Reception reports are invited by Amalgamated Wireless, VK2ME, 47, York Street, Sydney, Australia.

Coming-of-Age

To celebrate the twenty-first anniversary of its foundation the Technological Institute of Great Britain has issued a "Coming-of-Age" booklet, copies of which are obtainable from the Institute, at Temple Bar House, London, E.C.4.

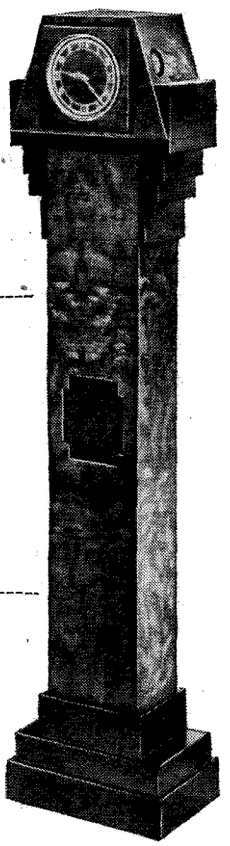
Whaling by Wireless

THE first wireless officer of the Norwegian *Kosmos* whaling expedition has constructed a midget USW transmitter, which is mounted on a flag harpoon, so that when shot into a whale it transmits a carrier wave which, it is claimed, by the aid of DF apparatus, aids the whalers in landing their catch in darkness.

The Laypak HT Battery

THE Acton Battery Co., Ltd., 57, Bridgman Road, London, W.4, have introduced an HT battery of compact size in which flat, rectangular cells are used instead of the conventional cylindrical type. Cells are assembled in 30-volt packs, after the manner of the original "Voltaic pile." The "standard" 120-volt battery measures 6¾ by 5¾ by 3in., and costs 5s.

British Tempovox MODEL RG3



Efficient Response from a Receiver of Unconventional Design

FEATURES. ***Waveranges.***—*(1) 200-570 metres. (2) 850-2,300 metres.* ***Circuit.***—*Triode hexode frequency-changer—var.-mu pentode IF ampl.—double-diode-triode 2nd det.—tetrode output valve. Half-wave rectifier—barretter current regulator.* ***Controls.***—*(1) Tuning. (2) Volume and on-off switch. (3) Waverange.* ***Price.***—*15 guineas.* ***Makers.***—*British Tempovox Ltd., Holly Road, Hampton Hill, Middlesex.*

THE idea of combining the wireless receiver with an electric clock is an attractive one, particularly in the modern small house where space sets a limit to the number of pieces of furniture which can be accommodated in any room. There is something more than mere novelty in the scheme, for the performance of the set is in every way comparable with a good table model superheterodyne, both from the point of view of liveliness and quality of reproduction.

A four-valve circuit is employed covering medium and long waves. The first valve is a triode hexode frequency-changer which is followed by a variable-mu IF amplifier operating at 465 kc/s. Signal rectification, AVC and first stage AF amplification are taken care of by a double-diode-triode and the output valve, which is a beam tetrode, is rated to give an undistorted output of 2½ watts under the prevailing conditions of operation.

AC or DC Mains

There is no mains transformer and the set functions equally well on AC or DC supplies. A half-wave rectifier supplies HT current and the valve filaments are connected in series with a barretter which is self-adjusting to mains voltages between 200 and 250 volts. When the set is to be used exclusively on AC mains a Smith's synchronous clock is fitted. Alternatively an 8-day spring clock can be provided, when the set may be safely used on either AC or DC mains.

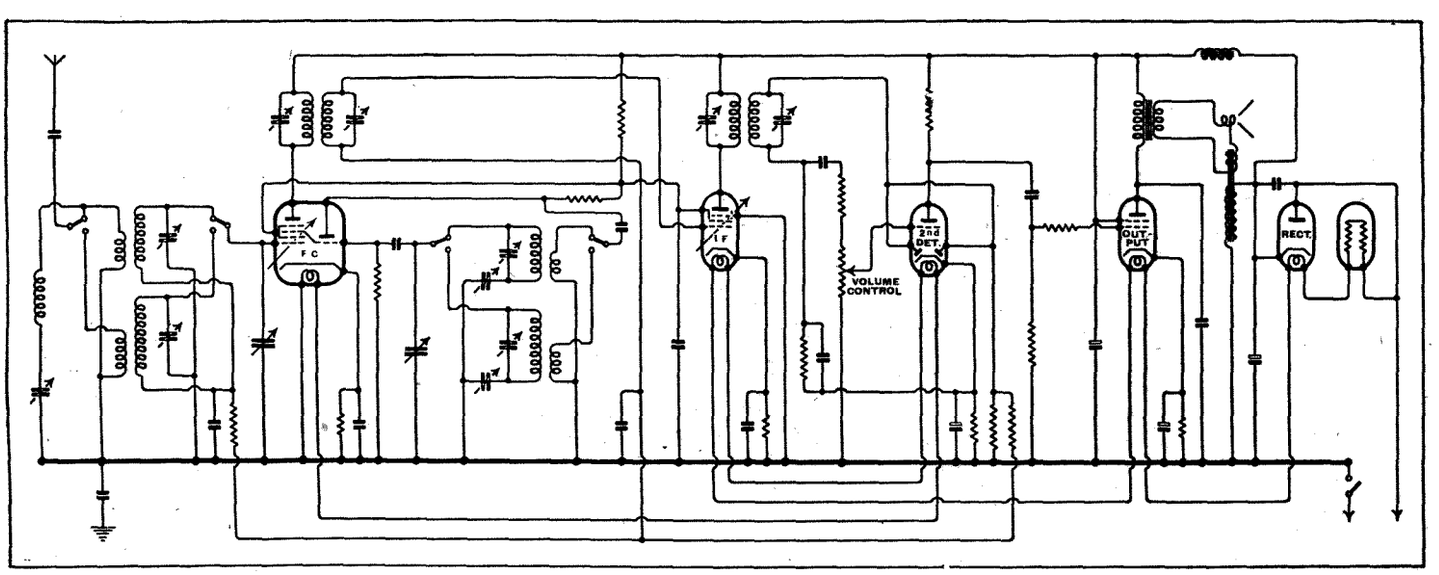
The "Grandmother" style case illustrated stands 4ft. 8in. high, but the radio chassis only occupies the space immediately behind the clock face. The layout of valves and components has been cleverly arranged to conform with the design of the case and the various tuned circuits are so disposed that individual screening cans are not required to achieve stability. Careful attention has been given to the question of heat dissipation and a metal cowl deflects the correction currents rising from the barretter and rectifier valve. The back panel is liberally slotted and the underside of the chassis is open to the centre column of the cabinet so that a cooling current of air is established. After a test extending over 4 hours the top of the cabinet was only just perceptibly warm.

Simple Tuning Controls

To preserve the non-wireless character of the cabinet the controls are hidden in recesses at each side. On the right is the tuning dial with station names engraved on the knurled and bevelled edge, and on the left a combined on-off switch and volume control with graduations showing the setting of the volume control. The switch action is light and when working the controls no fears need be entertained for the stability of the set despite the apparently small size of the base in relation to the height.

The set gives an excellent account of itself on a short indoor aerial, and even on the internal wiring between the alternative high and low level aerial terminal panels, which the makers have thoughtfully provided, the medium wave, locals and Droitwich come in at full loud speaker strength. With an outdoor aerial, which must be connected to the A2 terminal to prevent overloading of the frequency-changer on strong signals, any worthwhile European transmission is available. In fact, for general liveliness the set is at least the equal of any four-valve superheterodyne we have so far tested.

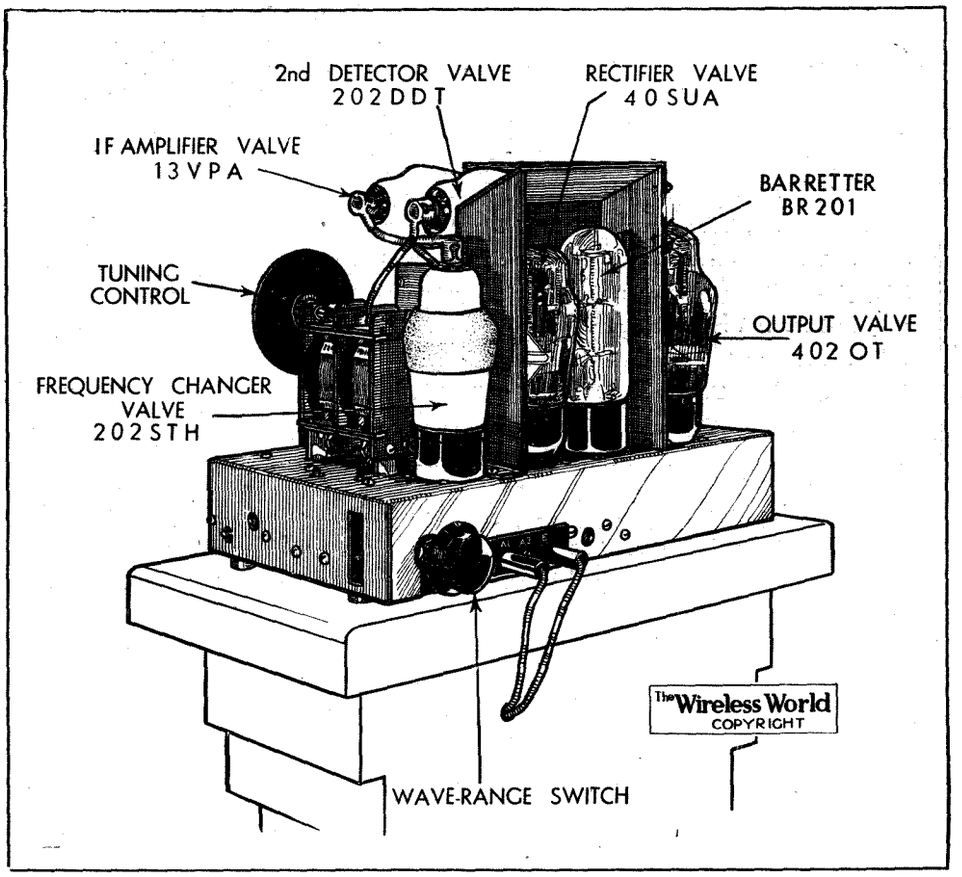
We were particularly impressed by the quiet background irrespective of the type



Complete circuit diagram. By careful disposition of the coils, individual screening has been dispensed with.

of aerial used, and the irritating hiss between stations which a set with AVC often produces, particularly on a short aerial, was practically non-existent.

the case above and below the unit, but the general tone does not betray the fact. The general effect leans towards a strong middle and upper register with consider-



The chassis layout is neatly arranged to fit the space behind the clock face.

The Celestion loud speaker is mounted midway down the centre column and ventilating slots are cut in the back panel immediately behind it. The baffle length from back to front is less than that of the average table model, but the bass response does not appear to suffer appreciably. Possibly some reinforcement is given by the air columns enclosed in

ably less directional radiation than is apparent in the conventional table model cabinet.

This must be one of the simplest sets to install and operate. There is no mains voltage adjustment to make, only two controls to work, and the hinged clock panel gives instant access to the back for starting and adjusting the hands.

Random Radiations

By "DIALLIST"

Astonishing

ONE of the most astonishing cases of wireless piracy that I've ever come across was that reported recently in the papers. It is just possible to understand why the licence payment is sometimes evaded by the very hard-up, whose receiving equipment consists of some ancient and ramshackle set, bought for a song or obtained as a gift. But it is almost beyond comprehension that the owner of a sixty-guinea radiogram should grudge the annual ten shillings that gives the right to entertainment from broadcasting stations all over the world. Representatives of the G.P.O. are reported to have stated in court that they had visited the owner's house no fewer than twenty-five times—so there was no lack of reminders.

Though the regulations lay down that an offender may have his set confiscated as well as being made to pay a fine, this punishment had never previously been inflicted. The magistrates, however, took such a serious view of this case that the owner who wouldn't pay ten shillings for a licence is now minus the sixty-guinea radiogram and a couple of pounds as well for the fine and the costs.

How Many Are There?

Just how many wireless pirates there are in this country no one can say. I shouldn't have put the total at much more than half a million, though it was suggested recently in the *Daily Telegraph* that there are twice as many as that. But whether they number half a million or a million, there are far too many of them, and the G.P.O. authorities are to be congratulated on the activity that they are displaying in looking them out. Several hundred prosecutions are undertaken each month, and, though sharp fines are often inflicted, they don't have sufficient deterrent effect on those who have, so far, escaped undetected. It would be no bad thing if it became a regular practice to order the confiscation of receiving sets in all cases where evasion of the licence payment was proved to be deliberate. That, I think, would "larn 'em," if nothing else would. People who don't mind risking the possibility of a fine of a pound or two would think twice about it if they knew that conviction would probably lead to the loss of a cherished receiving set or radiogram.

The Wireless Reserve

THE recently inaugurated Wireless Reserve of the Royal Air Force is going strong. It deserves the hearty support of all radio enthusiasts, and I am sure that it will receive it. Not every amateur, of course, is free to join. Many are already serving as citizen soldiers, sailors or airmen, or are holding important A.R.P. posts. But there must be a great number who are able to join the R.A.F. Civilian Reserve, and they're sure to come forward in strength. One great point about the scheme is that it gives the old 'uns a chance of doing their bit. Most of the training can be done at home, but those who want to gain experience by actual work with the Air Force, in the air or on the ground, will have opportunities of doing so.

No Loss!

AS I had expected, the Radiolympia attendance figures were a good deal below last year's. I should say, though, that any reduction in the numbers of the attendance was more than offset by its quality. What happened was that those who passed through the turnstiles in previous years just to see and hear the radio stars in the theatre or to add to their collection of autographs stayed away this time. They were no loss, for many of them simply made a bee-line for the fun fair and, if they went round the show itself at all, they focused their attention on any "stunts" that were to be found. This year's visitors came to hear wireless and to see television, which is as it should be. If you lingered for a few minutes at any stand, you couldn't help being impressed by people's keenness to discover what improvements had been made and by the knowledgeable questions that they put. This was particularly noticeable amongst those who had come to decide for themselves whether there really was anything in this press-button tuning.

Discrimination

Those on the stands, I'm sure, found that they had to deal with a much more discriminating type of enquirer than in the past. People who examined push-button sets weren't content to learn that if you pressed the button labelled Paris P.T.T., the set would at once deliver the goods in the shape of that station's programme. They wanted to know how the

automatic tuning was done, whether it was necessary to manipulate the wavechange switch if a long-wave station was involved, whether the button arrangements were likely to go out of adjustment, how changes in the repertoire of "buttoned" stations could be made, and so on and so on. One heard enquiries being made about the HT current drain of battery sets, about the cost and the capacity of replacement batteries, and about the provision of automatic grid bias. I imagine that far fewer sets will be sold this season just for the sake of their beautiful cabinets. The man-in-the-street has come to know that such beauty may be but three-ply deep, and he wants to know what's inside the cabinet.

By Easy Stages

THERE'S no doubt that the television receiver of the kind which brings in the "vision" only and contains an adaptor enabling an existing AC mains wireless set to deal with the accompanying sound has caught the fancy of those listeners who live within the service area of the Alexandra Palace transmitter. People may be loth to scrap a perfectly good wireless set in order to install a combined radio set and televisor. Or, again, they may not be attracted by the idea of buying an instrument which will receive nothing but the two parts of the television programmes. But the moderately priced device which enables the existing wireless set to be used appeals strongly to them. They feel, perhaps, that it will enable them to sample television for no great outlay, a point of view that one can readily understand. I believe that lots of people will go in for these "add-on" televisors, which may serve as an introduction to home television, just as in years gone by the crystal set and the one-valve set served as introductions to broadcast reception. They will thus graduate by easy stages to the full-blown radio-*cum*-television receiver.

Cut Off!

A CERTAIN firm of set makers was puzzled recently by the receipt of a letter, which read: "Dear Sirs, Enclosed is a postal order for ten shillings. I am sorry I forgot to send it before. Would you please send to reconnect my wireless set?"

They couldn't trace any outstanding debt of ten shillings from the customer, and, feeling that there must be more in the letter than met the eye, they despatched a representative to investigate. The owner of the set, a dear old lady, made him very welcome; she would be so glad to hear the programmes once more. Bit by bit he got her story out of her. On a certain evening the set had suddenly ceased to function. Looking up her wireless licence, she found that it had run out that very day: obviously she had been "cut-off" as a defaulter! A pity—isn't it?—that those who do default can't be cut off by the P.M.G.

Button Pushing

FOR the last few days I've been amusing myself with one of the very latest press-button sets. This particular model works its own wave-changing and it's almost uncanny to watch it. You're listening, perhaps, to W2XAD on 19.57 metres. A glance at your watch shows that it is just on 9.40—time for the third news bulletin from the home Nationals. All that you have to do is to press the Droitwich button. The American programme is cut off, there's a click inside the set and the indicator changes from short waves to long. Then, after a second or two of silence, whilst the pointer travels over the dial, you hear Bow Bells for a moment before the news begins. To go back to Schenectady after the news is over is almost as simple. Press the button marked "Short waves" and the indicator changes back again. Now touch the "cruising" button and keep your finger on it till the pointer reaches a point in the 19-metre belt somewhere near W2XAD's setting. Release the button, do the fine tuning by hand, and there you are.

Moths and Wireless

A READER who, besides being an amateur radio transmitter, is also a keen lepidopterist, writes to me about my recent note on the Oak Eggar moth. You may remember that I mentioned that if a female of this species is placed out of doors in a little cage, males will arrive from places miles away. I wondered whether or not their natural DF apparatus would be upset if the lady in the cage were placed in the neighbourhood of a radiating aerial. My correspondent says that the Puss moth is endowed with similar qualities; he believes, in fact, that all moths have them to some extent. But he holds that no kind of insect wireless is at work: scent, and nothing else, is the real explanation. I am not altogether satisfied, for five miles seems a long way for one small smell to travel! I am still hoping that some naturalist who is also an amateur radio transmitter, or a member of the engineering staff of a broadcasting or commercial transmitting station will experiment with moths and let us know what results he obtains. One interesting point, by the way, made by my correspondent, is that the Oak Eggar moth is very common in Cornwall, where radio DF is notoriously bad, owing to the large metallic deposits that are beneath the surface of the ground.

THE WIRELESS INDUSTRY

BIG increases in overseas sales of broadcast receivers are reported by the G.E.C. As an example, an order for 150 sets of various types has been received from Durban, Natal.

Wireless Supplies, Unlimited, has moved to Essex House, High Street, Stratford, London, E.15.

Messrs. Guy Campbell, H. L. Smith and L. R. Kavanagh have been appointed directors of Benjamin Electric, Ltd.

Rothermel-Brush piezo-electric microphones, pick-ups and other devices are described in a new catalogue issued by R. A. Rothermel, Ltd., Rothermel House, Canterbury Road, High Road, Kilburn, London, N.W.6.

Ferrolyte, of 67, Rue de la Croix Nivert, Paris 15e., has sent us an extremely well prepared and informative booklet (in French) dealing with Ferrolyte iron-dust cores and other productions. A great deal of technical information on the firm's products is given.

In view of the growing importance of sound insulation and acoustic treatment of buildings, it is interesting to observe that the makers of "Celotex" cane fibre insulating material are demonstrating the uses of their products in these directions at the Building Exhibition, which opens at Olympia to-morrow.

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

TELEVISION SETS

TELEVISION pictures are usually viewed in semi-darkness so as to make the most of the light from the fluorescent screen. This renders it somewhat difficult to effect accurate adjustment of the controls, unless the viewing is interrupted by introducing a light into the room.

To overcome the difficulty, the control scale is illuminated from the back by two dial lamps, supported inside a screen. The dial is made of translucent amber, or of some orange-coloured substance, the glow from which helps to increase the apparent whiteness of the picture appearing on the fluorescent screen. The dial and control knob may be covered, when out of use, by a sliding panel.

E. K. Cole, Ltd., and A. R. Knipe. Application date, February 5th, 1937. No. 485309.

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TIME-BASE CIRCUITS

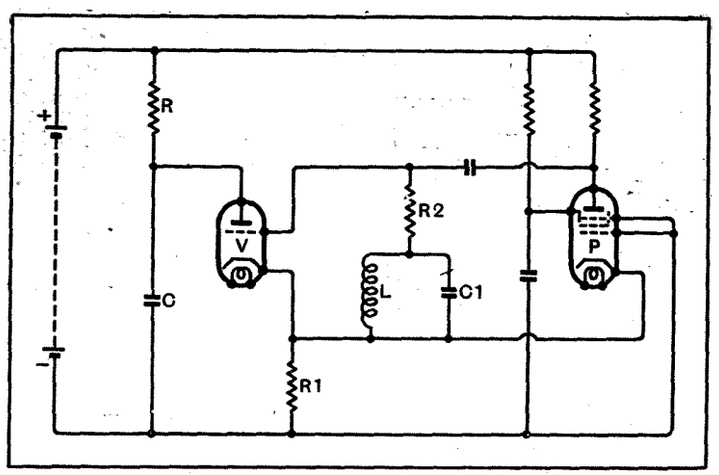
A TIME-BASE circuit for a television receiver is stabilised in frequency, even if the synchronising impulse should occasionally fail. It is also prevented from being "triggered" by interfering or undesired signals.

As shown in the figure, the condenser C is charged up through a resistance R, and is periodically discharged by a valve V to produce saw-toothed oscillations. During the charging period, the grid of the valve V is kept negative by the steady current flowing through a "control" pentode P which produces a bias across the cathode resistance R1.

A tuned "flywheel" circuit L, C1, in series with a resistance R2, is arranged in parallel with the pentode P and across the grid cathode circuit of the valve V. The current built up in this circuit applies a positive pulse to the grid of valve V, allowing that valve to discharge the condenser C rapidly, for the "fly-back" stroke. At the end of the discharge, the flywheel circuit applies a negative bias to the grid of V, to render it non-conductive, so that the condenser C can again charge up.

The synchronising impulses are applied to the coil L, but in any case the circuit L, C1 exercises a constant supervisory control over the timing of the discharge valve V.

The British Thomson-Houston Co., Ltd., and D. J. Mynall. Application date November 20th, 1936. No. 485934.



Television time-base embodying a frequency stabilising circuit.

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PENTODE VALVES

A PENTODE valve tends to generate second harmonics of the fundamental frequency it is handling. This is due to the fact that its "dynamic" characteristic is not symmetrical above and below the working point of the valve.

According to the invention this defect is corrected by setting up an asymmetrical space-charge on the cathode side of the suppressor grid. For instance, the suppressor grid may be wound as a spiral with turns which are more open at one part than another, the space-charge then tending to accumulate at the close-set parts of the winding. Or, instead of varying the pitch of the windings, the thickness of the wire can be graded to give the same effect.

The use of such a "variable" suppressor grid is found to reduce the power output of the valve to some extent, but it prevents any distortion due to the presence of even harmonics.

N. V. Philips Gloeilampenfabrieken. Convention date (Holland), March 25th, 1936. No. 485798.

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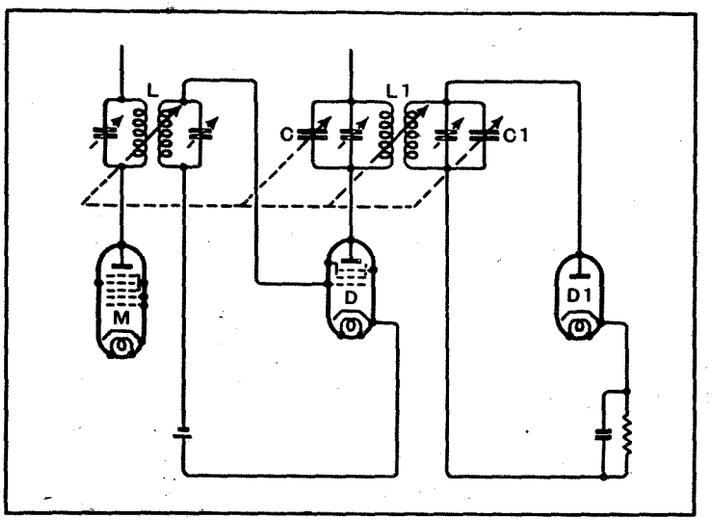
VARIABLE SELECTIVITY SETS

THE figure shows a band-pass filter for a superheterodyne circuit, in which the band-width can be varied within wide limits, yet so as to give uniform amplification of all the frequencies accepted.

The first part of the filter is inserted between the mixer valve M and the first detector D, whilst the second part couples the latter valve to the second detector D1. The coupling between the individual circuits of the first part is kept within the limits of "single-peak" resonance, whilst the coupling between the circuits of the second part is made sufficiently tight to produce a double hump. The combination will then give a "flat" resonance curve for the whole of the accepted band of frequencies.

Selectivity is adjusted by varying both the inductive couplings L, L1 and the ganged shunt capacities C, C1 so that for all settings the middle of the "accepted" band coincides exactly with the carrier frequency of the incoming signal, thus avoiding the usual frequency-distortion due to lack of symmetry.

N. V. Philips, Gloeilampenfabrieken. Convention date (Holland) June 29th, 1936. No. 485713.



Circuit details of wide-band amplifier for a superheterodyne receiver.

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PUBLIC ADDRESS SYSTEMS

ANY feed-back between the loud speaker and microphone in a public-address installation sets a limit on the amount of amplification which can be used, since the time comes when the whole system begins to "sing," particularly if there is any pronounced "resonance" frequency present.

According to the invention, feed-back is prevented by connecting the microphone to the loud speaker through a channel which contains a high-pass filter and an amplifier normally biased either to cut-off, or to low level of gain. A separate "control" channel is arranged, in parallel across the microphone, and is coupled through a low-pass filter to a rectifier which applies a gain-increasing bias to the main amplifier, so as to bring it into operation as soon as speech begins.

The different filters provided in the two circuits prevent feed-back between the two instruments, since the frequencies fed to the gain-control circuit are deliberately kept outside the transmission range of the filter feeding the loud speaker.

Radio Corporation of America. Convention date (U.S.A.) November 28th, 1936. No. 486290.

SHORT-WAVE OSCILLATORS

A MAGNETRON valve of the split-anode type is commonly used to generate high-frequency oscillations of the order of 100 megacycles or more. To handle such frequencies the anodes must be of small dimensions, and are usually made of carbon, tungsten, or tantalum. In the course of operation, the carbon or metal slowly evaporates from the anode and forms a film on the surface of the glass bulb. As the film is of high resistance, it tends to dissipate quite an appreciable amount of power in the form of eddy currents produced in it by the high-frequency field.

To prevent this loss, advantage is taken of the fact that less power is lost when eddy currents flow in a low-resistance conductor, even though the currents themselves may be large. Accordingly the surface of the glass tube, particularly near the pinch or sealing-in end, is coated, during manufacture, with a layer of highly conducting metal, on which any evaporated matter from the anodes can be deposited without creating a high-resistance film. A baffle-plate screens the insulation at the end of the tube from evaporated particles.

The M-O Valve Co., Ltd., and E. C. S. Megaw. Application date April 1st, 1937. No. 486244.

PRINCIPAL BROADCASTING STATIONS OF EUROPE

Arranged in Order of Frequency and Wavelength (Stations with an Aerial Power of 50 kW and above in heavy type)

Station.	kc/s.	Tuning Positions.	Metres.	kW.
Ankara (Turkey)	152		1973.5	5
Kaunas (Lithuania)	153		1961	7
Hilversum (No. 1) (Holland)	160		1875	10-150
Radio Romania (Romania)	160		1875	150
Lahti (Finland)	166		1807	150
Moscow (No. 1) (U.S.S.R.)	172		1744	500
Paris (Radio Paris) (France)	182		1648	80
Istanbul (Turkey)	185		1622	5
Irkutsk (U.S.S.R.)	187.5		1600	20
Deutschlandsender (Germany)	191		1571	60
National (Droitwich)	200		1500	150
Minsk (U.S.S.R.)	208		1442	35
Reykjavik (Iceland)	208		1442	100
Motala (Sweden)	216		1389	150
Novosibirsk (U.S.S.R.)	217.5		1379	100
Warsaw (No. 1) (Poland)	224		1339	120
Luxembourg	232		1293	150
Moscow (No. 2) (U.S.S.R.)	232		1293	100
Kalundborg (Denmark)	240		1250	60
Kiev (No. 1) (U.S.S.R.)	248		1209.6	100
Tashkent (U.S.S.R.)	256.4		1170	25
Bergen (Norway)	260		1153.8	20
Oslo (Norway)	260		1153.8	60
Vigra (Aalesund) (Norway)	260		1153.8	10
Leningrad (No. 1) (U.S.S.R.)	271		1107	100
Tromsö (Norway)	282		1065	10
Tiflis (U.S.S.R.)	283		1060	35
Moscow (No. 3) (U.S.S.R.)	300		1000	100
Saratov (U.S.S.R.)	340		882.3	20
Finmark (Norway)	347		864	10
Archangel (U.S.S.R.)	350		857.1	10
Rostov-on-Don (U.S.S.R.)	355		845.1	20
Budapest (No. 2) (Hungary)	359.5		834.5	18
Sverdlovsk (U.S.S.R.)	375		800	40
Banska-Bystrica (Czechoslovakia)	392		765	15–30
Boden (Sweden)	392		765	2.5
Voronezh (U.S.S.R.)	413.5		726	10
Oulu (Uleaborg) (Finland)	431		696	10
Baranowicze (Poland)	519		578	50
Ljubljana (Yugoslavia)	527		569.3	6.3
Viipuri (Finland)	527		569.3	10
Bolzano (Italy)	536		559.7	10
Wilno (Poland)	536		559.7	50
Budapest (No. 1) (Hungary)	546		549.5	120
Beromünster (Switzerland)	556		539.6	100
Klaipeda (Lithuania)	565		531	10
Palermo (Italy)	565		531	3
Radio Eireann (Ireland)	565		531	100
Stuttgart (Germany)	574		522.6	100
Alpes-Grenoble, (P.T.T.) (France)	583		514.6	20
Madona (Latvia)	583		514.6	50
Vienna (No. 1) (Germany)	592		506.8	100
Athens (Greece)	601		499.2	15
Rabat (Morocco)	601		499.2	20
Sundsvall (Sweden)	601		499.2	10
Florence (No. 1) (Italy)	610		491.8	20
Brussels (No. 1) (Belgium)	620		483.9	15
Cairo (No. 1) (Egypt)	620		483.9	20
Kouibyshev (U.S.S.R.)	625		480	10
Christiansand (Norway)	629		476.9	20
Lisbon (Portugal)	629		476.9	20
Tröndelag (Norway)	629		476.9	20
Prague (No. 1) (Czechoslovakia)	638		470.2	120
Lyons (P.T.T.) (France)	648		463	100
Petrozavodsk (U.S.S.R.)	648		463	10
Cologne (Germany)	658		455.9	100
Jerusalem (Palestine)	668		449.1	20
North Regional (Slaithwaite)	668		449.1	70
Sottens (Switzerland)	677		443.1	100
Belgrade (Yugoslavia)	686		437.3	20
Paris (P.T.T.) (France)	695		431.7	120
Stockholm (Sweden)	704		426.1	55
Rome (No. 1) (Italy)	713		420.8	120
Hilversum (Jaarsveld) (Holland)	722		415.4	17
Kharkov, (No. 1) (U.S.S.R.)	722		415.4	10
Madrid (EAJ2) (Spain)	731		410.4	3
Seville (EAJ5) (Spain)	731		410.4	5
Tallinn (Estonia)	731		410.4	20
Munich (Germany)	740		405.4	100
Marseilles (P.T.T.) (France)	749		400.5	100
Katowice (Poland)	758		395.8	12
Scottish Regional (Burghead)	767		391.1	60
Scottish Regional (Westerglen)	767		391.1	70
Stalino (U.S.S.R.)	776		386.6	10
Toulouse (P.T.T.) (France)	776		386.6	120
Leipzig (Germany)	785		382.2	120
Barcelona (EAJ1) (Spain)	795		377.4	7.5
Lwów (Poland)	795		377.4	50
Welsh Regional (Penmon) (Anglesey)	804		373.1	5
Welsh Regional (Washford)	804		373.1	70
Milan (No. 1) (Italy)	814		368.6	50
Bucharest (Romania)	823		364.5	12
Bodö (Norway)	823		364.5	10
Kiev (No. 2) (U.S.S.R.)	832		360.6	35
Stavanger (Norway)	832		360.6	10
Berlin (Germany)	841		356.7	100
Sofia (Bulgaria)	850		352.9	100
Valencia (Spain)	850		352.9	3
Simferopol (U.S.S.R.)	859		349.2	10
Strasbourg (France)	859		349.2	100
Pozna (Poland)	868		345.6	50
London Regional (Brookmans Park)	877		342.1	70
Graz (Germany)	886		338.6	15
Linz (Germany)	886		338.6	15
Helsinki (Finland)	895		335.2	10
Hamburg (Germany)	904		331.9	100
Dniepropetrovsk (U.S.S.R.)	913		328.6	10
Toulouse (Radio Toulouse) (France)	913		328.6	60
Brno (Czechoslovakia)	922		325.4	32
Brussels (No. 2) (Belgium)	932		321.9	15
Algiers (Algeria)	941		318.8	12
Göteborg (Sweden)	941		318.8	10
Breslau (Germany)	950		315.8	100
Paris (Poste Parisien) (France)	959		312.8	60
Odessa (U.S.S.R.)	968		309.9	10
Northern Ireland Regional (Lisnagarvey)	977		307.1	100
Bologna (Radio Marconi) (Italy)	986		304.3	50
Torun (Poland)	986		304.3	60
Hilversum (No. 2) (Holland)	995		301.5	10-60
Bratislava (Czechoslovakia)	1004		298.8	13.5
Chernigov (U.S.S.R.)	1013		296.2	4
Midland Regional (Droitwich)	1013		296.2	70
Barcelona (EAJ15) (Spain)	1022		293.5	3
Cracow (Poland)	1022		293.5	10
Königsberg (No. 1) (Heilsberg) (Germany)	1031		291	100
Parede (Portugal)	1031		291	5
Leningrad (No. 2) (U.S.S.R.)	1040		288.5	10
Rennes-Bretagne (France)	1040		288.5	120
West of England Regional (Washford)	1050		285.7	50
Bari (No. 1) (Italy)	1059		283.3	20
Tiraspol (U.S.S.R.)	1068		280.9	10
Bordeaux-Lafayette (France)	1077		278.6	60
Madrid (EAJ7) (Spain)	1095		274	5
Vinnitsa (U.S.S.R.)	1095		274	10
Kuldiga (Latvia)	1104		271.7	25
Naples (Italy)	1104		271.7	10
Melnik (Czechoslovakia)	1113		269.5	100
Nyiregyhaza (Hungary)	1122		267.4	6.25
North-East Regional (Stagshaw)	1122		267.4	60
Hörby (Sweden)	1131		265.3	60-100
Genoa (No. 1) (Italy)	1140		263.2	10
Trieste (Italy)	1140		263.2	10
Turin (No. 1) (Italy)	1140		263.2	7
London National (Brookmans Park)	1149		261.1	40
North National (Slaithwaite)	1149		261.1	40
Scottish National (Westerglen)	1149		261.1	50
Košice (Czechoslovakia)	1158		259.1	10
Monte Ceneri (Switzerland)	1167		257.1	15
Copenhagen (Denmark)	1176		255.1	10
Nice-Côte d'Azur (France)	1185		253.2	60
Coblenz (Germany)	1195		251	2
Frankfurt (Germany)	1195		251	25
Freiburg (Germany)	1195		251	5
Trier (Germany)	1195		251	2
Moravská-Ostrava (Czechoslovakia)	1204		249.2	5
Lille (Radio P.T.T. Nord) (France)	1213		247.3	60
Rome (No. 2) (Italy)	1222		245.5	60
Gleiwitz (Germany)	1231		243.7	5
Görlitz (Germany)	1231		243.7	5
Cork (Ireland)	1235		242.9	1
Saarbrücken (Germany)	1249		240.2	17
Riga (Latvia)	1258		238.5	15
Salamanca (Spain)	1258		238.5	20
Radio Mediterranée (France)	1276		235.1	27
Aberdeen	1285		233.5	1
Klagenfurt (Germany)	1294		231.8	5
Vorarlberg (Germany)	1294		231.8	5
Malmö (Sweden)	1312		228.7	2.5
Bremen (Germany)	1330		225.6	2
Flensburg (Germany)	1330		225.6	2
Hanover (Germany)	1330		225.6	2
Stettin (Germany)	1330		225.6	2
Dublin (Ireland)	1348		222.6	0.5
Genoa (No. 2) (Italy)	1357		221.1	5
Milan (No. 2) (Italy)	1357		221.1	4
Warsaw (No. 2) (Poland)	1384		216.8	7
Lyons (Radio Lyons) (France)	1393		215.4	25
Radio Normandie (Fécamp) (France)	1411		212.6	15
Vaasa (Finland)	1420		211.3	10
Kaiserlautern (Germany)	1429		209.9	2.5
Burgos (Spain)	1447		207.3	6
Paris (Eiffel Tower) (France)	1456		206	7
Bournemouth	1474		203.5	1
Plymouth	1474		203.5	0.3

SHORT-WAVE STATIONS OF THE WORLD

Arranged in Order of Frequency and Wavelength (Stations with an Aerial Power of 20 kW and above in heavy type)

Station.	Call Sign.	mc/s.	Tuning Positions.	Metres.	kW.
Amateurs	.....	1.71	.....	174.43	—
		to		to	
		2.00		150.00	
Amateurs	.....	3.50	.....	85.71	—
		to		to	
		4.00		75.00	
Bombay (India)	VUB2	4.90	.....	61.00	10
Madras (India)	VUM2	4.95	.....	60.61	10
Delhi (India)	VUD2	4.99	.....	60.06	10
Bandoeng (Java)	PMY	5.15	.....	58.30	1
Caracas (Venezuela)	YV5RC	5.97	.....	50.26	1
Mexico City (Mexico)	XEBT	6.00	.....	50.00	1
Pretoria (South Africa)	ZRH	6.00	.....	50.00	7
Montevideo (Uruguay)	CXA2	6.00	.....	49.96	5
Havana (Cuba)	COCO	6.01	.....	49.92	2.5
Podebrady (Prague) (Czechoslovakia)	**OLR2A**	6.01	.....	49.92	30
Sydney (Canada)	CJCX	6.01	.....	49.92	1
Zeesen (Germany)	**DJC**	6.02	.....	49.83	5–40
Podebrady (Prague) (Czechoslovakia)	**OLR2B**	6.03	.....	49.75	30
Boston (U.S.A.)	**W1XAL**	6.04	.....	49.67	20
Miami (U.S.A.)	W4XB	6.04	.....	49.67	5
Daventry (Gt. Britain)	**GSA**	6.05	.....	49.59	10–50
Cincinnati (U.S.A.)	W8XAL	6.06	.....	49.50	10
Philadelphia (U.S.A.)	W3XAU	6.06	.....	49.50	10
Lima (Peru)	OAX4Z	6.08	.....	49.33	15
Hong Kong (China)	ZBW2	6.09	.....	49.26	2.5
Capetown (South Africa)	ZRK	6.10	.....	49.20	5
Bound Brook (U.S.A.)	**W3XAL**	6.10	.....	49.18	15–35
Chicago (U.S.A.)	W9XF	6.10	.....	49.18	10
Belgrade (Yugoslavia)	YUA	6.10	.....	49.18	1
Daventry (Gt. Britain)	**GSL**	6.11	.....	49.10	10–50
Wayne (U.S.A.)	W2XE	6.12	.....	49.02	10
Montevideo (Uruguay)	CXA4	6.12	.....	48.98	1
Jelöy (Norway)	LKJ	6.13	.....	48.94	1
Havana (Cuba)	COCD	6.13	.....	48.92	1
Pittsburgh (U.S.A.)	**W8XK**	6.14	.....	48.83	28
Winnipeg (Canada)	CJRO	6.15	.....	48.78	2
San Jose (Costa Rica)	TIPG	6.41	.....	46.80	2
Riobamba (Ecuador)	PRADO	6.61	.....	45.31	2
Radio-Nations (Switzerland)	**HBQ**	6.67	.....	44.94	20
Amateurs	.....	7.00	.....	42.85	—
		to		to	
		7.30	.....	41.09	
Radio-Nations (Switzerland)	**HBP**	7.80	.....	38.48	20
Sofia (Bulgaria)	LZA	8.46	.....	35.44	1.5
Budapest (Hungary)	HAT4	9.12	.....	32.88	6
Havana (Cuba)	COCH	9.43	.....	31.80	1
Madrid (Spain)	EAR	9.49	.....	31.62	10
Rio de Janeiro (Brazil)	PRF5	9.50	.....	31.58	12
Melbourne (Australia)	VK3ME	9.50	.....	31.58	5
Bangkok (Siam)	HS8PJ	9.50	.....	31.58	5
Mexico City (Mexico)	XEWW	9.50	.....	31.58	10
Lahti (Finland)	—	9.50	.....	31.58	1
Daventry (Gt. Britain)	**GSB**	9.51	.....	31.55	10–50
Montevideo (Uruguay)	CXA8	9.51	.....	31.55	2.5
Skamlebaek (Denmark)	OZF	9.52	.....	31.51	6
Paris (Radio-Mondial) (France)	**TPB11**	9.52	.....	31.51	25
Pretoria (South Africa)	ZRH	9.52	.....	31.50	7
Hong Kong (China)	ZBW3	9.52	.....	31.49	2.5
Jelöy (Norway)	LKC	9.53	.....	31.48	1
Schenectady (U.S.A.)	**W2XAF**	9.53	.....	31.48	25
Zeesen (Germany)	**DJN**	9.54	.....	31.45	5–40
Podebrady (Prague) (Czechoslovakia)	**OLR3A**	9.55	.....	31.41	30
Vatican City (Vatican State)	**HVJ**	9.55	.....	31.41	25
Bombay (India)	VUB2	9.55	.....	31.41	10
Schenectady (U.S.A.)	W2XAD	9.55	.....	31.40	18
Sourabaya (Java)	YDB	9.55	.....	31.40	1
Zeesen (Germany)	**DJA**	9.56	.....	31.38	5–40
Lima (Peru)	OAX4T	9.56	.....	31.37	10
Millis (U.S.A.)	W1XK	9.57	.....	31.35	10
Manila (Philippine Isles)	KZRM	9.57	.....	31.35	1
Daventry (Gt. Britain)	**GSC**	9.58	.....	31.32	10–50
Lyndhurst (Australia)	VLR	9.58	.....	31.32	1
Philadelphia (U.S.A.)	W3XAU	9.59	.....	31.28	10
Sydney (Australia)	**VK2ME**	9.59	.....	31.28	20
Perth (Australia)	VK6ME	9.59	.....	31.28	2
Huizen (Holland)	**PCJ**	9.59	.....	31.28	60
Delhi No. 2 (India)	VUD2	9.59	.....	31.28	10
Moscow (U.S.S.R.)	**RW96**	9.60	.....	31.25	20
Capetown (South Africa)	ZRK	9.60	.....	31.25	7
Sourabaya (Java)	YDB	9.61	.....	31.20	1
Rome (Italy)	**12RO3**	9.63	.....	31.13	25
Lisbon (Portugal)	CS2WA	9.65	.....	31.09	2
Buenos Aires (Argentine Republic)	LRX	9.66	.....	31.06	10
Havana (Cuba)	COCQ	9.74	.....	30.08	1
Lisbon (Portugal)	CSW3	9.74	.....	30.08	5
Havana (Cuba)	COCM	9.83	.....	30.51	1
Madrid (Spain)	**EAQ**	9.86	.....	30.43	20
Marapicú (Brazil)	PSH	10.22	.....	29.35	12
Bandoeng (Java)	PMN	10.26	.....	29.24	1.5
Ruysselede (Belgium)	ORK	10.33	.....	29.04	9
Buenos Aires (Argentine Republic)	LSX	10.35	.....	28.99	12
Taihoku (Japan)	JIB	10.53	.....	28.48	10
Bandoeng (Java)	PLP	11.00	.....	27.27	1.5
Lisbon (Portugal)	CSW2	11.04	.....	27.17	5
Radio-Nations (Switzerland)	**HBO**	11.40	.....	26.31	20
Warsaw (Poland)	**SPD**	11.53	.....	26.01	20
Motala (Sweden)	SBP	11.70	.....	25.63	0.75
Winnipeg (Canada)	CJRX	11.72	.....	25.60	2
Paris (Radio-Mondial) (France)	TPA4	11.72	.....	25.60	12
Huizen (Holland)	**PHI**	11.73	.....	25.57	25
Boston (U.S.A.)	**W1XAL**	11.73	.....	25.57	20
Havana (Cuba)	COCX	11.74	.....	25.55	1
Daventry (Gt. Britain)	**GSD**	11.75	.....	25.53	10–50
Podebrady (Prague) (Czechoslovakia)	**OLR4B**	11.76	.....	25.51	30
Zeesen (Germany)	**DJD**	11.77	.....	25.49	5–40
Lahti (Finland)	—	11.78	.....	25.47	1
Boston (U.S.A.)	**W1XAL**	11.79	.....	25.45	20
Tokio (Japan)	**JZJ**	11.80	.....	25.42	50
Zeesen (Germany)	**DJO**	11.80	.....	25.42	5–40
Vienna (Germany)	OER3	11.80	.....	25.42	1.5
Rome (Italy)	**12RO4**	11.81	.....	25.40	25
Daventry (Gt. Britain)	**GSN**	11.82	.....	25.38	10–50
Wayne (U.S.A.)	W2XE	11.83	.....	25.36	10
Lisbon (Portugal)	CWS4	11.84	.....	25.34	5
Podebrady (Prague) (Czechoslovakia)	**OLR4A**	11.84	.....	25.34	30
Zeesen (Germany)	**DJP**	11.85	.....	25.31	5–40
Daventry (Gt. Britain)	**GSE**	11.86	.....	25.29	10–50
Pittsburgh (U.S.A.)	**W8XK**	11.87	.....	25.26	24
Paris (Radio-Mondial) (France)	**TPB7**	11.88	.....	25.24	25
Paris (Radio-Mondial) (France)	TPA3	11.90	.....	25.21	12
Moscow (U.S.S.R.)	**VZSPS**	12.00	.....	25.00	20
Reykjavik (Iceland)	TFJ	12.23	.....	24.52	7.5
Warsaw (Poland)	SPW	13.63	.....	22.00	2
Amateurs	.....	14.00	.....	21.42	—
		to		to	
		14.40		20.83	
Radio-Nations (Switzerland)	**HBJ**	14.53	.....	20.64	20
Moscow (U.S.S.R.)	RWG	14.72	.....	20.38	15
Moscow (U.S.S.R.)	**RKI**	15.08	.....	19.89	25
Zeesen (Germany)	**DJL**	15.11	.....	19.85	5–40
Vatican City (Vatican State)	**HVJ**	15.12	.....	19.84	25
Paris (Radio-Mondial) (France)	**TPB6**	15.13	.....	19.83	25
Boston (U.S.A.)	**W1XAL**	15.13	.....	19.83	20
Daventry (Gt. Britain)	**GSF**	15.14	.....	19.82	10–50
Bandoeng (Java)	YDC	15.15	.....	19.80	1.5
Tokio (Japan)	**JZK**	15.16	.....	19.79	50
Skamlebaek (Denmark)	OZH	15.17	.....	19.78	6
Daventry (Gt. Britain)	**GSO**	15.18	.....	19.76	10–50
Hong Kong (China)	ZBW4	15.19	.....	19.75	2.5
Lahti (Finland)	—	15.19	.....	19.75	1
Zeesen (Germany)	**DJB**	15.20	.....	19.74	5–40
Pittsburgh (U.S.A.)	W8XK	15.21	.....	19.72	18
Huizen (Holland)	**PCJ2**	15.22	.....	19.71	60
Paris (Radio-Mondial) (France)	TPA2	15.24	.....	19.68	12
Boston (U.S.A.)	**W1XAL**	15.25	.....	19.67	20
Daventry (Gt. Britain)	**GSI**	15.26	.....	19.66	10–50
Wayne (U.S.A.)	W2XE	15.27	.....	19.65	10
Zeesen (Germany)	**DJQ**	15.28	.....	19.63	5–40
Buenos Aires (Argentine Republic)	LRU	15.29	.....	19.62	7
Daventry (Gt. Britain)	**GSP**	15.31	.....	19.60	10–50
Schenectady (U.S.A.)	W2XAD	15.33	.....	19.57	18
Zeesen (Germany)	**DJR**	15.34	.....	19.56	5–40
Budapest (Szekesfehervar) (Hungary)	HAS3	15.37	.....	19.52	6
Hicksville (U.S.A.)	W2XGB	17.31	.....	17.33	5
Hong Kong (China)	ZBW5	17.75	.....	16.90	2.5
Zeesen (Germany)	**DJE**	17.76	.....	16.89	5–40
Wayne (U.S.A.)	W2XE	17.76	.....	16.89	10
Paris (Radio-Mondial) (France)	**TPB3**	17.76	.....	16.88	25
Huizen (Holland)	**PHI2**	17.77	.....	16.87	25
Bound Brook (U.S.A.)	**W3XAL**	17.78	.....	16.87	15–35
Daventry (Gt. Britain)	**GSG**	17.79	.....	16.86	10–50
Buenos Aires (Argentine Republic)	LSY3	18.11	.....	16.56	5
Radio-Nations (Switzerland)	**HBH**	18.48	.....	16.23	20
Bangkok (Siam)	HS8PJ	19.02	.....	15.77	5
Zeesen (Germany)	**DJS**	21.45	.....	13.99	5–40
Daventry (Gt. Britain)	**GSH**	21.47	.....	13.97	10–50
Schenectady (U.S.A.)	W2XAD	21.50	.....	13.95	18
Wayne (U.S.A.)	W2XE	21.52	.....	13.94	10
Daventry (Gt. Britain)	**GSJ**	21.53	.....	13.93	10–50
Pittsburgh (U.S.A.)	W8XK	21.54	.....	13.93	6
Daventry (Gt. Britain)	**GST**	21.55	.....	13.92	10–50
Amateurs	.....	28.00	.....	10.71	—
		to		to	
		30.00		10.00	
London Television (Sound)	.....	41.50	.....	7.22	3
London Television (Vision)	.....	45.00	.....	6.66	17
Amateurs	.....	56.00	.....	5.35	—
		to		to	
		60.00		5.00	
Amateurs	.....	112.00	.....	2.67	—
		to 120.00		to 2.50	

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CONTENTS

EDITORIAL COMMENT

Broadcast Frequency Tests

A Gap in the B.B.C. Service?

CORRESPONDENCE arising from the recent broadcast in which Mr. Reginald Foort demonstrated the frequency range of the B.B.C. Theatre Organ makes it quite clear that further tests of a similar character would be popular. As one reader puts it—"I found this run up the organ the best tit-bit I have had from the B.B.C. for years."

All agree that a more systematic presentation, with, for instance, an announcement of frequency accompanying each note, is required. Many have been puzzled by the poor response to the last few notes, terminating at 8,000 cycles per second, on receivers which had been designed to cover a much wider frequency response and which were, in fact, quite capable of reproducing heterodynes of the order of 9 kc/s. The probability is that these high-pitched organ pipes do not speak with the same intensity as those in the middle register, and we would hesitate to condemn any receiver or even entertain doubts regarding its frequency response on the basis of so vague a test.

A Standard Test Signal

Some years ago the B.B.C. transmitted calibrated tones from an oscillator which were invaluable to experimenters. We suggest that the practice might be revived. To make it of greater value to those who do not possess measuring instruments and must rely on aural judgment, the modulation in the middle register might be reduced and that in the bass and treble raised in accordance with the well-known equal loudness contours of the human ear. An average curve for the region in the vicinity of 75 phons could be prepared and followed either manually or mechanically at the modulation control as the frequency scale was traversed. It would then be possible to say that the rising or falling tone should sound of equal intensity throughout its duration within the range of loudness levels at which the average set is operated. A limited frequency range, from, say, 75 to 5,000 cycles, for commercial broadcast sets might be supplemented by a special transmission covering the full modulation range of the transmitter. Suitable speeds of traversing the scale, and methods of marking frequencies could be decided upon by experiment in collaboration with listeners.

P.A. Application

Belated I.E.E. Example

IT was with satisfaction that we learned that the Institution of Electrical Engineers has at last decided to place microphones and loud speakers in the Institution lecture theatre. Complaints have been made for a very long while that the acoustics of this theatre are deplorably bad and this, coupled with the fact that many of those who participate in the discussions or who read papers are unaccustomed to speaking in public, has deprived audiences of much of the benefit of these meetings through inability to follow the speakers.

It is to be hoped that this example by the Institution will be adopted widely in other lecture theatres and, as we have so often urged, in our entertainment theatres as well.

Electromagnetic Deflection

THE experimenter with electromagnetic deflection is often surprised to find very high voltages appearing on the line deflection output valve, in spite of its being operated from a supply of a few hundred volts only. The reason for the appearance of these voltages is given in this article

GENERATION OF HIGH PEAK VOLTAGES

AT one time electrostatic deflection of the electron beam in the cathode-ray tube was almost invariably adopted for television purposes. Although this method is still widely used, electromagnetic deflection is becoming more popular. With this system deflection is obtained by passing saw-tooth currents through coils mounted outside the tube and around its neck, whereas with the electrostatic method saw-tooth voltages are applied to plates mounted inside the tube.

This is no place to enter into the relative merits of the two rival methods; each has its own advantages and disadvantages. A great point is often made of the fact that with electromagnetic deflection the time-base can be run from a low-voltage HT supply—in fact, the same supply as the receiver. It is true that high-voltage equipment is reduced to a minimum and that only one high-voltage condenser and lead are required, but too much importance should not be attached to this.

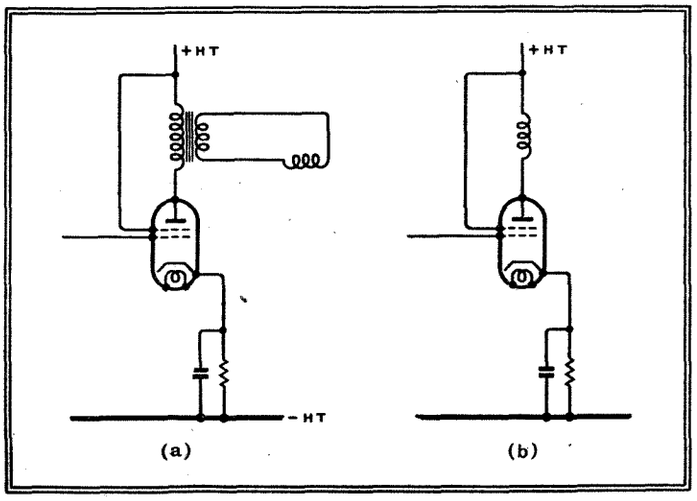


Fig. 1.—The conventional output circuit of the line time-base is shown at (a) and the equivalent circuit with the coil connected directly in the anode circuit of the valve at (b).

Although the time-base operates at a low voltage it usually consumes a more than proportionately heavy current, and in spite of the HT supply being low, very high voltages appear at certain points.

A time-base for electrostatic deflection usually operates at about 1,000 volts, takes some 20 mA., and gives a push-pull output of about 1,000 volts p-p. The HT power is thus 20 watts, the mean anode voltage of the valves is of the order of 500 volts, and the peak potential 750 volts. A magnetic time-base, however, probably takes 100 mA. at 300 volts, or 30 watts. The applied anode voltage of the output valve is only 300 volts, but the maximum peak potential may be several thousand volts!

At first this may seem unbelievable, but it is nevertheless true. It is, however, difficult to see how voltages, which may easily be ten times the supply voltage, can appear on the anode. The effect is caused by the waveform of the signal and the nature of the anode circuit load impedance.

The usual circuit is shown in Fig. 1 (a) from which it can be seen that the deflecting coil is fed from a tetrode or pentode valve through a transformer. This is necessary to keep the mean anode current out of the coil, for if it were allowed to flow through the coil it would deflect the spot off the screen of the tube. For the moment, however, this can be ignored and the simpler circuit shown at (b) considered. Here the coil is directly in the anode circuit.

The valve forces a saw-tooth current through the coil. In passing it should be noted that the voltage waveform on the grid is not necessarily of saw-tooth shape. The grid voltage necessary depends on L/R where L is the coil inductance and R is the resistance, including the valve anode AC resistance. If L/R is large, the grid voltage must be of rectangular waveform to give a saw-tooth current through the coil; if L/R is small, the grid voltage must be of saw-tooth waveform; if L/R is moderate, the grid voltage must be more complex and consist of a combination of rectangular and saw-tooth waveforms.

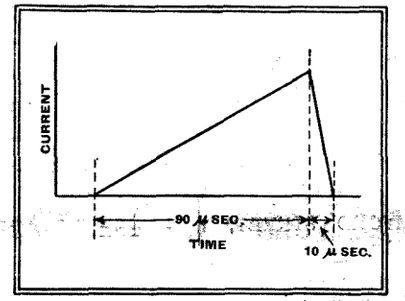


Fig. 2.—An idealised saw-tooth waveform is shown here with a linear stroke and fly-back.

It is usually easiest to generate a saw-tooth voltage wave, and in practice L/R is made small by making R large. Hence the use of a tetrode or pentode output valve; its AC resistance is often further increased by an appropriate form of negative feed-back.

In Fig. 2 is shown the ideal line scanning waveform. The current rises steadily for 90 μsec. for the line stroke and then falls back in 10 μsec. for the fly-back. (These figures are approximate only, for the line time is taken at 100 μsec. for convenience; it is actually 1/10,125 sec.) Now when the current through an inductance changes a back EMF is generated in such a direction as to oppose the change of current. This back EMF $e = \frac{-Ldi}{dt}$ where L is the inductance in henrys, and di is the change of current (amperes) occurring in an infinitesimally small interval of time dt (seconds). With the particular waveform of Fig. 2 the changes of current are linear so that we can take the total change of current over the total time in which it occurs.

To fix our ideas, let us suppose that the coil inductance is 0.5 H. and the current change 100 mA. Over the line scan the back EMF is $e = -0.5 \times 0.1/0.00009 = -556$ volts. If the output valve is operated at 300 volts, its anode potential would be −256 volts. On the fly-back, the change of current and the inductance are the same, but the time is 10 μsec.; hence, the back EMF is 5,000 volts. With 300 volts anode supply the anode potential becomes +5,300 volts!

Peak Voltage on the Valve

In practice, of course, these particular conditions could not arise, for the anode potential cannot become negative during the line scan. If the valve were driven hard in an endeavour to obtain a 100 mA. current change, a much smaller current would be secured and the waveform would be distorted. In general, the anode potential cannot swing below +50 volts, and with tetrodes and pentodes it is as well to limit it to +100 volts. For the current and inductance we have assumed, therefore, the minimum HT voltage for the valve must be 656 volts and then the peak anode voltage will vary between +100

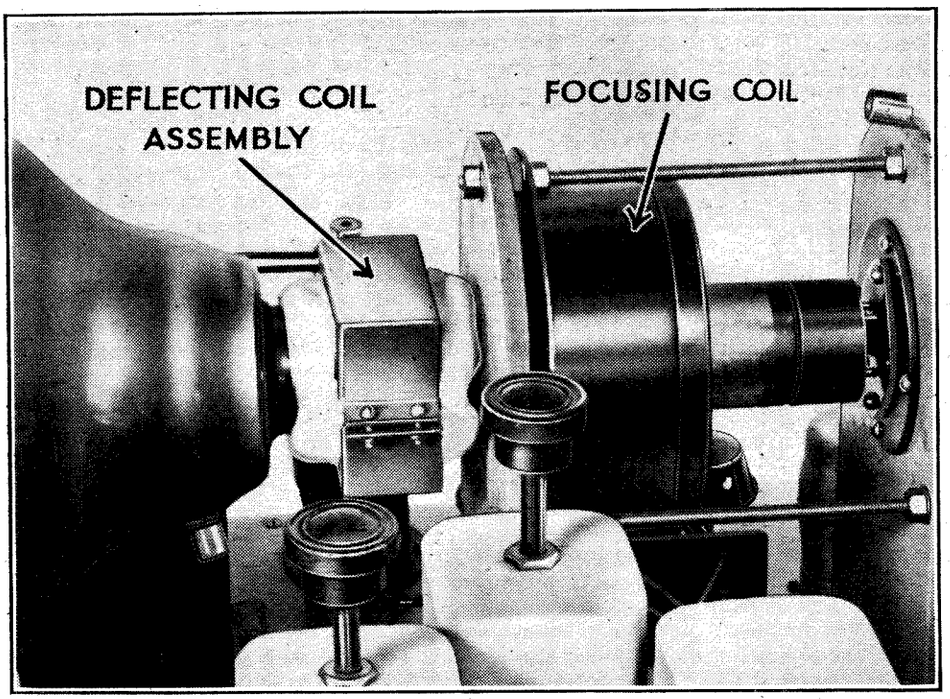
in Television

By W. T. COCKING

volts and +5,656 volts.

In actual practice the peak voltage will be even higher because the current on the fly-back is not linear but exponential; at the start of the fly-back it changes more rapidly and the peak voltage is proportionately higher. At the end of the fly-back, of course, the current change is slower and the peak voltage is lower.

In a practical case the conditions depend on the tube, its anode voltage and the coil design. The above example was selected at random for illustrative purposes and does not fit normal practice. In general, a pentode is used taking 70 mA. at 300 volts. If the minimum anode potential is 100 volts the back EMF on the line scan must be 200 volts, so that with a linear fly-back the peak anode voltage will be 300 + 1800 = 2,100 volts. In practice it will be greater because of the exponential fly-back.



A view of a typical magnetic tube with the focusing and deflecting coils in place.

Now if the valve is to be reasonably linear we can hardly let the minimum anode current fall below 15 mA.; the total change in anode current is thus 2(70 − 15) = 110 mA. We can now work out the maximum inductance for the coil; we have

$$200 = L \times \frac{0.11}{0.00009} \quad \text{or} \quad L = \frac{0.00009 \times 200}{0.11}$$

$$\frac{1.8}{1.1} \times 10 = 0.164 \text{ H.}$$

For deflection we require that the magnetic field shall change by a given amount in a given time. The magnetic field is proportional to the ampere turns—that is, to ni where n represents the turns and i the current. The inductance, however, is proportional to the square of the turns, and the back EMF to the inductance. It is thus only possible to reduce the back EMF by using a lower inductance coil and increasing the current.

Reducing the Coil Voltage

Thus, in the above example we have for a linear fly-back a back EMF of 1,800 volts, a current of 110 mA., and an inductance of 0.164 H., for which n turns are needed. Suppose we wind the coil with n/10 turns, the current must become 1.1 ampere for the same magnetic field, and the inductance will be 0.00164 H. Consequently the back EMF will be 180 volts only (ten times the current, one-hundredth the inductance).

Such a coil can be fed from the valve with a 10-1 ratio transformer, as in Fig. 1(a). Conditions on the valve are unchanged, and the same back EMF appears on its anode, for the coil voltage is stepped up to the valve by the transformer. A transformer, or choke-condenser, feed must in any case be used to keep the mean anode current out of the coil, and by using a step-down ratio in the transformer the peak voltages in the coil are reduced. This is important, for it is difficult to secure high insulation in the coil, since it must be as compact as possible to secure the desired field with the minimum current. The insulation requirements are transferred to the transformer primary, where they are more easily met.

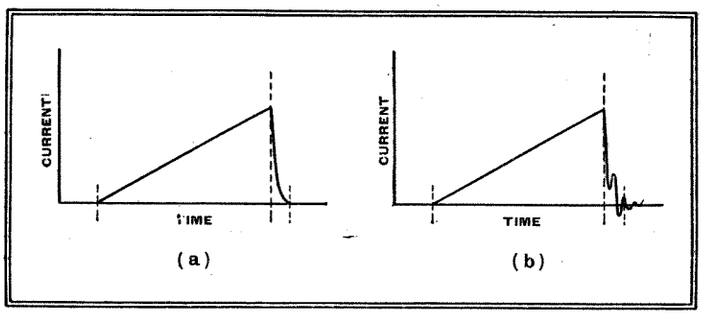


Fig. 3. — A good practical saw-tooth wave is shown at (a); the stroke is linear, but the fly-back is exponential. The waveform at (b) is met with sometimes and leads to the generation of very high peak voltages.

The back EMF on the valve can only be reduced by using a valve passing a heavier anode current so that the saw-tooth current can be greater and the effective anode circuit inductance less. This is uneconomical, and in practice one chooses the smallest current possible subject to the back EMF that the valve will stand. The precise conditions depend upon the tube, its anode voltage and its coil design. A tube with a small deflection angle, which means either a small picture or a long tube, operated at a moderate anode voltage, can with good coil design be operated by a valve taking only 30-40 mA. anode current. On the other hand, some of the new short tubes have such large deflection angles that at least 70 mA. is needed.

The linear fly-back upon which the calculations have been based does not occur in practice, and it gives the minimum value of back EMF. The exponential fly-back causes much higher voltages, and in practice steps must be taken to reduce them. The fly-back time can be 15 per cent. of the line time without harm to the picture, and a slightly greater time does not have a very bad effect on the picture. It is undesirable, however, in that one loses a bit of the picture. The longer fly-back time reduces the back EMF, but there is nothing else that can be done.

In the foregoing, any stray capacities and self-capacities of coil and transformer have been ignored. These capacities with the inductance form a resonant circuit which is kicked into oscillation on the fly-back. This lengthens the total fly-back time and increases the back EMF, because, although the total time is longer, the current changes more rapidly over part of the time. This is shown in Fig. 3, where (a) depicts an exponential fly-back, and (b) shows the fly-back when the circuit is kicked into oscillation. To prevent this, the series combination of a resistance and a condenser is often connected across the primary or secondary of the transformer. This resistance capacity circuit damps the coil, and the op-

Electromagnetic Deflection in Television—

timum conditions are obtained when it is adjusted so that the damping is just sufficient to prevent oscillation. Unfortunately, it tends to lengthen the fly-back time.

Reference has been made to the current changing by a certain amount in a given time, but no mention has been made of what makes it do so. The minimum time is governed by the time-constant of the deflection circuit—that is, by L/R. If the grid volts of the output valve fall instantaneously to zero (or in practice if they fall more quickly than the anode current) the anode current change is only limited by the anode circuit, and it falls exponentially. This means that it takes infinite time to complete its change. In practice the next scan voltage on the grid comes along before the current has fallen completely and starts the next rise of current. The result is some loss of output. Suppose we arbitrarily say that in one-tenth the line time (10 μ-sec.) the current must fall to 1 per cent. of its initial value. Then approximately $L/R = t/2.5 = 10^{-5}/2.5 = 4 \times 10^{-6}$. We have seen that in a typical case L = 0.164 H., hence R = 41,000 ohms.

An output pentode has an AC resistance of the order of 20,000-60,000 ohms and meets the case admirably, especially if its resistance is increased by the right sort of negative feed-back. There is one point to beware of if this is done, however, and especially if the resistance-capacity limiting circuit is not used. If the fly-back time of the saw-tooth voltage applied to the grid is more rapid than is necessary, or if it contains very rapid changes of voltage as when there is a superimposed oscillation, the anode current will be able to follow them, and the back EMF on the coil will be abnormally high. This is especially important in experimental work with saw-tooth oscillators, for when they are not working properly very peaky waveforms may be secured.

Arcs on the Fly-Back

The writer has experienced trouble of this kind. Curiously enough, the trouble is usually external to the valve. An occasional flash-over inside may occur in experimental work and apparently without doing any harm. He has had, however, a continuous arc develop between the sockets of the valveholder! Valves designed for magnetic time-base use now usually have a top-anode connection, but this is by no means essential if care is exercised in the choice of valveholder. As might be expected, quite a nasty shock can be obtained from the anode of the line output valve in spite of the supply of 300 volts only.

The same troubles do not occur in the case of the frame time-base. It is usual to operate with about half the current and four times the inductance (the same ampturns), but the fly-back time is roughly 100 times as long. The back EMF is thus only about one-fiftieth of that on the line valve, and no difficulty arises. Of course, one must always be on one's guard against faults which cause very peaky waveforms and so give rise to unusually high peak voltages.

The Fluorescent Screen

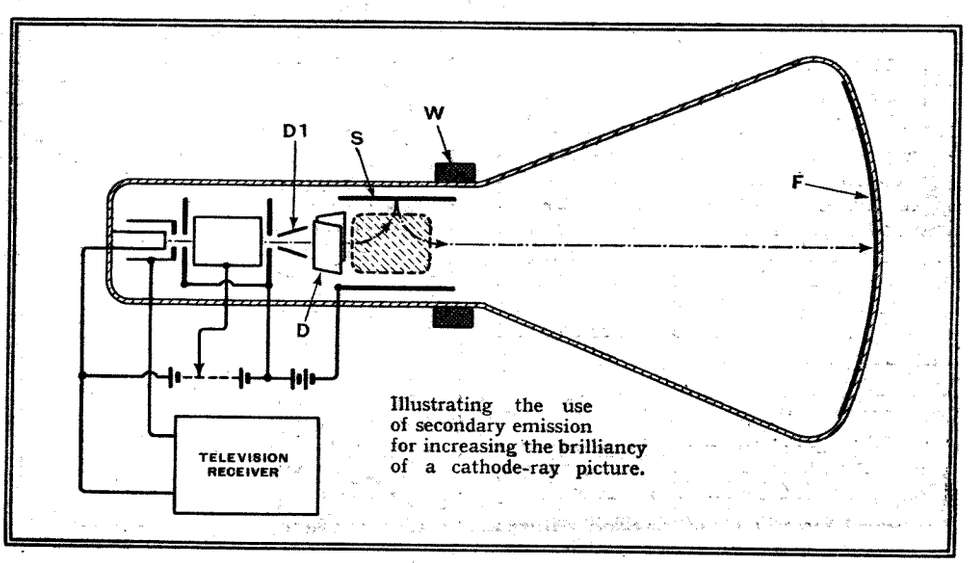
LIMITS OF BRILLIANCE

THE cathode-ray tube, in spite of many outstanding merits is still handicapped by the restricted size and comparatively poor illumination of the picture produced on the fluorescent screen. A possible alternative may be found in the so-called "projection tube," in which a brilliant incandescent image is built up by the impact of the electron stream on a special screen made of extremely thin metal. The glowing picture admits of considerable optical magnification, and promising results have already been secured in this way.

Meanwhile, the problem of improving the performance of the ordinary fluorescent screen is being tackled in other ways. One ingenious scheme makes use of secondary emission in order to augment the normal strength of the electron stream flowing through a cathode-ray tube under given operating conditions. There is, of course, a limit to the illumination that can safely be produced from the screen without shortening its life—or actually burning it out—and "boosting" by secondary emission can only be applied to get the best possible results within this safety factor. In other words, it is intended to produce a more brilliant picture than could otherwise be obtained from a given range of supply voltages.

One such arrangement is shown in the accompanying drawing (from Patent 486915), where the secondary-emission electrode S is interposed between the scanning electrodes D, D1 and the fluorescent screen of a cathode-ray tube. It will be observed that the auxiliary "emitting" electrode is set parallel with the path of the main electron stream, so that the latter must be deflected through a right-angle, as shown by the arrowed line, in order to make the impact necessary to produce secondary electrons. A strong magnetic field, represented by the shaded area, and passing through the tube at right-angles to the plane of the paper, deflects each primary electron from the straight path on to the surface S. It is obvious that the resulting secondary electrons must travel away from the surface S in the opposite direction to the arriving electrons. But since the deflecting action of the applied magnetic field is also reversed, the departing stream will be bent clear away from the arriving stream, as shown, until it reaches the main axis of the tube.

Here an external magnetic coil W focuses the reinforced electrons on to the fluorescent screen F, where the increased energy produces a brighter picture than usual. In order to ensure copious secondary-emission, the electrode S is separately heated by a local battery.

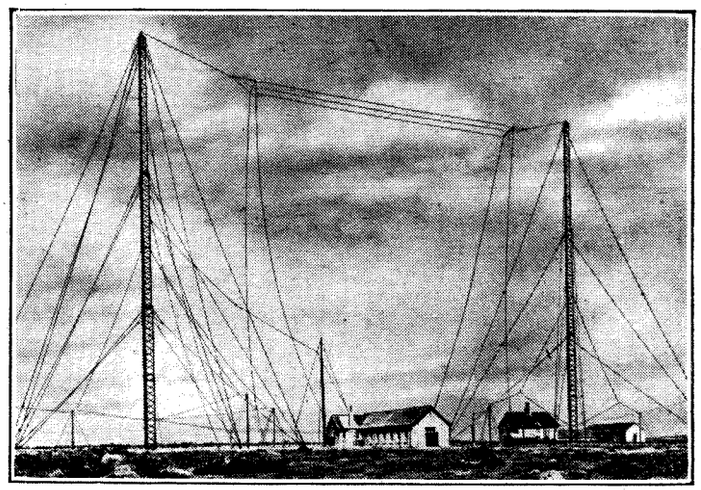


Illustrating the use of secondary emission for increasing the brilliancy of a cathode-ray picture.

How to Use the Cathode Ray Tube. By J. H. Reyner, B.Sc. Pp. 40. Published by Furzehill Laboratories, Boreham Wood. Price 1s.

AS its title implies, this booklet deals with the operation of a cathode-ray oscillograph. A brief description is given of the CR tube and the effect of the controls usually fitted to an oscillograph is dealt with. Clear instructions are given, in general terms, for its use in the more common applications, such as waveform examination, viewing resonance curves, and valve characteristics.

The booklet is illustrated by numerous photographs of CR tube traces which will be particularly helpful to the beginner in showing him what to expect. W. T. C.



Landsend Radio

BRITAIN'S SOUTH-WESTERN WIRELESS OUTPOST

By

J. AINSLIE

ALTHOUGH GLD has been somewhat eclipsed in importance by short-wave ship-to-shore working, it is still the first Home station with which communication is established by many homeward-bound ships. It also handles a large volume of traffic relating to marine casualties in the mouth of the Channel.

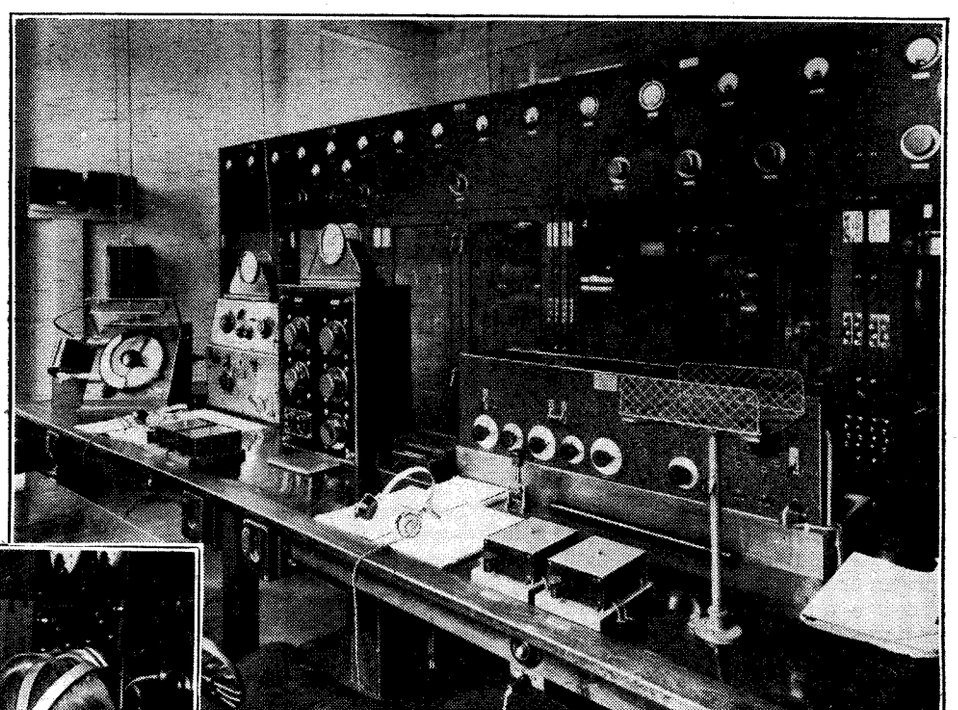
SITUATED on the Cornish moors near St. Just and about seven miles from Penzance, Landsend Radio (GLD) was opened in 1913 to take the place of The Lizard Wireless Station (LD). The latter—one of the first Marconi shore stations—was erected in 1901 for communication with ships. This two-roomed wooden hut near Lizard Head housed a ten-inch induction coil transmitter for "plain aerial" working and a coherer receiver. The coil was energised from a battery of dry cells and the transmitter condenser was made up of 12 leyden jars; the range of the station was 50 miles. Some years later the dry battery was replaced by accumulators charged from a dynamo, belt-driven by a two-stroke paraffin engine, and the coherer was replaced by a magnetic detector and Multiple Tuner. This gave the station a daylight range of 100 miles on 600 metres; provision for working on 300 metres was also made.

The Post Office took over The Lizard station in 1908, but it continued to be worked by Marconi operators until 1911, when the Post Office provided its own staff. It was closed in 1913 when Landsend Radio came into service, but was reopened during the war; the wooden masts and buildings were dismantled in 1920.

The GLD of 1913 had a 5-kW (input) synchronous spark transmitter with a note frequency of 600 c/s, and to the magnetic detector and multiple tuner were added perikon and carborundum-steel detectors. The wavelengths then employed were 300, 450 and 600 metres—frequencies were not quoted in those days—and the daytime range of the station was an official 250 miles, but 800 to 1,000 were commonly worked after dark.

On the power side the prime mover was a 15 h.p. engine driving a direct-coupled DC generator; this equipment was duplicated, and the battery consisted of 120 300-ampere-hour accumulators. A second transmitter employed 1.5-kW asynchronous spark apparatus, and for emergency purposes a 10in. coil with a dry-cell battery was used.

The station was modernised in 1932, and the present main CW/ICW transmitter then installed has an aerial power of 5 kW and can put 26 amperes in the aerial on 600 metres. The note frequency employed is 1,100, and the transmitting valves in use are 6 rectifiers, 1 oscillator, 1 amplifier, 2 modulators and 1 modulator amplifier. The transmitter is supplied from the mains, and has a day range of 500 and an effective night one of 1,500 miles. The emergency CW/ICW valve transmitter—1-kW output—obtains its supplies from a battery-driven 230-volt 550-cycle motor alternator; it has a day range of 300 and a night one of 500 miles.



(Above) Operating bench at GLD, with transmitter control panel in the centre. On the left is the directional receiver, with the help of which much interference is avoided.

Landsend Radio—

A third 0.3-kW battery-supplied transmitter is used for short-range radio-telephone (RT) purposes. This set has a day range of 100 miles on telephony, and can be worked on CW or ICW on frequencies between 3,000 and 1,200 and 500 and 375 kc/s.

The power supply—a 3-phase one at 240 volts 50 cycles—is obtained from 11,000-volt overhead transmission lines which are terminated at a 40-kVA transformer on the site. This voltage is stepped down to 415 between phases and 240 volts between the phases and neutral; a 15-kVA 3-phase transformer steps up the mains-supply voltage for the high-tension supply to the rectifiers of the main transmitter.

In the event of a mains failure continuity of the station's radio services is ensured by the availability of 52 450-ampere-hour accumulators. This battery supplies the emergency transmitter and lights the premises; it can be charged either by an engine-driven dynamo or a mains-driven motor-generator. The engine is a 4-cylinder 15 h.p. one; it runs on paraffin and is directly coupled to the dynamo.

Two 210-foot steel lattice masts carry the main transmitting and receiving aerials as well as two sets of Bellini-Tosi loops. One set of these loops is calibrated for direction-finding purposes, and is supplemented by an Adcock DF aerial system situated about three-quarters of a mile away and connected to the station by a buried cable.

Directional Reception

The receiving apparatus includes two modern direction finders covering the 2,500/75 kc/s band of frequencies, and two other receivers capable of operation on 3,000-1,360 kc/s. The former are used for morse ship services and the latter for radio-telephony reception; the HT supplies are obtained from metal rectifiers and the LT from accumulators.

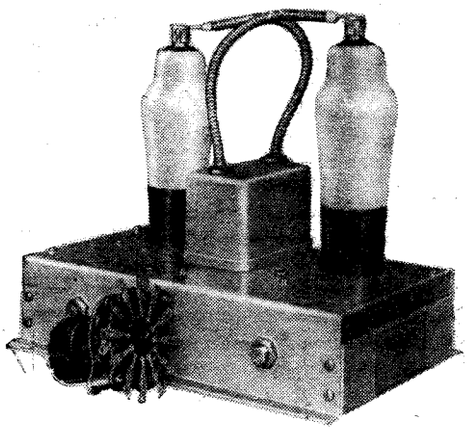
The Lizard had a staff of three operators; there are eleven at Landsend. Of the latter there are three on duty 0800-2300 GMT daily and two at other times. A continuous watch is maintained on 500 kc/s for morse signals from ships, and one on 375 kc/s from 8 a.m. to 11 p.m. Additionally, there is always one operator on land-line duty to attend to the teleprinter (duplex), telephone and radio-telephony circuits. The officers on the 500 and 375 kc/s morse listening points have automatic control of the transmitters from where they sit side by side; one transmits or receives radio-telegrams while the other searches directionally for ships' calls on 500 kc/s.

The wireless services performed by Landsend are very similar to those of Humber Radio, to be described later. The main difference in the work of the stations lies in the fact that the greater part of Landsend's business is with morse ships, many of which come into touch at appreciable ranges, and that there is not yet a radio-telephone link at the Cornish station. About 100 ships communicate with Landsend each day—some of them may do so a dozen times daily for several days—and the number of maritime casualties which have been dealt with at that station is probably in excess of that handled by any other wireless station.

Landsend's morse frequencies are 375, 385, 439, 500 and 1,520 kc/s; and the radio-telephony ones are 1,650, 1,837 and 2,500.

Haynes Radio Programme

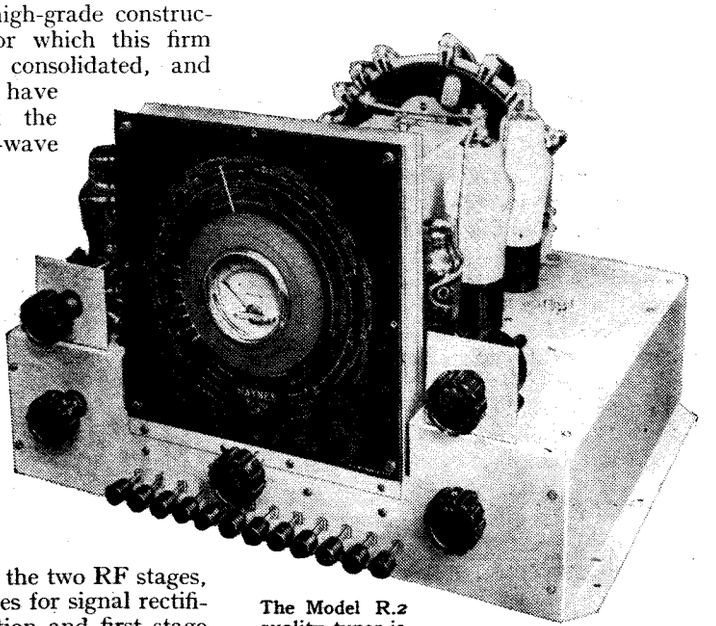
NEW CHASSIS UNITS FOR BROADCAST AND TELEVISION RECEPTION



Haynes Radio Model HTS converter unit for ultra-short-wave broadcast reception.

FOR the 1938-39 season the series of quality amplifiers, tuner units and components of high-grade construction and neat finish for which this firm is noted have been consolidated, and numerous additions have been made to meet the demand for ultra-short-wave sound and television equipment.

The Model R.2 straight 2 RF tuner unit can now be obtained with press-button motor controlled tuning for £19 10s. including valves. A choice of eleven stations is provided, and the twelfth button changes from automatic to manual tuning. In addition to the two RF stages, there are separate valves for signal rectification, AVC amplification and first stage AF amplification.



The Model R.2 quality tuner is now available with press-button motor control.

Two new USW converter units have been introduced. They are the Model TS single triode hexode frequency-changer unit at 50s., and the Model HTS with an additional stage of RF amplification at 70s. They are designed for use in conjunction with any standard receiver for the reception of the high quality broadcasts from Alexandra Palace at distances up to 10 miles and 40 miles respectively.

The "Duo Phase" push-pull amplifiers with 6- and 14-watt outputs are being continued. Their specification includes oil-immersed condensers in grid coupling and smoothing circuits, and from every point of view they are a well-turned-out job. New accessories include valve tone control and mixer units at £4 and £3 3s respectively.

In addition to the "Viceiver" complete television, sound and broadcast receiver with automatic record-changer which costs 120 guineas there is now a complete range of television chassis units. The time base units are of the hard valve type, and cost £8 for the line (10,125 sweeps per sec.) and £7 10s. for the frame (50 sweeps per sec.). A four-valve sync separator is available at £4 15s., and there is also a range of HT supply units. In the television input chassis at £11 5s. a superheterodyne circuit is employed. The triode-hexode frequency-changer is preceded by an RF amplifier, and there are three IF stages followed by a diode detector and pentode output valve.

Many of the quality amplifiers and broadcast tuners are assembled in high-grade cabinets as complete receivers and radiogramophones at prices ranging from £27 to £67. Components such as mains transformers, chokes and noise-free potentiometers are being continued to meet the demands of the home constructor.

Working Out Tone-control Circuits

RESISTANCE, CAPACITY AND INDUCTANCE VALUES

By "CATHODE RAY"

LAST week we got as far as seeing that tone control has its uses and need not be despised as an attempt to render a bad set tolerable. We also saw that the usual commercial control does only one of a considerable number of desirable things. In particular, it fails to restore the large amount of bass that is missing from gramophone records. To provide anything up to a fivefold boost at the lowest frequencies it is hopeless to tinker with existing amplifier stages; it is really necessary to add a special tone control stage of which only a small amount of the available amplification is normally used, leaving the rest for the said boosting. Adopting the method of using a special sort of intervalve coupling in place of the more usual resistance, this means that the valve must at some frequencies work into an abnormally low impedance, which is liable to cause amplitude distortion—harmonics, intermodulation; we needn't go over all that controversy again. The only way of dodging it is to make sure that the tone controlling is done at a very small signal voltage.

To make all this more definite, suppose we have a "straight line" amplifier, high fidelity, super quality, and all the rest of it; and want to use it for reproducing gramophone records. If records were made throughout on a straight line frequency basis there would be nothing more to say. But as this policy would require the waggle of the record groove to get progressively larger as the frequency is reduced, so that at the lowest frequencies it would take up too much width for

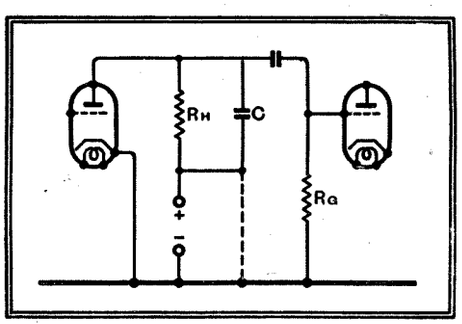


Fig. 1.—Without the condenser C this is an ordinary resistance-coupled stage. C is a tone-control component, which may be connected as shown, or, alternatively, as by the dotted line. RH and RG have to be kept in order to connect the valves to the right voltages.

getting a reasonable duration of recording on a disc, the policy actually adopted by the recorders is to keep the maximum amplitude of waggle constant below about 250 cycles, which is equivalent to a steadily increasing loss in pick-up output. At 125 cycles the output from a "straight line" pick-up is only half what it should be; at 62½ cycles only a quarter; at 50 cycles only one fifth. So, obviously, quite a lot of boost is needed. As the frequency is halved (in other words, one octave lower) the voltage amplification must be doubled (in other words, 6 decibels gain) so what is wanted is described with scientific brevity at 6 db. per octave.

Now the impedance of a condenser valve stranded, cut off from its base of So if the amplification of a stage can be made to vary at the same rate as the impedance of a condenser, that ought to do the bass-lifting trick. Unfortunately, a condenser can't just be substituted for the resistor in a resistance-coupled stage, because that would leave the anode of the valve stranded, cut off from its base of supplies. To maintain the line of communication with the HT source it is necessary to leave the resistor there; but it can be made so much higher in resistance than the impedance of the condenser as to pass a negligible share of the signal current. Such a circuit would appear as in Fig. 1. A practical point is that as the condenser can't short-circuit the HT there is no objection to connecting it as shown dotted; it is still effectively in parallel with the resistor, and there is the advantage that the bulk of the signal current is kept out of the HT source.

As I explained last week by taking a few representative figures, one can't get

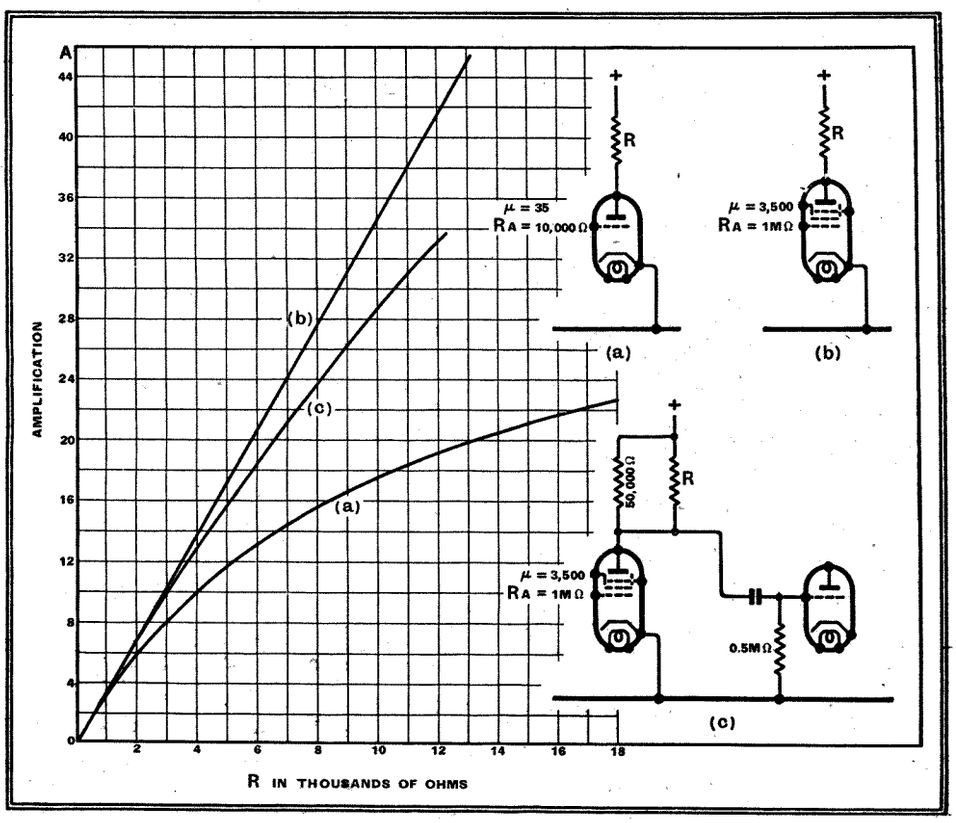


Fig. 2.—Showing how the amplification given by a triode (a) starts off by being proportional to the coupling resistance, but soon droops off. The pentode (b) is very nearly perfect, and even with the resistance necessary to feed the valve when the coupling element happens to be a condenser (c) it is much better than the triode.

more amplification than the valve has to give—namely, its amplification factor μ—even if an infinite-impedance coupling is used. The formula is $A = \frac{\mu R}{R + R_A}$ where R is the resistance of the coupling and R_A is the valve's resistance. It is not quite correct if impedance, Z, is substituted for R, but for the purposes we are considering it is not very badly wrong. Working this formula out for the most popular sort of triode valve having a μ of about 35 and R_A of 10,000 ohms, we get Fig. 2(a). Only up to an amplification of about 5 is it anything like directly proportional to the resistance; and much the same is true of the

Working Out Tone-control Circuits—

impedance of a condenser. So if nearly full correction is required for records down to 50 c/s the normal amplification can be only about 1; that is, the stage gives out just what it gets—except at low frequencies, when it gets less, but owing to

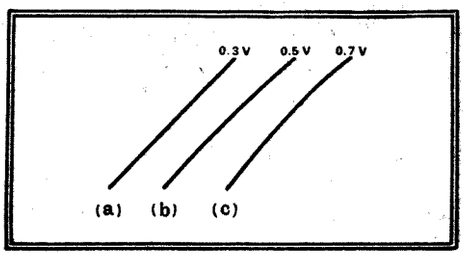


Fig. 3.—Cathode-ray lines showing no distortion (a), very slight distortion (b), and appreciable distortion (c), with the signal input voltages marked.

the boosting it keeps on giving out the same as at other frequencies. If resistance is connected in series with the valve, in order to "swamp" the amplitude distortion of the valve, the curve (a) droops still more.

For comparison, Fig. 2(b) is the same sort of curve worked out for a typical screened pentode, having a μ of 3,500 and an RA of 1 megohm. It is practically perfect up to more amplification than a triode could ever give. But we mustn't forget the resistances RH and RG in Fig. 1. Unless an absurdly high HT voltage is used, RH must be low enough to feed sufficient current for distortionless working of the valve. It might have to be as low as 50,000 ohms, and allowing for this and an RG of half a megohm, Fig. 2(c) results. Actually, the impedance of a condenser (or coil) puts up a slightly better show. But even apart from this it leaves the triode far behind, and the normal amplification can be 4 or 5, or even more.

Investigating Distortion with a CR Tube

The next point is the allowable signal strength. Using my namesake to examine the distortion due to such a stage, I took the oscillograms shown in Fig. 3. A diagonal straight line shows perfect amplification, and a perceptible departure from this form is a sign of distortion. The valve used was an AC/S2 Pen, with about 150 volts on the anode, 100 on the screen grid, and −2 on the control grid; and it passed an anode current of just over 5 milliamps. I used 50-cycle mains supply as a signal, and the output was the same as the input when the coupling resistance was 250 ohms. This, incidentally, showed the working mutual conductance to be 4 milliamps per volt. With 0.3 volt (RMS) input the result was, as nearly as can be seen from Fig. 3(a), distortionless. At 0.5 volt the distortion was just visible (b), and with 0.7 volt it was quite easily noticeable—about 4 per cent. harmonic. Increasing the load resistance quite a lot—up to 10,000 ohms, for example, when the amplification rose to nearly 40—brought in distortion at a lower input. Allowing for the possibly greater liability to distortion with a condenser or coil coupling, 0.2 volt would be a maximum, and 0.1 volt a *very* safe figure. A reasonable choice would be 0.2 volt *peak* (0.14 volt RMS) and the output would be 1 volt with 1,250 ohms in the anode circuit and *pro rata*, with a maximum of, perhaps, 8 or 10 volts.

Compared with this a triode is less liable to distortion, and in particular it enjoys the higher coupling resistances (or impedances) more, so should be preferred unless one wants a really substantial boost at the full 6 db. per octave rate.

As at the moment we do want to get as nearly as possible 15 db. boost in less than $2\frac{1}{2}$ octaves, we choose the pentode.

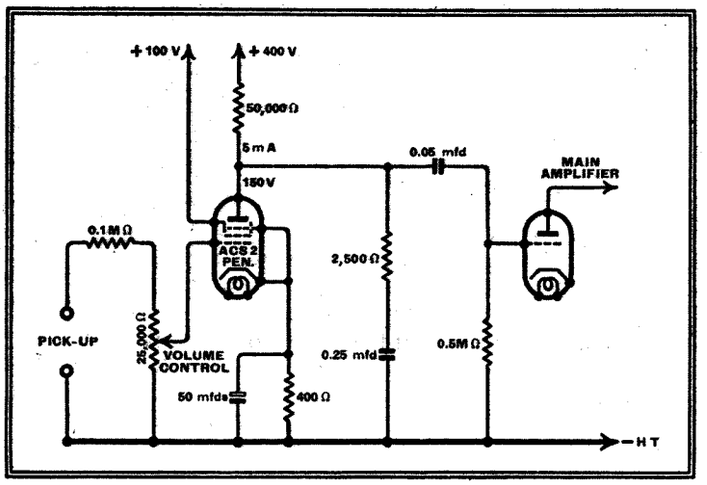


Fig. 4.—Complete circuit diagram of tone corrector for gramophone records, designed as described.

What to do now depends on how much input the "high-fi." amplifier needs to give full output. Probably not more than 2 volts peak. Supposing that actually is the figure, what we want is an amplification of 10 at frequencies above 250 cycles, increasing to 50 at 50 cycles. The level part of the curve above 250 would be given by an anode load of 10 × 250, or 2,500 ohms. And at 50 the effect of this resistance can be neglected; the condenser that gives the rise should be 12,500 ohms at 50 cycles. I gave formulæ for this a month or two ago—June 30th, to be exact—and they are repeated here, with a table of typical values to make it easier. Evidently 0.25 mfd. is about the right capacity to use.

So the job is done! (See Fig. 4.) Obviously it doesn't produce a perfectly sudden change-over from the level to a 6 db. per octave slope at the 250-cycle mark, any more than a real railway line literally changes instantaneously from "Level" to "1 in 50" as the gradient post at the side of the track makes out it does. But the tone correction is as near

APPROXIMATE VALUES OF CONDENSERS AND COILS TO GIVE A DESIRED NUMBER OF OHMS AT DIFFERENT FREQUENCIES.

Frequency	Impedance : Ohms									
	100	250	500	1,000	2,000	5,000	10,000	25,000	100,000	
50	32	12	6	3	1.5	0.6	0.3	0.12	0.03	Mfd.
	0.3	0.8	1.6	3	6	15	30	80	300	Henry
100	16	6	3	1.5	0.75	0.3	0.15	0.06	0.015	Mfd.
	0.16	0.4	0.8	1.6	3	7.5	15	40	150	Henry
250	6	2.5	1.3	0.6	0.3	0.13	0.06	0.025	0.006	Mfd.
	0.05	0.16	0.3	0.6	1.2	3	6	16	60	Henry
500	3	1.2	0.6	0.3	0.15	0.06	0.03	0.012	0.003	Mfd.
	0.03	0.08	0.16	0.3	0.6	1.5	3	8	30	Henry
1,000	1.6	0.6	0.3	0.15	0.075	0.03	0.015	0.006	0.0015	Mfd.
	0.015	0.04	0.08	0.15	0.3	0.75	1.5	4	15	Henry
2,000	0.8	0.3	0.15	0.075	0.04	0.015	0.0075	0.003	0.00075	Mfd.
	0.008	0.02	0.04	0.08	0.15	0.4	0.8	2	8	Henry
3,000	0.5	0.2	0.1	0.05	0.025	0.01	0.005	0.002	0.0005	Mfd.
	0.005	0.015	0.03	0.05	0.1	0.25	0.5	1.5	5	Henry
4,000	0.4	0.15	0.075	0.04	0.02	0.0075	0.004	0.0015	0.0004	Mfd.
	0.004	0.01	0.02	0.04	0.08	0.2	0.4	1	4	Henry
5,000	0.3	0.12	0.06	0.03	0.015	0.006	0.003	0.0012	0.0003	Mfd.
	0.003	0.008	0.016	0.03	0.06	0.15	0.3	0.8	3	Henry
7,500	0.2	0.08	0.04	0.02	0.01	0.004	0.002	0.0008	0.0002	Mfd.
	0.002	0.005	0.01	0.02	0.04	0.1	0.2	0.5	2	Henry
10,000	0.16	0.06	0.03	0.015	0.0075	0.003	0.0015	0.0006	0.00015	Mfd.
	0.0015	0.004	0.008	0.015	0.03	0.075	0.15	0.4	1.5	Henry

Approximate formulae: Ohms $= 6.3 \times$ c/s $\times$ henrys. Ohms $= \frac{1{,}000{,}000}{6.3 \times \text{c/s} \times \text{mfds.}}$

Working Out Tone-control Circuits—

theoretical requirements as the ear is likely to notice (or, may I whisper, as near as the recorder's apparatus is likely to be?). Fig. 5 shows how it compares with what we set out to do. If a triode had been used the result would have been more like the dotted line—which, of course, might be quite enough for radio tone control. The anode voltage is high; in view of the conservative design it could probably be cut down substantially without appreciable distortion. It must be remembered that it is designed for 0.2 volt peak input, so if the pick-up gives more it must be cut down by a potential divider. Fig. 4 includes this part of the works, assuming a pick-up with a maximum output, on ordinary records, of 1 volt peak.

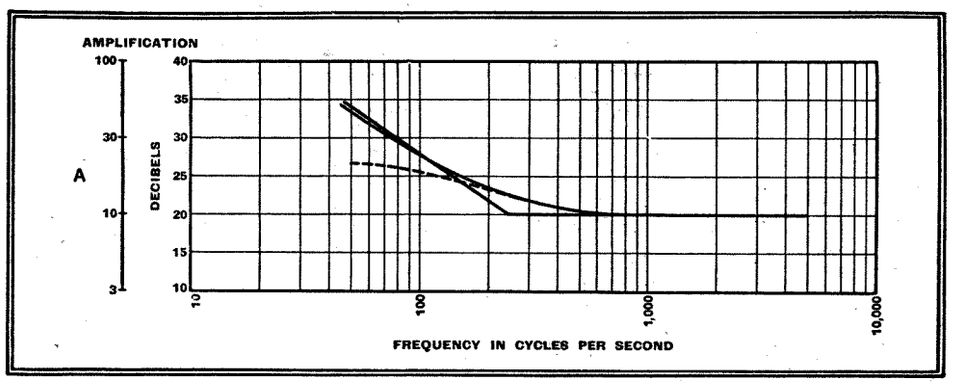


Fig. 5.—The straight lines at an angle are the theoretical requirements of the gramophone tone corrector, and it can be seen how closely the actual results of the circuit of Fig. 4 fit it. The dotted line shows the sort of attempt a triode could make.

A top cut, if required, is obtained by a condenser *in parallel* with the resistance. Suppose we would like the amplification to be reduced to one-fifth at 7,500 cycles, with the idea of quietening needle scratch. Then the condenser should be about one-fifth of 2,500 ohms at that frequency; 0.05 mfd. is not far wide of the mark.

For top boosting or bass cutting, a coil in series or parallel respectively can be used; the table gives some idea of the necessary inductance.

Is it possible to get more than 6 db. per octave for more sudden changes of amplification? Yes, it is, by using circuits containing both coil and condenser; but, oddly enough, the 6 db. slope with this class of circuit is the limit beyond which it is more or less *resonant,* and although that is all right for steady, sustained notes, it is not ideal for actual speech or music, as it causes *transient distortion.* If the coil is fairly compact and has no iron core (as generally it should be), its resistance is likely to be so large as to rule out anything like sharp resonance.

Fig. 6 summarises the commonest tone control circuits with their effects; besides the fundamental ones some typical combinations are included.

Even if you don't feel sure enough of all this to design a complete tone-control system, the study may at least have been helpful in showing what can be done and what can't. A most important point is that one can hardly do the tone controlling at too low a signal voltage. And a triode is preferable for moderate rises and falls. But only a pentode is capable of maintaining a 6 db. per octave slope for more than an octave or so. Coils, if used, should be small and kept well away from transformers and smoothing chokes from which they might pick up hum. And, of course, in view of the low signal level, the tone control stage should be provided with exceptionally well-smoothed HT current and the other usual precautions against hum observed.

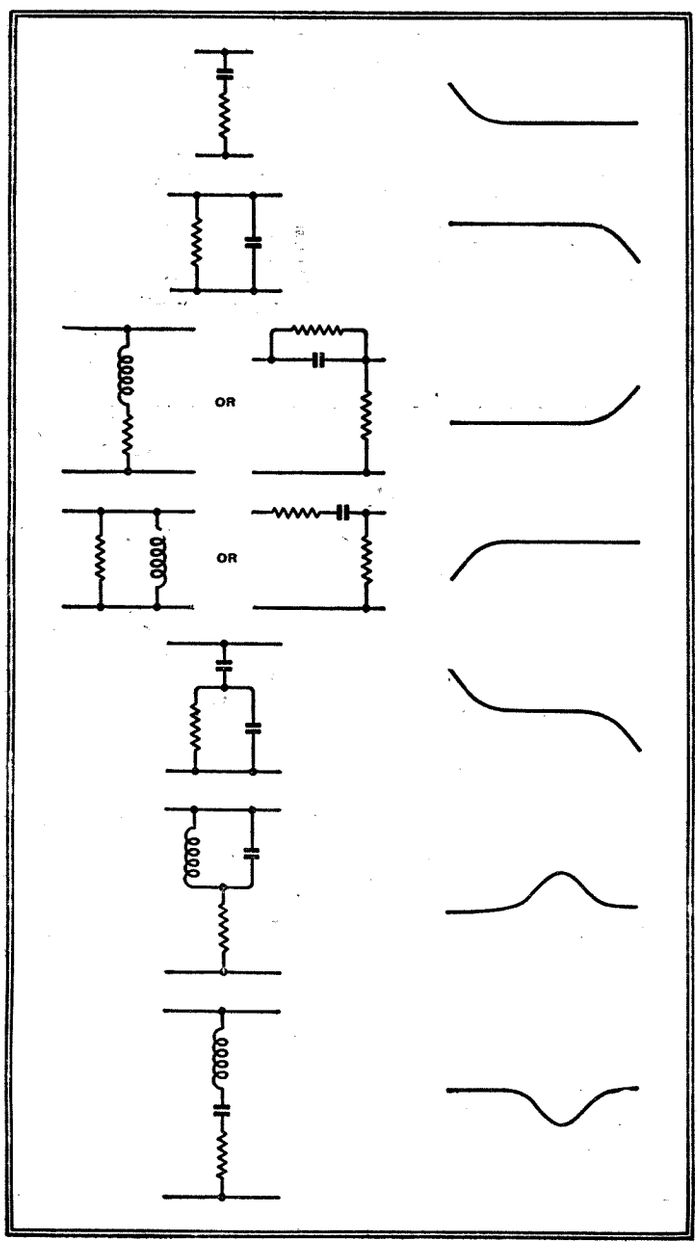


Fig. 6.—A few of the different departures from straight-line amplification that can be got by using the circuits shown. An example of the first type has been fully worked out, and the others can easily be substituted. For practical reasons it is better to stick to resistors and condensers — hence the alternatives shown.

INTRODUCE YOUR FRIENDS

AT this time of the year *The Wireless World* makes the acquaintance of many new readers, large numbers of whom are introduced by regular readers of the journal. To assist these readers in making *The Wireless World* more widely known among their friends we are inserting a form in this issue to be filled in and sent to us, on receipt of which we shall be glad to post a free specimen copy to the address given.

We hope our readers will make full use of these forms, as we like to feel that they take an active interest in making the paper even more widely known.

BOOK RECEIVED

Wireless Servicing Manual. (4th edition.) By W. T. Cocking. Pp. 288, with numerous diagrams and illustrations. Published by Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1. Price 5s. net; by post, 5s. 5d.

THIS book, the previous edition of which was reviewed in our columns on September 3rd, 1937, has now been revised and considerably extended in scope. Fifty pages of new matter have been added, and these include a chapter dealing with the tracing and curing of faults in television receivers. Instructions for building a resistance and capacity testing bridge and a valve testing bridge have now been added to the appendices. Base connections for British, American and Continental valves have been revised.

Contrast Expansion and Its Application

THE authors describe a system of volume expansion in which a valve is used as the variable element of a potentiometer. The design of an amplifier suitable for working with the expander is also discussed at length.

By L. COLSTON-JONES and G. C. BOCKING

(Tungsram Research Department)

EVER since radio telephony began to be used as a means of entertainment it has been the natural and obvious aim of the receiver design engineer to produce a set capable of giving as faithful and realistic a reproduction of whatever the microphone picks up as would be heard by a person standing alongside the microphone and picking up the same sound with the human ear.

While admitting that vast strides have been made in the design and efficiency of the modern broadcast transmitter and also probably to an even greater extent in the modern receiver, perfection has not yet been achieved. One of the main reasons for the lack of realism in the reproduced transmission is that for technical reasons the programme peaks and troughs of volume are manually contracted towards a mean level. Some means, therefore, has to be adopted to restore this contrast at the receiving end. Due to electrical contraction in the process of gramophone recording the same applies here, in fact, to an even greater extent. Various methods have been evolved for restoring volume contrasts, but, in general, they have introduced excessive distortion.

A simple yet very satisfactory system can be used, employing a low-impedance triode valve as the lower limb of a potentiometer, such that, since it is not directly a part of the amplifying chain, it does not introduce any appreciable distortion.

Briefly, the operation of the system is as follows (see Fig. 1, a and b) : A triode valve is operating as a linear variable impedance, controlled by the voltage on its grid. The impedance of this valve forms the lower limb of a potentiometer connected in the grid circuit of an amplifying valve, in such a way that if the grid control voltage be arranged to vary in sympathy with the rise and fall in volume of the incoming signal, the impedance will naturally vary in sympathy with this, thus effectively increasing the input to the amplifier valve on large signals, and reducing it on small.

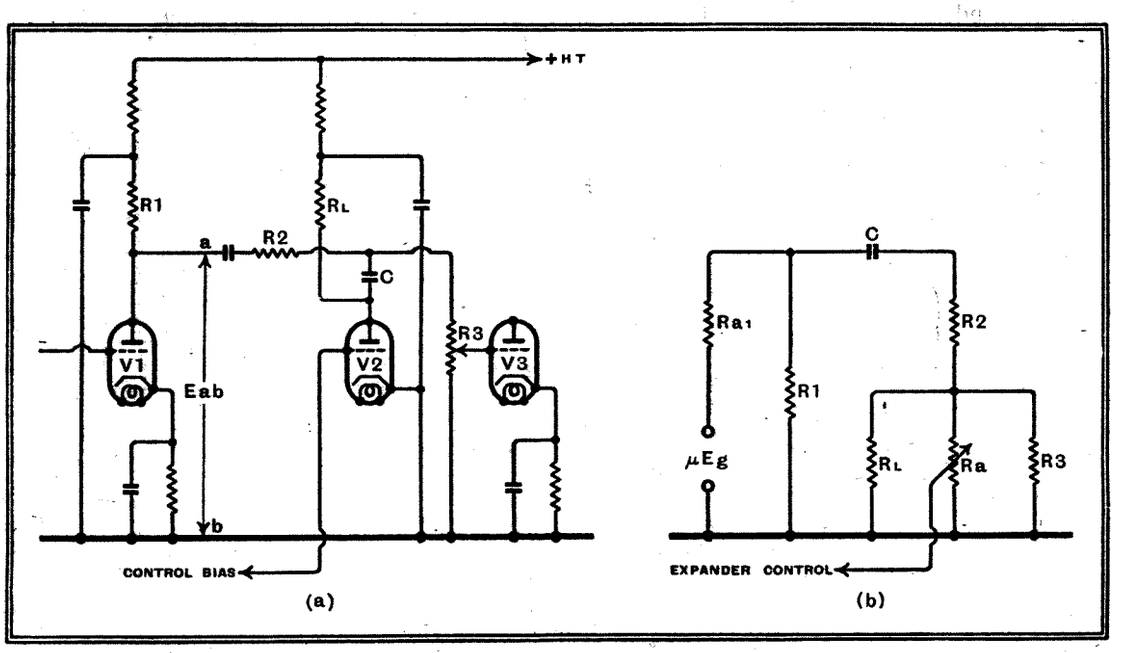


Fig. 1. A volume expansion circuit in which a triode valve functions as one limb of a potentiometer. Diagram (b) shows the equivalent circuit of the expander valve and its associated components.

DESIGN OF EXPANDER AND AMPLIFIER

Since in radio transmissions the volume contraction is performed manually to no given law, it is theoretically impossible for an electrically controlled expanding device to accurately compensate for this contraction. Fig. 2 shows the approximate law which the transmission follows, reaching its peak at 40 db. with curve A showing perfect contraction, which would mean that maximum expansion must occur at 40 db., after which no further expansion could take place.

Since, however, the actual control is more like curve B, a certain amount of expansion will still take place, although nevertheless, the maximum must still occur at 40 db.

In the case, however, of gramophone recording, the contraction follows a linear law, consequently the expander which also follows a linear law can be designed to compensate exactly for the effects of the contraction. This, therefore, forms a very satisfactory basis for the design of the expander as a whole.

The expander circuit consists of two main parts, one the valve forming the actual variable impedance, the other, the controlling-amplifier valve, which provides the DC control voltage, proportional to the signal amplitude.

Volume Range Needed

Considering first of all the expander valve; the volume range required is generally considered to be 60 db. maximum, since, however, normal transmission range is only 40 db. the expander must provide a further 20 db.

Fig. 3 shows the anode-volts, anode-current characteristics of a low-impedance triode, such as the Tungsram LL4, with a very high value of anode load resistance. It will be observed that as the grid bias is varied, so the impedance varies, between very wide limits (in actual practice 5,000 to 500,000 ohms).

Fig. 1 (*b*) shows the skeleton equivalent circuit of the expander valve and its associated components, where RL is its load resistance, R3 the grid resistance of the succeeding valve and R2 the upper limb of the potentiometer. Ra1 is the imped-

Contrast Expansion and Its Application—ance of the preceding valve in the amplifying chain and R1 its load resistance.

It will be observed that since RL and R3 are in parallel with R*a*, they will serve effectively to reduce the range of expansion obtained; hence it is desirable that

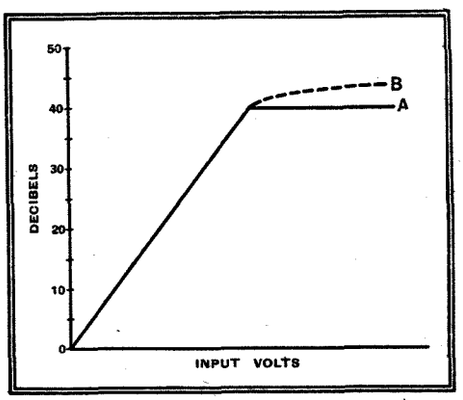


Fig. 2. Showing the approximate effect of volume contraction in the broadcast control room.

they should both be as large as possible. From consideration of linear impedance variation, RL should be 250,000 ohms (see Fig. 3).

The value of R3 cannot, however, be greater than 0.5 megohm, owing to the possibility of grid blocking on heavy peaks. With these values, an expansion range of 20 db. is obtained (equation 1; Appendix).

It will be appreciated that the inclusion of the expansion circuit will cause a certain loss, termed "insertion loss." This loss will, of course, vary with variation of expansion and will have a minimum value of 5 db. (equation 2; Appendix). This minimum loss occurs only on peaks of volume, and, at the average level at which the amplifier normally operates, the insertion loss is considerably greater. It is generally accepted that the mean audio signal of symphonic music is 25 db. down from maximum, i.e., the normal listening level will be 25 db. down from that obtained at peak volume. It is to this mean level that we normally adjust our output, by means of the volume control to suit our ordinary listening requirements. At this mean level the insertion loss, as shown in the appendix (equation 3) is 13 db.

AF Amplifier Design

Let us now consider the audio-frequency section of a receiver to be used with contrast expansion. It will be agreed that for normal domestic use an output of 10 watts will be ample for comfortable listening.

Since quality is naturally the prime object of anyone interested in contrast expansion, the output stage of a receiver in which it is used will be push-pull. Two triodes, or two high-slope pentodes with negative feedback, will probably be employed. Obviously, if low-slope triodes are used, transformer coupling from the first AF succeeding the expander can be used, but if resistance coupling is desired throughout, it will be essential to use a further pair of AF push-pull amplifying valves succeeding the phase changer.

The AF stage of a satisfactory form of receiver would consist of a pair of P-12/250 or PX4 valves in push-pull, fed from a pair of low-impedance triodes such as the LL4. The anode loads for the LL4's should be 10,000 ohms, the grids of the P-12/250's being coupled through condensers of 0.25 mfd. The P-12/250's should have grid leaks of about 50,000 ohms.

The system of phase inversion used consists of a normal medium-impedance triode such as the AC/HL or HL4+ with anode and cathode load resistances of 25,000 ohms, coupled through 0.1-mfd. condensers to the grids of the LL4's. These latter valves have their grid circuits completed to ground through 0.25-megohm grid leaks.

The phase inverter is biased in the normal manner by means of a 1,250-ohm resistance in the cathode circuit. This valve is fed from the first AF valve succeeding the expander, which is a further medium-impedance triode similar to the phase inverter.

For gramophone reproduction with extreme fidelity a maximum output of 25 watts is desirable, and with this output, the listening level is approximately 0.25 to 0.5 watt, and the output for the softest sound (such as single wood wind, or violin playing softly) will be 0.03 mW, which is just audible above extraneous room noises.

Two 4-V indirectly heated pentodes, Type APP4E, when operated in Class AB1 push-pull give an output of 25 watts and are thus eminently suitable for our purpose. Allowing a margin for negative feed-back, the APP4E's require an input voltage of about 50 volts grid-to-grid, which may be readily provided by one LL4 as phase inverter amplifier. Since the LL4 gives a gain of one, it will be fully loaded by a single HL4 triode.

To compensate for the 13 db. average level loss of the expander a further stage of amplification, which can conveniently be another HL4+ giving a gain of 22 db., must be added, leaving approximately 10 db. to allow for increased loading.

The Control Circuit

The control of the expander mentioned earlier in this article will now be dealt with more fully. For control purposes a double diode triode was used, whereby the triode is used to amplify the signal input, which is then rectified by the diodes to provide the control voltage. Inspection of Fig. 3 will reveal that to obtain maximum impedance of 0.5 megohms, −25 volts are required as full control bias to the expander valve. The DDT4 is a suitable valve for this purpose and will give a gain of 25 times, hence with a signal input voltage of 1 volt the requisite controlling voltage of 25 can be obtained.

Since this control bias must be linearly proportional to the input voltage, we can not feed the control amplifier from any part of the main amplifier succeeding the expander. Nevertheless, it would appear feasible to feed it from the input to the expander potentiometer (E*ab* in Fig. 1 (a)). In practice, however, it is found that this causes a most disagreeable "flutter" effect unless a large measure of decoupling is resorted to. This flutter may be eliminated by making the time constant of the decoupling combination between diode and expander grid sufficiently large, but this time constant also determines the speed at which the expander operates, and the larger it is, the slower the operation. There is a complete

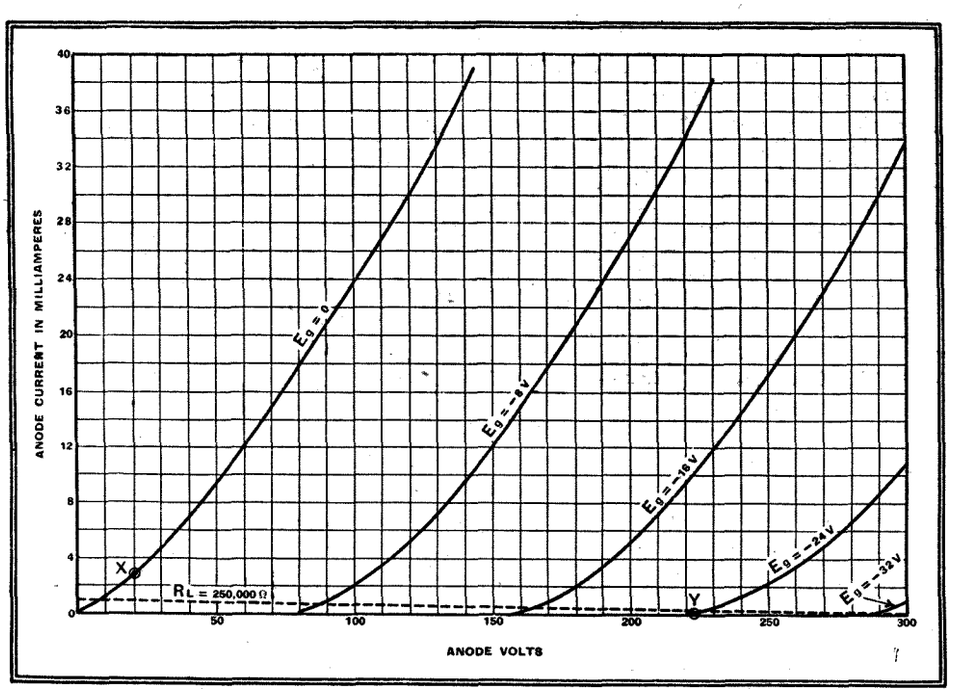


Fig. 3. Characteristics, as measured with a very high value of load resistance, of a low-impedance triode valve (Tungsram LL4).

Contrast Expansion and Its Application—

lack of agreement among investigators as to what value of time constant is desirable, but it has been found by empirical test that a resistance value of 0.5 megohm and a condenser of 0.5 mfd. allows a sufficiently rapid rate of expansion for all notes to be expanded. This value, however, is insufficient to eliminate flutter and we must, therefore, feed the control amplifier from the input source to the main amplifier. This interposes a separate valve between the control circuit and the expander and prevents any tendency to flutter.

It is desirable that the degree of expansion should be variable at will, and we can do this in three ways:

(1) By varying the input to the control amplifier.

(2) By varying the amount of bias applied to the expander after the control amplifier.

(3) By varying the standing bias on the expander valve.

Mr. K. S. Macfayden, in a recent issue of *The Wireless World*,* gave the reasons for the undesirability of varying the degree of expansion by either of the first two methods, since these cause the range of volume handled to fall either above or below the expansion range.

* December 2nd, 1937.

If we use method 3 we can obtain quite simply a variation of expansion, but in this case the expander reaches a maximum impedance before the full output has been achieved from the amplifier. We can compensate for this by using for the expansion control a pair of ganged potentiometers, one of which varies the standing bias, and the other varies the applied control voltage at the same time. This is theoretically the ideal method of obtaining the required variation, but a much simpler method is to use a variable cathode bias resistor which will automatically compensate for the excessive control bias. Thus, if, for instance, the initial bias equals -10 V, the cathode current will be approximately $\frac{1}{2}$ mA and will decrease as the bias increases, automatically reducing the standing bias and allowing the expander to accept the full -25 V control voltage for maximum expansion and zero anode current.

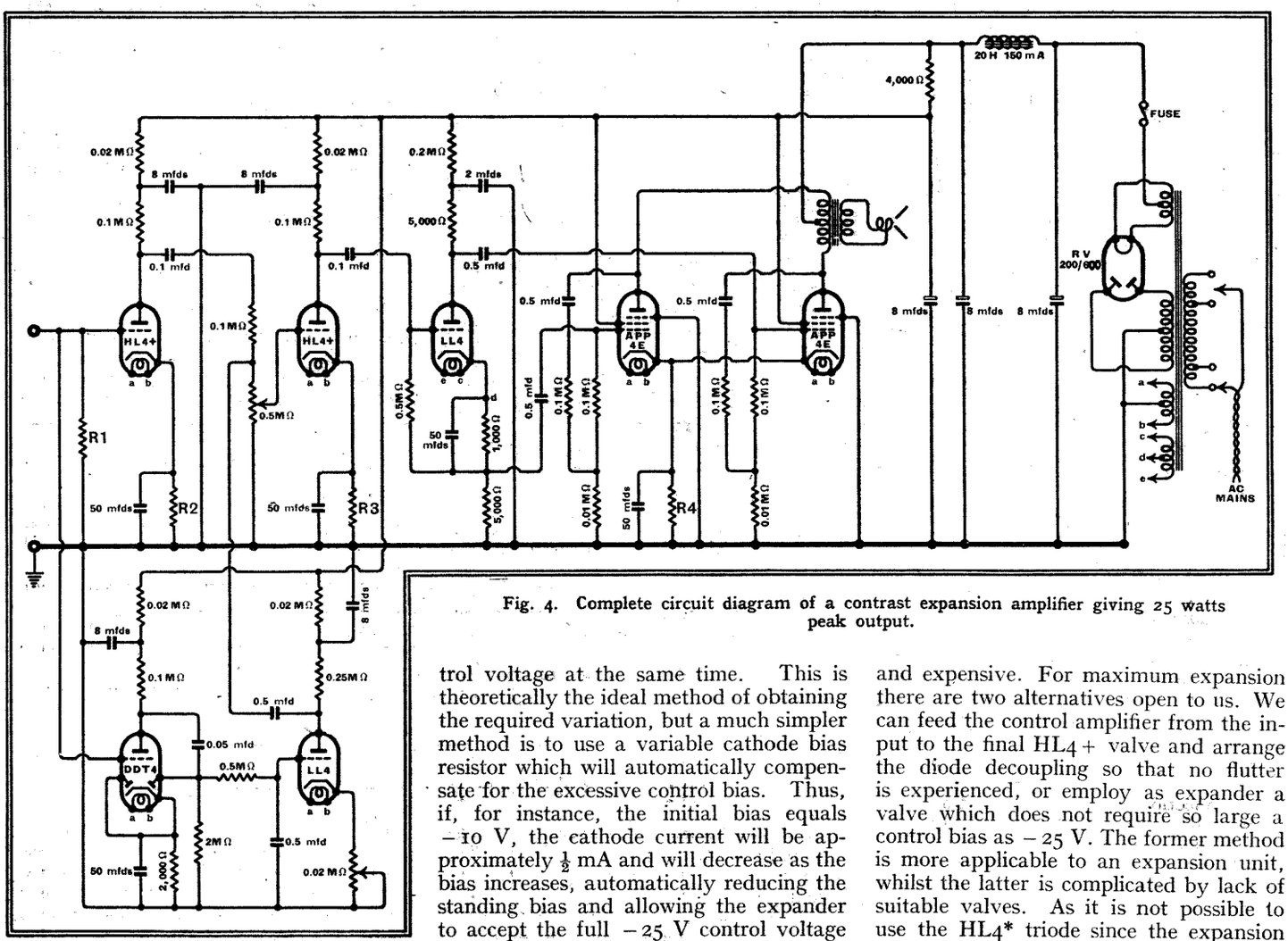


Fig. 4. Complete circuit diagram of a contrast expansion amplifier giving 25 watts peak output.

The Complete Design

We now have the design for a high quality volume expanding amplifier giving 25 watts peak, and thus suitable for high fidelity reproduction of gramophone records. The complete circuit is shown in Fig. 4 and it should be noticed that a stabilised high-tension supply to the screens of the output valves is obtained by utilising the anode currents of the preceding valves for stabilisation.

It will be noticed that the main amplifier volume control occurs after the expansion section, and it should be remembered that overloading may occur on peaks of volume if this is turned up too far. Various writers have advocated a dual control to decrease the expansion as the volume is increased, but no satisfactory agreement appears to have been reached as to the extent to which this should be applied, and it has been thought desirable in this instance to use separate controls only.

In cases where it is not possible to obtain the full 1 V, maximum signal input, such as when using a dynamic pick-up, the full -25 V control bias for maximum expansion will not be obtained. We can, of course, insert a further amplifier to provide 1 V input, but this is both undesirable and expensive. For maximum expansion there are two alternatives open to us. We can feed the control amplifier from the input to the final HL4+ valve and arrange the diode decoupling so that no flutter is experienced, or employ as expander a valve which does not require so large a control bias as -25 V. The former method is more applicable to an expansion unit, whilst the latter is complicated by lack of suitable valves. As it is not possible to use the HL4* triode since the expansion obtained is not linear, the difficulty can be overcome by using the APP4C high slope output triple-grid valve connected as a triode. With this connection only -14 V bias is required for full expansion, which is readily obtainable from $\frac{1}{2}$ V peak input using the DDT4.

Another aspect of contrast expansion which so far does not appear to have attracted much attention is that of automatic tone compensation. Since in the expander we already have a variable impedance of which the value is a function of the output power, we can arrange a tone control circuit to increase the bass response of the amplifier as the volume decreases. Thus we can compensate for the well-known property of the ear, which is less sensitive at low audio intensities to low frequencies than to medium. If we insert in series with the blocking condenser a small choke of suitable value, we then have a series resonant circuit whose impedance varies with frequency, and if the succeeding stages are fed from the top end of this

Contrast Expansion and Its Application—

choke, we shall obtain the desired tone compensation. Assuming a condenser value of 0.5 mfd., a suitable value for the choke would be 0.05 H. This combination resonates at 1,000 cycles (reactance equals zero), and at 50 cycles has a reactance of 6,400 ohms. Because this reactance is in series with the expander impedance, which, as we have shown, has a value of 5,000 ohms minimum, the overall impedance becomes effectively double its original value at minimum volume. At maximum volume the overall impedance is virtually unchanged since the added effect of the 6,400 ohms reactance in series with the maximum impedance of 500,000 ohms is negligible and no compensation is obtained.

Appendix

From Fig. 3:

At point X ($Ea = 20$V; $Eg = 0$V.)

Rax (the anode impedance) $= \frac{5 \text{ volts}}{1 \text{ mA}} =$ 5,000 ohms.

and at point Y ($Ea = 220$ V; $Eg = -24$ V).

$Ray = \frac{0.5 \text{ V}}{1\ \mu\text{A}} = 500{,}000$ ohms.

The degree of expansion obtained $=$

$$\frac{\text{Z max.}}{\frac{20 \log. \text{Z max} + R2}{\text{Z min.}}} \text{db} \quad \ldots\ldots\ldots \quad (1)$$
$$\text{Z min} + R2$$

where $\frac{1}{Z} = \frac{1}{RL} + \frac{1}{RA} + \frac{1}{R3}$

and Z max. $= 125{,}000$ ohms and Z min. $=$ 5,000 ohms.

Hence the expansion range $= 21$ db.

The minimum insertion loss $=$;

$$20 \log. \left(\frac{\frac{1}{\text{z max.}}}{\text{Z max} + R2}\right) \quad \ldots\ldots\ldots \quad (2)$$
$$= 5 \text{ db.}$$

The mean level insertion loss assuming a listening level of 25 db. down from maximum volume, and an expanded range of 60 db. $= 5 + \left(\frac{25 \times 21}{60}\right) = 13$ db. approx. (3)

On the Short Waves

IT seems rather unfortunate that, upon again taking up my pen to write on short-wave matters it is necessary to record in these first notes that short-wave conditions are abnormally poor.

Even more unfortunate, too, that the G.P.O. must needs choose the day I am writing this to announce its new MUSA (Multiple Unit Steerable Array) receiving station, which it was stated by the P.M.G. would be ready to combat the expected poor short-wave conditions in the year 1940, when sunspot activity would be at a maximum.

The connection here is perhaps not at first obvious, but it so happens that we appear already to have passed the maximum of the present 11-year solar cycle and the poor conditions during the week ended September 17th were due not to an excess of activity but more likely to a lack of it. Certainly at the start of the week no sunspots were visible at all.

Modern opinion attaches much more importance to solar chromospheric eruptions, which generally occur in the vicinity of sunspots, than to the spots themselves.

One can only hope for the P.M.G.'s sake that his speech was misreported, a common failing of the lay press when dealing with technical matters.

Nevertheless, the MUSA receiving station will be a valuable addition to the G.P.O. radiotelephone system and it is particularly well adapted for the reception, with almost complete absence of fading and distortion, of high quality broadcast transmissions, so that we may look forward to improved relays of American short-wave stations in this country.

In view of the magnitude and the capabilities of the equipment, the G.P.O. is deserving of every praise for its enterprise.

Before turning to the ultra high frequencies, comment must be made on the much improved signal from W3XAL on 17.78 Mc/s during recent weeks; evidently the new horizontal "V" aerial is now working properly.

For transmission to Europe separate horizontal "Vs" are now used by W3XAL on 6.1 and 17.78 Mc/s, and a single horizontal "V" by W2XE on all its frequencies, i.e., 21.52, 17.76, 15.27 and 11.83 Mc/s.

For transmission to South America, on the other hand, W2XE uses parallel *inverted* "V" aerials.

Five-metre activity continues to be high, but a number of London stalwarts still seem to be on holiday, and amongst the voices missed is that of G2OD.

On Sunday, September 11th, the writer, complete with portable and picnic basket, went for a trip with G5MA and G3CU to Holybourne Downs, near Alton, Hants. It was a matter of only a few minutes to set up the transmitter and steerable dipole, and almost immediately G5MA(P) made contact with G2XC (CW) at Portsmouth.

Afterwards comments and experiences were exchanged on 56 Mc/s with G8LY Winchester, G2NH(P) on Epsom Downs, G2ZV Bury Hill, G2GH—G2GG's portable transmitter at Watlington—G5RD and G6XH, G6XM Farnborough, and, finally, with G8OS Billingshurst.

G2ZV, whose party had been camping out, reported 56 Mc/s reception at Bury Hill that afternoon of ON4DJ, G6DH Clacton and G6GO Rugby.

On the previous Saturday night, G2GH reported G6OT had heard GW6AA on Snowdon, and that late on Sunday afternoon G5ML Kenilworth was picked up.

The best performance, however, must have been that of G5RD, who, on Friday night, maintained contact with G6FO, Newport, Mon., from Abbots Langley, over a considerable period. Good signals from G6FO were also intercepted on this occasion by G5MA at Ashtead and by others. During the afternoon a strong, unmodulated carrier, on the bearing of London, was heard on about 64 Mc/s, but not identified.

It is of interest to note that September 9th, evidently excellent for 56 Mc/s propagation, was also a day of excellent world-wide short-wave reception.

Finally, although sunspot activity is temporarily low, reception of 28 Mc/s signals is generally on the up-grade and many 26-27 Mc/s U.S. high-fidelity broadcasters have been heard during the past weeks.

"ETHACOMBER."

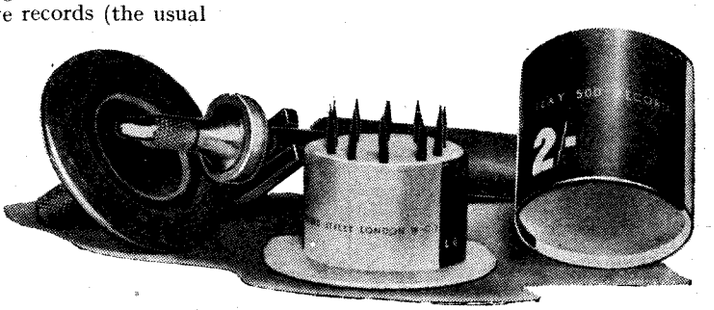
"IM" LONG-PLAYING NEEDLES

THE gramophone enthusiast of long standing with a large library of valuable records will generally be found to show a strong partiality for fibre needles. Experience shows that the technical objections to the use of these needles are outweighted more often than not by their practical advantages. This is unquestionably the case where the needle point reaction of the pick-up is high, for the fibre needle acts as an effective buffer and prevents damage to the wall of the groove. Surface noise and mechanical noise from the pick-up are also much less with fibre than with steel needles.

The "IM" long-playing needles produced by Alfred Imhof, Ltd., 112-116, New Oxford Street, London, W.C.1, are made from the thorns of the South African prickly pear plant and are hard enough to withstand the wear of eight consecutive records (the usual number in automatic record-changing units) after which they can be repointed an used for at least 50 playings.

Our tests confirmed the claims for low surface and mechanical noise, and also showed that the reduction in output at the high frequencies by comparison with steel needles was much less than usual. Taking the output from a "permanent" steel needle as standard a uniform reduction of level of 6 db. was recorded with the "IM" needle up to 3,000 c/s. At 6,000 c/s the output voltage was down a further 2 db., at 7,000 c/s 6 db., and at 8,000 c/s, 11 db. After playing two sides of a 12in. record no measurable falling off in output could be detected up to 3,000 c/s, and the wear produced a reduction of 2 db. at 5,000 c/s and 3 db. at 8,000 c/s. There is a visible flat on the point after eight playings, but this is easily removed by the sharpening tool.

The needles are attractively packed and a box of ten costs 2s.



"IM" long-playing thorn needles and BCN needle sharpener.

PRAGUE recently broadcast a report on the fortifications along the Czechoslovakian frontiers. The picture shows officers being interviewed by representatives of the "Radiojournal" during the course of the programme.

NEW ATLANTIC RADIO-TELEPHONE SYSTEM

Scheme to Offset Sunspot Effects

DURING the course of the P.M.G.'s speech at the luncheon of the Newcastle-on-Tyne Chamber of Commerce, at which he was the guest of honour, he made special reference to the interference caused during sunspot activity to the long-distance international radio-telephone services, which are mainly operated on the short waves.

He said: "The approaching period of sunspot activity (1940) has been viewed with grave concern by both the British Post Office and the American authorities. After long research and investigation the Post Office and the American telephone authorities have come to the conclusion that the adverse effects of sunspot activity can be offset to a great extent by adopting an entirely new technique in the reception of short-wave transmissions. The new method is bound up chiefly with the use of a number of receiving aerials suitably spaced in the direction of the incoming signal."

As a result of the investigations, referred to by the P.M.G., a new station is to be erected at Cooling Marsh, Rochester. The aerial system of this station, the site of which is approximately two miles long and a quarter of a mile wide, is of particular interest. It will consist of sixteen separate aerials, all erected in line in the direction of America with the receiving building behind the aerial most remote from that country. Each aerial is in the form of a diamond, viewed in plan, approximately 200 yards long and 80 yards wide. The aerial itself consists of a single wire about ⅛in. diameter supported by four 50ft. wooden poles, one at each point of the diamond.

Each aerial is connected individually to the receiving building by a line of special construction. These will be placed underground and will be laid in a trench 2ft. 6in. deep, progressively increasing in width to a maximum of about 8ft. at the building end. Each line will consist of a ⅜in.-diameter copper tube supported co-axially within an outer tube 2in. in diameter.

The new building is expected to be completed shortly, and it is hoped to commence the service from the new station early next year.

MAKING B.H. GASPROOF

Self-contained Broadcasting Centre

A.R.P. work is perhaps as advanced in Broadcasting House as in any other building of importance in or around London. Certain portions of the building necessary for use by the staff in case of emergency are being fitted with complicated-looking massive steel rubber-lined doors which appear to be as effective for their purpose as the hatches of a submerged submarine are for the work which they have to perform. A new system, of what are euphemistically called "fire alarms," has been installed throughout the building; but as warning sirens they will be equally effective. Short of a direct hit by an enemy bomb, Broadcasting House should be a perfectly safe retreat for its staff. Other precautions have been taken which are expected to result in an unimpaired broadcasting service, however great the danger from outside.

The basement and sub-basement is being equipped as a self-contained broadcasting centre, completely isolated from the rest of the building. Cables running direct from this centre to the transmitters would be used should the control room on the top floor be put out of action. Power plants and an artesian well make it still more self-contained.

NEWS OF

BROADCASTING IN THE EMPIRE

Recent Developments Summarised

RECENTLY compiled statistics relating to broadcasting in the Empire outside Great Britain show a considerable increase in the listening habit and in the interest taken in the development of their services by the various Dominions and Colonies. The information provided may be summarised as follows:—

Australia: The number of licence holders is 1,045,363. The reorganisation of Australian broadcasting is to be considered by the Federal Government in October.

Canada: The number of licence holders is 1,103,768. The Committee appointed by Parliament to investigate the activities of the C.B.C. has submitted its report, which—

(a) Generally approves the Corporation's policies, organisation, and business administration;

(b) Recommends that the effect of the recently raised licence fee should be studied in the light of this year's experience, with a view to making a reduction;

(c) Recommends the establishment of a powerful short-wave station "to interpret and advertise Canada abroad," the station to be financed as a national project and operated and controlled by the C.B.C.

New Zealand: The number of licence holders is 285,559. Work is to begin as soon as possible on a broadcasting centre in Wellington. Provision will be made for the gradual development of a conservatorium of music and for the future installation of a short-wave station and television.

India: The number of licence holders is 54,288. There are twelve All-India Radio stations in operation and Trichinopoly and Decca are to have stations by the end of the year or early in 1939. The Governments of Baroda and Travancore are also contemplating the erection of stations. The Government of India has appointed an Administrative Officer to All-India Radio, and is reported to be considering the appointment of advisory committees to the different stations, possibly on the model of the present Delhi Advisory Committee.

Union of South Africa: Johannesburg is to have a special station for relaying overseas programmes. There are at present thirteen stations operating in the Union—eight medium-wave and five short-wave. The South African Broadcasting Company reports that, although the result of the 1937 referendum was in favour of "absolute segregation of programmes on different wavelengths on the language basis," the Board has come to the conclusion that this policy would be a mistake in view of "the true South African spirit which the service must further." Alternative programmes have been introduced in Cape Town and Johannesburg, but finality in this matter has not been reached. It is estimated that English-speaking and Afrikaans-speaking listeners are in the ratio of 80 to 20.

Burma: A 10-kilowatt transmitting station is to be erected to serve all Burma. The city of Rangoon itself is to be served by a low-power medium-wave transmitter. A permanent service will, it is expected, be established before the new year.

Ceylon: The number of licence holders is 5,334. The Radio Advisory Board is not universally welcomed; members are appointed for life.

Hong Kong: There were 8,539 licences at the end of 1937, since when no figures have been available. The medium-wave station ZBW has been given over to European programmes for some months, while station ZEK has provided an entirely Chinese service.

Newfoundland intends to build a 10-kilowatt station at Mount Pearl, five miles from St. John's. A committee is being set up to consider and advise on the constitution and powers of the broadcasting authority.

The West Indies and Central America are also developing their broadcasting services. In British Guiana a new company called the British Guiana United Broadcasting Company is now in full operation. In the Cayman Islands assembly halls are being built to serve as centres of broadcast reception, and Daventry programmes are to be rediffused by loud speaker every Saturday night. The Jamaican Government is erecting a broadcasting station which, it is hoped, will be ready by the end of the year.

Malta has approximately 6,000 licence holders, with some 2,000 subscribers to the radiodiffusion service. Malaya's subscribers number 11,500, of whom 4,309 are in Singapore. Kenya has issued 2,832 licences, Northern Rhodesia 1,338, and the Gold Coast's total is 3,000 (1,100 in Accra alone).

THE WEEK

THE BUILDING EXHIBITION

Items of Interest to the Broadcast Listener

IN the construction of all modern buildings the problems of sound insulation are given careful consideration and at the Building Exhibition, which is open at Olympia until October 1st, numerous examples are to be found of the methods adopted to suppress air- and structure-borne noises. These included floating floors, double-glazed windows and a wide variety of special wall-boards and sound-absorbing partitions.

The Department of Scientific and Industrial Research have a convincing ripple tank experiment to show that double party walls, while effecting a considerable reduction, are not completely effective unless transmission of sound is also suppressed in the flanking walls.

For the keen listener the feature of greatest interest is the unit flat (Stands 370 and 372), which contains a radio study specially designed for late listening without disturbing neighbours. The walls are built of "Thermacoust" slabs and are insulated from the floor. There are no windows and ventilation is maintained by a compact air-conditioning plant. The studio can be erected inside an existing room and in order to make the best possible use of the space available special furniture, incorporating the broadcast and television receivers, bookshelves, writing table, cocktail cabinet, etc., has been produced by Easiwork, Ltd.

Undoubtedly this offers a complete solution of the flat-dwelling wireless enthusiast's most pressing problem, and those concerned in arranging this exhibit are to be congratulated on their initiative.

N.B.C.'s TELEVISION PROGRESS

Public Demonstrations

WHILE Radiolympia sought in a rather modest way to bring before the public the progress of television, our American confrères are tackling the matter in another way; they are now staging virile demonstrations of how television works, without, of course, giving their public anything similar to the regular service which televiewers in this country enjoy.

The American exhibition includes a complete television studio; an explanation of the fundamentals of television is provided, together with an opportunity to examine the apparatus at close range. Some of the earlier television devices are shown, including the mechanical scanning machine used by Dr. E. F. W. Alexanderson for his first demonstration of television ten years ago.

Also on exhibition are mechanical scanners dating back to the earliest days, from the one which scanned images in forty-eight lines.

For the demonstration the transmitter is eliminated, but the principle of television is illustrated in detail. Coaxial cables carry the impulses from the camera direct to four receiving sets placed in an adjacent room.

TELEVISION AND THE CINEMA

Televising Feature Films

A CERTAIN amount of tension regarding the televising of films is apparent in the film industry just now, and this feeling has been intensified by the recent increase in sales of television receivers. At recent meetings of the Portsmouth and Sussex Branches of the Cinematograph Exhibitors' Association, it was urged that their General Council should form a joint committee with other sections of the trade in an endeavour to check the televising of films by the B.B.C.

Last week's "telecasts" of the Maurice Chevalier feature film, "Man of the Moment," was permitted because the dialogue was in a foreign language.

A New Field of Employment

Opinion on the subject of television and the cinema was recently voiced by Mr. J. L. Baird at Foyle's Literary Luncheon, when he said that he foresaw the day when television would supersede the cinema, and all cinema programmes would be radiated by wire or wireless from central studios.

Mr. Baird pointed out that already there was a considerable demand for research workers and service engineers in television, and television and the cinema was opening up a big new field of employment for the radio man.

TELEVISION CONFERENCE

MANY eminent scientists in the world of wireless have taken part in the Television Conference, which has been held in Zürich under the auspices of the Physical Society of Zürich from September 19th to the 21st.

Among those who read papers were: R. Barthélémy, Société des Compteurs et Matérial d'Usines de Gaz, Paris; E. M. Deloraine, Laboratoire L.M.T., Paris; F. Fischer, Institut für technische Physik der E.T.H., Zürich; C. M. Horn, N.B.C. and R.C.A., New York; H. F. Mayer, Siemens and Halske A.G., Berlin; L. M. Myers, Marconi's W.T. Co., London; M. J. O. Strutt, Philips, Eindhoven; and E. H. Traub, The Television Society, London.

The papers and discussions of the Conference will be published in a special issue of the *Schweizer Archiv für angewandte Wissenschaft und Technik.*

FROM ALL QUARTERS

Increase in Wireless Licences

THE total number of licences in force in Gt. Britain at the end of August was 8,689,850, as compared with 8,295,950 at the end of August, 1937, an increase during the year of 393,900, and of 32,147 during the past month. This is 65 per cent. greater than the increase established in July.

New American Transmitter

AFTER four weeks of exhaustive tests under the supervision of Mr. E. K. Cohan, C.B.S. Director of Engineering, the new 50-kW transmitter, KNX, at Torrance, California, was officially put into service on Friday, September 16th. Linked with the $1,750,000 KNX studios, which were opened last spring, in Columbia Square, Hollywood, the new transmitter completes one of America's most elaborate broadcasting units.

End of Summer Time

AMERICA reverts to standard time on September 25th, so she will be six hours back until we follow suit on October 2nd.

Television "News-Flash"

VIEWERS were treated to an up-to-the-minute news item last Friday, when three cameras of the B.B.C. mobile television unit took their places among news reel and press cameras at Heston Airport for the arrival of the Prime Minister on his return from his peace mission to Herr Hitler.

Radio Luxembourg

As a result of a recent agreement with the State, Radio Luxembourg will in future maintain a Government representative on its staff. He will have an insight into the entire business of the Corporation. It is estimated that the Government's share in the earnings of the station this year is some 5,000,000 francs.

Philips' Hungarian Factory

AT Kolbanya, Hungary, a new factory employing some 200 people has been built for Philips. The contract for the reconstruction of the Budapest wireless station has been granted by the Hungarian Postal Administration to Philips, and provincial stations in the future are to employ Philips' transmitters.

Technical Data

THE Bulgin Radio Service Manual for 1938 has now made its appearance. Useful not only to the professional service-man, but also to the amateur, this 80-page book is a handy source of information on many subjects. The new edition has been enlarged and revised; push-button tuning is treated, and another section of growing importance is that devoted to vibratory HT generators.

Paderewski on the Air

PADEREWSKI, the world-famous pianist, will be heard in a concert relayed from Lucerne by the N.B.C. short-wave station, W3XAL, on September 25th, at 8.15 p.m. (B.S.T.).

Experiments Afloat

THE owner of a 7-ton yacht wishes to get into touch with a transmitting amateur, "young enough to enjoy the rigours of small-boat sailing," with a view to co-operating in various experiments in transmission and reception, including direction-finding. Letters, addressed to "Yachtsman," c/o *The Wireless World*, will be forwarded.

TELEVISION TOUR. The first group to see television and how it works, in the N.B.C. studios at Radio City, New York, receives an explanation from a specially trained guide, one of a uniformed corps which escorts visitors round the exhibition of America's latest developments in television at 10-minute intervals throughout each day. An invitation to visitors to come and be televised is, we are told, meeting with a more enthusiastic response than was shown by the more retiring British public at Radiolympia.

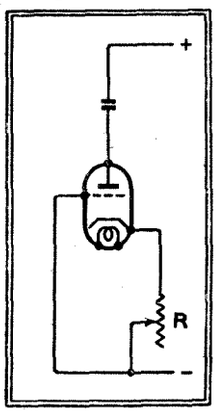
Letters to the Editor

The Editor does not necessarily endorse the opinions of the correspondents

Time-base Circuit

I HAVE read the article by your contributor "Cathode Ray" on negative feedback with interest. During some recent research on engine indicators I discovered a further use for it which may or may not be original. As this has obvious applications in television work you may be interested. Here is a brief description.

When a condenser has to be charged at a steady rate it is usual to place a constant current device, such as a pentode, in the charging circuit. The reason for the choice of a pentode is clearly the high value of Ra possessed by these valves. The usual procedure is to vary the screen volts in order to control the rate at which the condenser charges. In the present scheme, however, the control grid volts are varied by the cathode resistance R shown in the figure.



If the grid and anode volts are varied, the variation of anode current is given by the equation:—

$$Ia = \frac{Va}{Ra+R} + \frac{\mu Vg}{Ra+R}$$

Since the positive bias on the cathode is obtained by the flow of anode current through R, we may write IaR for Vg.

Substituting and simplifying,

$$Ia = \frac{Va}{Ra+R}(1+\mu)$$

It appears, therefore, that this method of control increases Ra by an amount μR, and as a result Ia varies less for a given variation of Va.

In practice it was found that providing that R was not allowed to become too small approximately linear traversing could be obtained with a triode. When a pentode is used in this circuit the traverse is sensibly linear over the whole of the oscillograph screen, and if the pentode is of the variable mu type, the control is smooth over a very wide range. It should be noted that with variable-mu valves μ tends to decrease more rapidly than R increases. This, however, is largely offset by the fact that Ra tends to increase with increase of negative grid volts.

Isleworth. W. R. GROVES.

Wireless at the Universities

IN *The Wireless World* of September 8th it was stated that the Ohio State University had recently completed a large-scale SW reception survey, and it was asked why the Universities of Oxford and Cambridge conducted no similar activities.

As a present and foundation member of the Oxford University Wireless Society, I feel obliged to point out that at both these English Universities there are wireless societies, formed and run by undergraduates, which reach a very high standard of technical achievement.

Both are entirely amateur organisations, the C.U.W.S. being of long standing, while the O.U.W.S. has been more recently formed.

In several of the scientific syllabi radio forms a part, and while the University authorities do not officially recognise the societies, at Oxford, at any rate, they have afforded much valuable assistance, even to giving the society ample free accommodation and electric current in the electrical laboratories, together with the loan of some apparatus and like facilities.

Thus, readers may be well satisfied that the two great British Universities do not lag behind similar institutions in other countries.

Oxford. SEÄN O'NEILL.

"Debunking Intermodulation"

HAVING made a prolonged study of Messrs. Callendar and Clarke's "second salvo" (August 25th issue) I have come to the conclusion that it is a salvo of dust in the eyes rather than of illuminating fire. In the first place it is confusing enough when they follow the American practice of using decibels for reckoning two different things—Intensity and Loudness—but when they go on to distinguish a third quantity —Sensation level, also presumably in db —it is too much.

My Wegel and Lane figures were extracted from the top left-hand curve sheet on p. 401 of Olsen and Massa's *Applied Acoustics*, and were reckoned in intensity levels, as given, for, of course, one does not use subjective loudness figures for reckoning objective harmonic percentages, and if I did I would use the proper unit for this quantity—the phon.

When Messrs. Callendar and Clarke go on to give their revised "zero" as $1\mu W$ per sq. cm. the possibility that we are arguing at cross purposes presents itself, for all the literature of the subject I have seen places 0 db. at $10^{-10}\mu W$ per sq. cm.—a rather important difference.

The reference to 80 db Sensation Level being equivalent to 95 db Loudness Level is irrelevant in any case, for the reason given above; but, assuming 80 db Sensation Level to be what I call 80 phons, it is very inaccurate, because, according to the accepted Fletcher and Munson curves, 80 phons at 200 c/s is 82 db, and my own experiments with various sound meters puts me in agreement with other published work in describing this level as "fairly loud." Even a level of 95 phons (or db—they are practically the same here) is obtainable with a hundredth of the power mentioned by Callendar and Clarke.

Getting back to the general question; it will take more withering fire than any to which I have yet been subjected to make me abandon the position that, normally, intermodulation forms by far the greatest proportion of audible distortion, harmonics being relatively unimportant (except possibly when appreciable quantities of high harmonics are present). But, unlike Mr. Harries, I am not well enough informed to be able to decide on the best method of measuring offensiveness. If measurement of harmonics can be relied upon as a measure of the more audible intermodulation type of distortion, by all means let them be measured. Nevertheless, my little experiment that started the argument should be repeated occasionally, if only to conceive one of the large relative importance of intermodulation.

"CATHODE RAY."

Ignition Interference: Modern High-voltage Systems

IT would be an interesting experiment to set the points of the plugs in a car engine as close as they will fire the mixture and drive the vehicle past a receiving station; then to set them as wide apart as possible and again measure the interference. It might cause twice as much noise in the receiver.

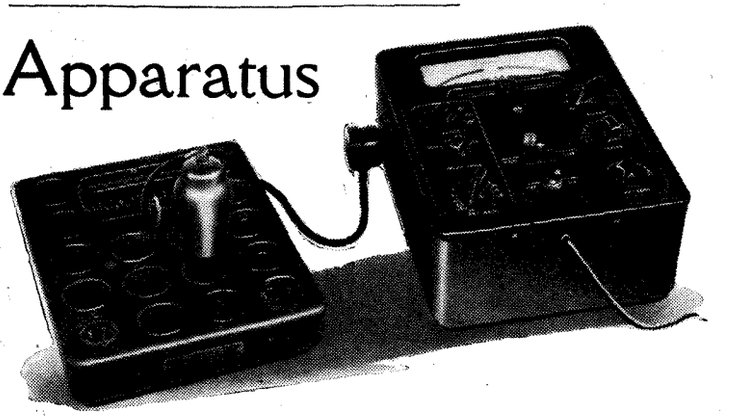
If it is a fact that the interference varies as the voltage across the spark gap, then the new high-voltage ignition which is a feature of the latest "economy" cars will make short-wave reception increasingly difficult. L. HOWARD-FLANDERS.

London, W.5.

New Apparatus

Products of the Manufacturers Reviewed

NEW "AVO" VALVE TESTER



THE well-known "Avo" valve tester was reviewed in *The Wireless World* for May 7th, 1937, and it will be remembered that it consists of a "tester" and two valve-panels. The tester is the heart of the instrument and contains the indicating meter, mains equipment and control switches. The valve panels each have twenty valve-holders and are connected to the tester by a 9-way cable and plug; one panel is for British and the other for American valves.

With the growth in the number of valves and the increase in the number of bases these panels no longer accommodate all types and they have been replaced by a new panel. This new panel has twelve valve-holders: British 5-, 7-, 9-pin, octal, 5-, and 8-contact, American 4-, 5-, 6-, 7-pin and octal, and Continental 7-pin. In addition there are four blanks, so that new holders can be fitted in the future if they should be necessary.

Having provided a holder for any valve, the problem of its connection arises, and this is solved by switching. The switch is in external appearance rather like a barrel switch, but it consists of nine independently operated segments, each of which has ten possible positions.

Accompanying the panel is a booklet which gives the switch positions for current valves, and there is plenty of space available for adding fresh specimens. This booklet gives also the settings of the switches on the tester and the meter reading, which should be obtained with a good specimen. For instance, take the MSP41, the valve panel switch is set so that its figures read 040231500, and the valve is inserted in holder No. 9. On the tester the heater volts switch is set to 4v., the anode volts switch to 250, and the screen volts to 200. The meter reading for mutual conductance should be 3.2 mA/V.

The switch code, or "combination," does not, of course, differ for every valve. It is the same for all valves with the same base connections. While not, perhaps, quite as quick to use as the old-type panels, this new one has the great advantage of catering for a wider range of valves, and of being readily adaptable to new types when they come along.

The tester itself is unchanged and needs no description. The complete tester with the new panel costs 12 gns., but the panel is available separately at 3 gns. The makers are The Automatic Coil Winder & Electrical Equipment Co., Ltd., Winder House, Douglas Street, London, S.W.1.

COSSOR GANGING OSCILLATOR

DESIGNED for use in conjunction with the oscilloscope type 3332, the Cossor Ganging Oscillator, Model 3343, enables a visual trace of the resonance curve of a receiver to be obtained on the screen of the cathode-ray tube.

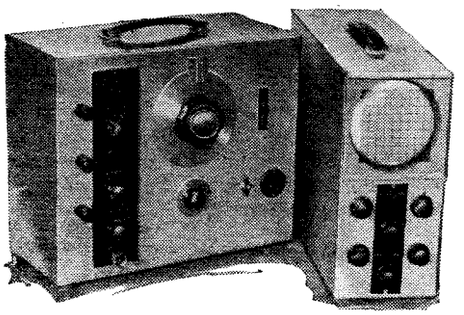
The oscillator contains four valves of which one is the rectifier for the HT supply. A fixed triode oscillator is used and functions at 380 kc/s; its frequency is varied by means of a control valve at a rate depending on the setting of the time-base in the oscilloscope. This control valve is a pentode arranged to have a reactive input impedance and it is connected to the oscillator circuit. The effective capacity of the oscillator thus varies in sympathy with the saw-tooth waveform of the CR tube time-base. The oscillator frequently consequently varies also, and the change is some ±15 kc/s.

In order to obtain an output at any desired frequency but with a constant "wobble," the superheterodyne principle is resorted to. Instead of varying the frequency of the "wobbly" oscillator it is left fixed and a separate oscillator is provided which can be tuned over a wide range by a panel control. This oscillator is actually the triode section of a triode-hexode valve to the control grid of which the output of the "wobbly" oscillator is applied.

Sum and difference frequencies appear in the anode circuit and it is the latter of these which is used. It is selected by a tuned circuit, the variable condenser of which is ganged to that controlling the variable oscillator. The range covered is 20 Mc/s to 80 kc/s in five bands.

The output is controllable in three steps by a switch and there is a potentiometer for precise adjustment. The fourth position of the switch enables a 400 c/s AF output to be secured. Another switch gives a change-over between frequency modulated RF output, unmodulated RF output, and 400 c/s amplitude modulated RF output. The oscillator can thus be used with or without an oscilloscope as an ordinary test oscillator.

The output of the receiver is taken to the oscilloscope from the diode load in most



On the left is shown the Cossor Ganging Oscillator and on the right is the Oscilloscope.

cases, so that a single trace resonance curve appears on the screen.

On test the oscillator proved very satisfactory and easy to use. A clear and steady resonance curve is easily obtained. Synchronism is inherent, but it is advisable to lock the time-base at a sub-multiple of the mains frequency, otherwise mains hum may cause a small ripple on the image.

The makers are A. C. Cossor, Ltd., Highbury Grove, London, N.5, and the oscillator is priced at £20.

FILTERS AND TONE CONTROL COMPONENTS

THE new season's programme of Kinva accessories and components includes a newly introduced needle-scratch filter for use with piezo-electric pick-ups. An adjustment of frequency characteristics is provided. A similar filter for modern magnetic pick-ups is also available at the same price (16s.).

Improved whistle filters, designed to have extra steep sides to their characteristic curves in order to minimise the effect on quality of reproduction, have also been produced. The series of Kinva air-cored coils for tone control and similar purposes comprise values between 0.01 henry and 3 henrys, including values specified from time to time in *The Wireless World* articles. The makers are Postlethwaite Bros., Church Hill, Kinver, Staffs.

THE WIRELESS INDUSTRY

THE standard range of Celestion loud speakers is described in a leaflet obtainable free from Cyril French, 29, High Street, Hampton Wick, Kingston-on-Thames. The Models 66 and 33 (formerly Magnavox) have been increased in price to £6 15s. and £6 6s. respectively.

◇ ◇ ◇ ◇

A Presto Sound Recorder, of the type supplied in this country by R. A. Rothermel, Ltd., was successfully used by a recent French expedition to the Sahara for recording native dialects, etc.

◇ ◇ ◇ ◇

It is regretted that in our last week's issue the price of the Ambassador table model receiver was incorrectly given as 15 guineas instead of 14½ guineas.

◇ ◇ ◇ ◇

A brochure recently produced by Goodmans Industries, Ltd., Lancelot Road, Wembley, Middx, and entitled "The Attainment of an Ideal," gives much useful technical information on the design and methods of testing Goodmans loud speakers. Copies will be sent to those interested on receipt of 1½d. to cover postage.

◇ ◇ ◇ ◇

Change of address: National Radio and Television Service Company, to 126, Elthorne Road, Holloway, London, N.19. Tel.: Archway 1319.

◇ ◇ ◇ ◇

The 1938 Year Book of The Electrical Industries Benevolent Association, which has just appeared, records a 43 per cent. increase in the amount paid out in grants.

◇ ◇ ◇ ◇

Marconiphone has secured the contract for the PA installation at the Woman's Fair and Exhibition at Olympia. The same firm has been entrusted with the sound amplification arrangements at the launching of the *Queen Elizabeth*.

◇ ◇ ◇ ◇

Mr. Frank Heaver is starting business on his own account as agent for the production of many well-known American firms. His company, to be known as Frank Heaver, Ltd. (address: Bush House, Kingsway, London, W.C.2), commences activities on September 26th.

TELEVISION PROGRAMMES

A special film transmission intended for demonstration purposes will be given from 11 a.m. to 12 noon each weekday.

Sound	Vision
41.5 Mc/s	45 Mc/s

THURSDAY, SEPTEMBER 22nd.

3, Jam Session, programme of spontaneous swing music. **3.20,** British Movietonews. **3.30,** 175th edition of Picture Page.

8, Promenade Concert (sound only). **9,** Nelson Keys in Cabaret. **9.30,** Gaumont-British News. **9.40,** 176th edition of Picture Page. **10.10,** Interval Music. **10.25,** News.

FRIDAY, SEPTEMBER 23rd.

3, Round the Film Studios, a return visit to Pinewood. **3.15,** Gaumont-British News. **3.25,** "Autumn Laughter"—Henry Sherek's Dorchester Hotel Production.

8, Promenade Concert (sound only). **9,** "St. Simeon Stylites," a play. **9.30,** British Movietonews. **9.40,** Return visit to Pinewood. **10.25,** News.

SATURDAY, SEPTEMBER 24th.

3, A Return visit to Pinewood. **3.15,** Cartoon Film. **3.20,** British Movietonews. **3.30,** Nelson Keys in Cabaret.

8, Promenade Concert (sound only). **9,** Return visit to Pinewood. **9.15,** Jam Session. **9.40,** Gaumont-British News. **9.50,** Wilfrid Walter in his sketch "The Man who Sold his Shadow." **10,** Interval Music. **10.25,** News.

SUNDAY, SEPTEMBER 25th.

8.50, News Bulletin. **9.5,** Alicia Markova. **9.15,** Film. **9.25-10.30,** "Henry IV," a play by Pirandello.

MONDAY, SEPTEMBER 26th.

3-4.15, "The Ascent of F6," a play by W. H. Auden and Christopher Isherwood. **5.30-7.10,** O.B. of the Preston North End v. Arsenal Football Match.

8, Promenade Concert (sound only). **9,** West End Cabaret. **9.30,** Gaumont-British News. **9.40,** Talk. **10,** Interval Music. **10.25,** News.

TUESDAY, SEPTEMBER 27th.

3, Cabaret. **3.35,** Gaumont-British News. **3.45,** David Seth-Smith presents Friends from the Zoo.

8, Promenade Concert (sound only). **9,** Speaking Personally. **9.10,** British Movietonews. **9.20,** Friends from the Zoo. **9.35,** Cartoon Film. **9.40,** The Ballet Russe de Monte Carlo from the Royal Opera House, Covent Garden. **10,** Interval Music. **10.25,** News.

WEDNESDAY, SEPTEMBER 28th.

3-4, "Henry IV," a play by Pirandello.

8, Promenade Concert (sound only). **9,** Starlight. **9.10,** Feature Film, "So Ended a Great Love," with Paula Wessley and Willy Forst. **10.40,** News.

Random Radiations

By "DIALLIST"

The Stations in China

DO you remember my writing recently about the derelict wireless transmitters that Sir Eric Teichman found in the wilds of Mongolia and Sinkiang during his memorable journey from Peking to Turkistan? I asked the Marconi Company if they could tell me anything about these lost stations, and I am indebted to Mr. W. G. Richards for some interesting facts. Each station contained a Marconi 25-kilowatt arc transmitter, designed for a wavelength of about 3,000 metres and provided with high lattice steel masts. The whole of the gear, including the aerial masts, was transported over the roughest of roads from Peking by means of carts drawn by oxen. When you recall that all the stations were 600 miles apart, and that Urumchi, the most distant of them, was 2,550 miles from the railhead, you will agree that this astonishing feat well deserves Sir Eric's description, "One of the epics of engineering history." The stations were erected between 1921 and 1923, and for some time maintained communication with the Son-of-Heaven Station at Peking. They deserved a better fate than the destruction by bands of raiders which befell them.

"Extension" Viewing Screens

WE'RE all familiar with the "extension" loud speaker—no self-respecting receiver is complete without terminals, sockets or jacks arranged for its connection. It is now suggested that something on similar lines should be done with the television set and its viewing screen, whether this be a cathode-ray tube or anything else. There seems to be something in this idea for two quite different reasons. The viewing-screen, after all, is to the televisor exactly what the loud speaker is to the wireless receiving set. There are very distinct advantages, as many of us have proved for ourselves, about removing the built-in loud speaker and using a separate external unit. By so doing you can get rid of cabinet boominess and you free the set from that constant vibration which may not be good for its health. Put your cathode-ray tube all by itself in a cabinet of its own, connected to the set by means of flex leads, and you reap two rewards: the tube is no longer subjected to the vibrations caused by a neighbouring loud speaker and it is safely away from the external fields of components in the receiver.

Viewing in Comfort

The second reason why I like the suggestion is that it would mean much greater comfort for the viewer. An objection that not a few people have to television is that the family can't sit round the fire in their accustomed chairs and look in at the same time. To see the television programmes they must move their chairs. The televisor itself, unless it is a midget, is too large and too heavy to be moved about with ease. Not so this extension viewing screen; you can put it just where you like. Owing to its small weight it would be genuinely transportable. It might have a stand, enabling its height or its angle to be adjusted to your liking; but even with no such stand you could always put it on a small table, propping it, if necessary, with books until its position was just right for comfortable viewing. There seems to be certain possible snags—but that is the case with so many new ideas, and part of the business of inventors is to find ways and means of removing them.

Still They Come

TALKING of inventions reminds me of a note I wrote some months ago about the number of inventors who send me accounts of discoveries which they are convinced are both epoch-making and money-making. The flow still continues, and it's surprising to find how many of these brain waves are just old ideas, some of which are already in use, whilst others have been tried and found wanting. Just the other day I heard from a man who was burning to patent a delayed-film process for television transmission, which is identical with that used by the Baird people at A-P before the adoption of the electron camera! And this very morning as ever is comes a long screed from an enthusiast whose idea is to project large-sized television images by a contrivance on the lines of the old magic lantern, the screen of the tube playing the part of the slide. Just where the illumination of the "full cinema-sized" viewing screen is going to come from, I don't quite know. 'Ware freak results if you invent. I once attended a demonstration of a hook-up receiving set which gave really remarkable results. Quite a bit of money was spent in putting it into production, but it was found impossible to produce anything that would repeat the performances of the original set.

Radio-Proof Flats

THE other day I saw that a block of flats either had been built or was about to be built (I forget which it was now) in which each apartment was guaranteed to be absolutely immune from the nuisance that can be caused by the bellowings of neighbouring loud speakers. The worst of wireless is that you can't keep it within bounds. Transmission intended for the delectation of those only who live within the frontiers of the country in which they originate are heard at the ends of the earth and cause unwelcome heterodynes or background interference with

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, SEPTEMBER 22nd.

Nat., 7.20, Peter Yorke and his Orchestra. 8, By Act of Parliament: talk by a barrister on The Inheritance Act, 1938.

Reg., 6.20, Radio version of the new film "Alexander's Ragtime Band." 8, Concert Party from New Brighton. 8.45, "Nights Out," by Jeanne de Casalis. 9.5, "The Belle of Boopadoo," a burlesque in rhythm. 10.25, Commentary on the World Flyweight Boxing Championship.

Abroad.

Radio Eireann, 7.20, 'Burning Questions"—War must be cruel to get it over quickly. 7.50, Frank Hammond conducts the First Symphony Concert of the Season.

FRIDAY, SEPTEMBER 23rd.

Nat., 7.45, "Paradise Isle"—variety. 8.15, Jack Payne and his Band. 9, From the Promenade Concert. 10.5, "My Best News Photo."

Reg., 6.45, Jack Wilson and his Versatile Five. 8, "White Ladies," a play. 9, Northern Music Hall. 9.50, From the Promenade Concert, with Egon Petri, pianoforte.

Abroad.

Cologne, 8.10, "A Festival Concert from Bückeburg Castle.

Strasbourg and Rennes, 8.30, "Faust in Music"—concert from Paris.

SATURDAY, SEPTEMBER 24th.

Nat., 4.30, Parachute Jumping; O.B. from an aeroplane flying over Northolt Aerodrome. 5, Henry Hall and his Orchestra. 7.30, Hill Billy Round Up. 8, Promenade Concert.

Reg., 8.30, Music Hall, including Will Fyffe, Bebe Daniels and Ben Lyon. 9.30, "Farewell to Summer." 10.30, Tommy Dorsey and his Orchestra, relayed from America.

Abroad.

Hamburg, 8.10, "Der Prinz von Thule," operetta (Kattnigg).

SUNDAY, SEPTEMBER 25th.

Nat., 4, Light Music from Holland, with Janet Lind. 6.15, The Winning Band of the Alexandra Palace International Championship. 7.30, Melodic Strings from Canada. 9.5, Marie Tempest in the play "Victoria and Disraeli."

Reg., 5.45, Eugene Pini and his Tango Orchestra. 6.15, Reginald Foort. 9.5, Theatre Composers, III.—André Messager—The Man and his Music.

Abroad.

Frankfurt, 8.25, "The Taming of the Shrew," comic opera (Goetz).

MONDAY, SEPTEMBER 26th.

Nat., 7, Mr. and Mrs. Neemo. 7.45, Carroll Gibbons, pianoforte. 8, Wagner Promenade Concert. 10.5, "The Past Week."

Reg., 6.20, Commentary on F.A. Charity Match. 8, George Scott-Wood and his Swingers. 8.45, "Speed," a programme of tunes in fast tempo. 9, The Story of the Building of the *Queen Elizabeth*.

Abroad.

Berlin (Deutschlandsender), 8.10, Chopin Recital by Raoul von Koszalski.

Stuttgart, 12 (midnight) "Falstaff," opera (Verdi) Salzburg recordings.

TUESDAY, SEPTEMBER 27th.

Nat., 6.30, Sonata Recital by Marie Wilson and Henry Bronkhurst. 8.15, Lou Preager and his New Swing Band. 9, Variety Mansions, including Claude Dampier and Billie Carlyle.

Reg., 6.35, Mantovani and his Orchestra. 8, Mozart Promenade Concert. 9.40, Boxing Commentary, Phillips *v.* Doyle.

Abroad.

Milan Group, 9, "Fidelio," opera (Beethoven).

WEDNESDAY, SEPTEMBER 28th.

Nat., 7, Talk on the Matrimonial Clause Act of 1937. 8, "Mademoiselle Ixe," a play. 8.55, From the Promenade Concert. 10.5, "London Raided," commentary on A.R.P. demonstration.

Reg., 2.45, Launch of the *Queen Elizabeth* 8, Variety from Birmingham. 8.50, "The Golden Wedding"—a tribute to those who have celebrated their fiftieth year of marriage. 9.50, From the Promenade Concert.

Abroad.

Warsaw, 7, Lehár Operetta Concert.

Leipzig, 7.30, "La finta giardiniera," opera (Mozart).

stations vast distances away. And the loud speaker of which the lovely quality and realistic volume are the delight of its owner's heart may be regarded as a thing accursed by others who live nearby. Possibly the sound-proof flat or house will provide the solution. I say possibly, because as things now are the sound-proof building costs a heap of money to construct. Perhaps some cheap but effective way of erecting it will be worked out before long. Meantime all that we can do is to live and let live, letting the volume attain its full majesty only at appropriate times and seasons.

Car Ignition Again

AN instance of the height to which the field of the interference caused by radiation from car ignition systems may rise is given by "Superhet," writing in the Calcutta *Statesman*. After referring to the recent discussion of this topic in these columns, he mentions that his own anti-interference aerial, suspended between masts rising 45ft. above a roof which is itself 35ft. from the ground, is by no means immune from this interference. Making full allowance for sag, he estimates the height of his aerial at not less than 75ft. above ground level. I don't know Calcutta, but I seem to remember seeing overhead telephone wires in photographs of various parts of the city. If so, the interference may well be due to re-radiation from such wires. You may remember a report that I quoted from a reader who had been able to observe the effects of telephone and telegraph wires in increasing the extent of the interference field. It is also noteworthy that in London, where the wires are in underground conduits, the interference does not appear to be effective at any great height above the dense traffic of the streets.

"Improvements"!

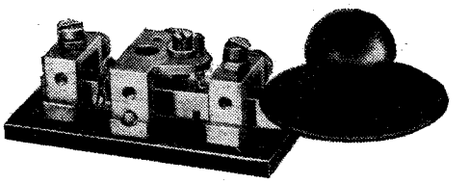
NO dyed-in-the-wool wireless man can possibly use a set made by anyone else for more than a few minutes without discovering several obvious improvements which he yearns to make. I remember constructing a very special set some years ago as a present for an old lady, who was a great friend of mine and passionately fond of music. She wanted to hear just the two local stations and to hear them at their very best. The set was a "straight" with an aperiodic high-frequency stage but without reaction, so that there should be no top-cutting. Though I say it as shouldn't, the quality was pretty good and she was delighted. I didn't see her after that for some weeks; then one day I went round to call and asked how the wireless set was behaving itself. She looked rather uncomfortable and when I glanced at the set, I saw why. Its panel (it was in the days of panels) had sprouted a rich growth of knobs and dials. A young nephew, it emerged, had been staying with her and was horrified to find that the set would bring in no foreign stations. He got down immediately to the job of "improving" it and scrapped every one of the aids to quality that I had so carefully worked out. So thorough had he been that I had to make her another set!

The Old Urge

I WAS reminded of that episode by my own feelings when I had been handling one of the last words in push-button receivers for an hour or two. I burned to take it to my workshop and wreak a variety of improvements (?) upon it. Here are two of the things that occurred to me, and I'd like to know how they strike you. First of all, why should you have to switch the set on? Why shouldn't that be done automatically when you press the button corresponding to the station you want? Then the motor would get to work at once and the station would come in as soon as the valves had warmed up. There might be an additional button which would be pushed to switch off. Next, I think it would be fascinating to search slowly over any waveband with the help of the motor. To do this you'd need a button bringing a low speed into play; and when you pressed this the set wouldn't be silenced while the pointer travelled. Directly your heard a likely station, you'd relax the pressure on the button and finish the tuning by hand in the ordinary way. You can "cruise" with some sets as it is, but there is no slow speed, and the instrument is silent until you release the button.

W.B. MORSE KEY

A MORSE key of the kind usually described as the "straight" variety has just been introduced by Whiteley Electrical Radio Co., Ltd., 109, Kingsway, London, W.C.2. It is a delightful key to operate, for it has that feeling of solidity that contributes so much to good sending and there is not the slightest trace of side play or whip. Some idea of the massive nature of its construction can be gauged from the fact that the rocker arm is $\frac{3}{8}$in. square, while the Tungsten contacts measure $\frac{3}{32}$in. in diameter. It is claimed, and appearances support this, that the key will handle up to 8 amps. of current.



Morse key of massive construction made by Whiteley Electrical Radio.

An unusual feature of its construction is that the main contacts are at the back, or remote from the knob, of the key, one is located on the top of the rocker arm and the fixed contact is on a screw attached to a stirrup-shaped piece of metal. A similar fitting supports another contact just in front of the knob, and this serves the same function of the usual "back contact" on the key.

The parts are assembled on a small ebonite base about $\frac{3}{16}$in. thick, which should preferably be secured to a larger base of insulating material if the key is employed in high-voltage circuits as the heads of the screws securing the various parts are not countersunk sufficiently for mounting on a metal base.

The price of this new key is 21s.

News from the Clubs

Dollis Hill Radio Communication Society

Headquarters: Braintcroft Schools, Warren Road, London, N.W.2.
Meetings: Alternate Tuesdays at 8.15 p.m.
Hon. Sec.: Mr. E. Eldridge, 79, Oxgate Gardens, Cricklewood, London, N.W.2.

On September 6th a lecture was given by the President (G6SK), entitled "Aerials and Aerial Design." A lecture by Mr. A. Turner, M.I.R.E. (G2XO), has been arranged for October 4th, and on October 18th Mr. J. H. Walters, of Belling and Lee, will give a lecture and demonstration on "Causes of Interference, Suppression at the Source and Receiver End, and Proposed Legislation."

Exeter and District Wireless Society

Headquarters: Y.W.C.A., Dix's Field, Southernhay.
Meetings: Mondays at 8 p.m.
Hon. Sec.: Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

The programme arranged for the Society during the period up to October 31st, 1938, is as follows:—

September 19th.—General meeting. Members will give their impressions of the Radio Show and a discussion will follow.
September 26th.—"High Spots of Amateur Radio, 1928-1938," by Mr. H. A. Bartlett (G5QA).
October 3rd.—Short-wave night. Members are invited to bring their sets.
October 10th.—Test of the Society's amplifier. A set of test records will be available.
October 17th.—Visit to the showrooms at Electricity House, Fore Street, Exeter.
October 24th.—Demonstration of the season's sets by Mr. F. J. Thorn.
October 31st.—"Pioneers of Radio," by Mr. B. Searle, M.Sc.

The annual subscription of the Society is 5s. and the entrance fee 1s. 6d. For members under 17 years the fees are 2s. 6d. and 1s. respectively.

London Transmitting Society

Headquarters: 40, Raeburn Road, Edgware.
Meetings: Sundays at 11 a.m.; Thursdays at 8 p.m.
Hon. Sec.: Mr. G. Yale, 40, Raeburn Road, Edgware.

The winter season commenced on September 11th. Membership is open to holders of AA or full transmitting licences. Applications for membership must be made on QSL cards, and those interested are invited to attend meetings. Mr. Yale is making enquiries concerning the R.A.F. Civilian Wireless Reserve, and the Society is applying for its full licence.

Maidstone Amateur Radio Society

Headquarters: The Clubroom, 244, Upper Fant Road, Maidstone, Kent.
Meetings: Tuesdays at 7.45 p.m.
Hon. Sec.: Mr. P. M. S. Hedgeland, "Hillview," 8, Hayle Road, Maidstone, Kent.

The following meetings have been arranged:—

October 4th.—A demonstration by the President, Mr. H. W. Goldsmith, of several modern all-wave receivers.
October 19th.—"Condensers for the Amateur, Receiving and Transmitting," by Dr. F. C. Stephan, of the Telegraph Condenser Co.

On other Tuesdays during this period short lectures and demonstrations will be given dealing with amateur subjects, and morse practice has been arranged. The Society has now applied for a transmitting licence and, should it be granted, transmitting lectures will be included. A booklet of information about the Society is being prepared and will be distributed to members. Anyone who is interested in the Society is invited to attend lectures, which commence at 8 p.m., and can obtain particulars and the booklet concerning the Society from the Hon. Secretary.

Romford and District Amateur Radio Society

Headquarters: Red Triangle Club, North Street, Romford, Essex.
Meetings: Tuesdays at 8.30 p.m.
Hon. Sec.: Mr. R. Beardow, 3, Geneva Gardens, Chadwell Heath, Romford.

The Society has been active lately concerning DF receivers and a team has been entered in a competition on September 24th. On September 6th, G8TV gave a lecture and demonstration of the oscilloscope. Morse practice is given by members holding G calls, and the Society invites anyone who is interested to attend meetings.

West Herts Amateur Radio Society

Hon. Sec.: Mr. A. W. Birt, 6, Hampstead Road, King's Langley, Herts.

At the September meeting Mr. D. G. Martin concluded his series of talks on "Television" by dealing with the Electron camera. Mr. Birt (G3NR) read papers regarding the proposed civilian wireless reserve of the R.A.F., and, after a demonstration of G3PV's 7-Mc/s apparatus, the evening concluded with a morse class.

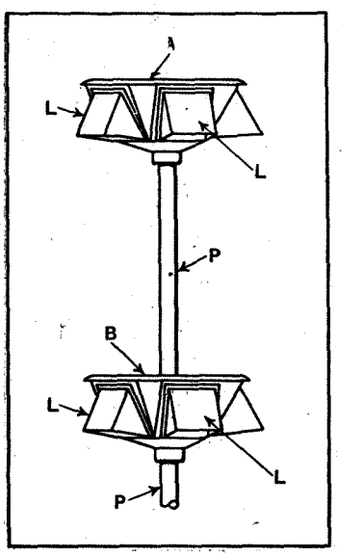
Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

PUBLIC ADDRESS SYSTEMS

THE Figure shows an arrangement of loud speaker units for a high-powered sound-radiating system designed for use, say, at sports grounds, or for open-air work at the seaside. Two groups A and B are mounted, one above the other, on the same post P, each group consisting of five speaker units, facing out symmetrically as shown.

In the sports stadium, for example, it is essential that those



Loud speaker assembly for outdoor PA work.

near the speaker installation shall hear as distinctly as those farther afield. To ensure this, and also to prevent the higher-frequency notes from creating disturbing echoes, say, between upper tiers of seats and a roof sloping parallel with them, adjustable deflecting members L are fitted to each speaker diaphragm, and serve to focus the radiated sounds outwards and downwards.

Telefunken Ges Für Drahtlose Telegraphie m.b.h. Convention date (Germany) July 4th, 1936. No. 486038.

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ELECTRON-MULTIPLIERS

IN a known type of electron-multiplier, a stream of primary electrons passes through a small aperture in a plate electrode, and is then accelerated through a ring-shaped anode on to a second plate electrode, where secondary electrons are produced. These are then kept moving to and fro between the two plates to build up a considerable current.

The invention relates to this type of device, but is designed to handle primary electrons flowing in a stream of considerable cross-section, such as that liberated from the "electric image" formed on the photo-sensitive screen of a television transmitter.

Instead, therefore, of focusing the stream into a narrow beam, so that it can pass through a small aperture in the first electrode, the whole of the latter is made of metal-foil which is permeable to primary electrons moving at a high velocity. Once the stream has passed through the first electrode to begin the to-and-fro motion between the two target electrodes, the electron velocity falls below the point at which the first electrode is permeable, so that the secondary emission current can build-up in the enclosed space between the two.

Fernseh Akt. Convention date (Germany) December 2nd, 1935. No. 486437.

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AUTOMATIC VOLUME CONTROL

THE figure shows a wheatstone-bridge coupling R1, R4 between the mixer valve M and the first IF amplifier A of a superhet receiver. The arrangement is designed to transmit signals of very low amplitude, or, alternatively, can be used to introduce a high transmission loss between the two valves.

The output from the mixer valve M is applied to the vertical diagonal of the bridge, whilst the input to the amplifier A is taken from the horizontal diagonal. The amount of energy transferred depends upon the degree to which the bridge is unbalanced. This, in turn, is controlled by varying the effective impedance of an auxiliary valve V, which is shunted across one side R4 of the bridge.

The valve V is subject to the AVC voltage supplied through a resistance R by a rectifier D coupled to the output of the amplifier A. Accordingly, the impedance of the valve V, the resulting "unbalance" of the bridge, and, therefore, the effective coupling between M and A, are all made to depend upon the amplitude of the received signal, thus providing a flexible system of automatic gain control.

Standard Telephones and Cables, Ltd. (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) September 19th, 1936. No. 486372.

o o o o

CATHODE-RAY INDICATORS

THE bearing of a distant wireless transmitter is shown as a flash of light on the fluorescent screen of a cathode-ray tube coupled to a direction-finding aerial system. The screen is fitted with a rotatable "cursor," which is adjusted by hand so as to "frame" the line of light in order that it may more easily be read against the compass scale.

The "cursor" is coupled through links with a cam-shaped disc which is shaped so as to introduce an automatic "correction" for quadrantal or "site" error.

J. P. Jeffcock. Application date November 26th, 1936. No. 485764.

o o o o

TELEVISION

THE "gun" of a cathode-ray television receiver is arranged in a right-angled branch of the tube. It consists of a cathode, which may be of the photo-sensitive type, and energised by a steady ray of light, followed by a series of "target" electrodes on which the liberated electrons are made to impact at considerable speed. This amplifies the stream by secondary emission.

The last "target" electrode is situated at the "elbow" of the tube, and forms the source of the electron stream used to scan the fluorescent screen.

The incoming television signals are applied from the aerial to a control electrode situated close to the original photo-sensitive cathode, where their effect is greatly intensified by the subsequent amplification due to secondary emission.

Cie Pour La Fabrication des Compteurs et Materiels d'Usines a Gaz. Convention date (France) May 23rd, 1936. No. 485412.

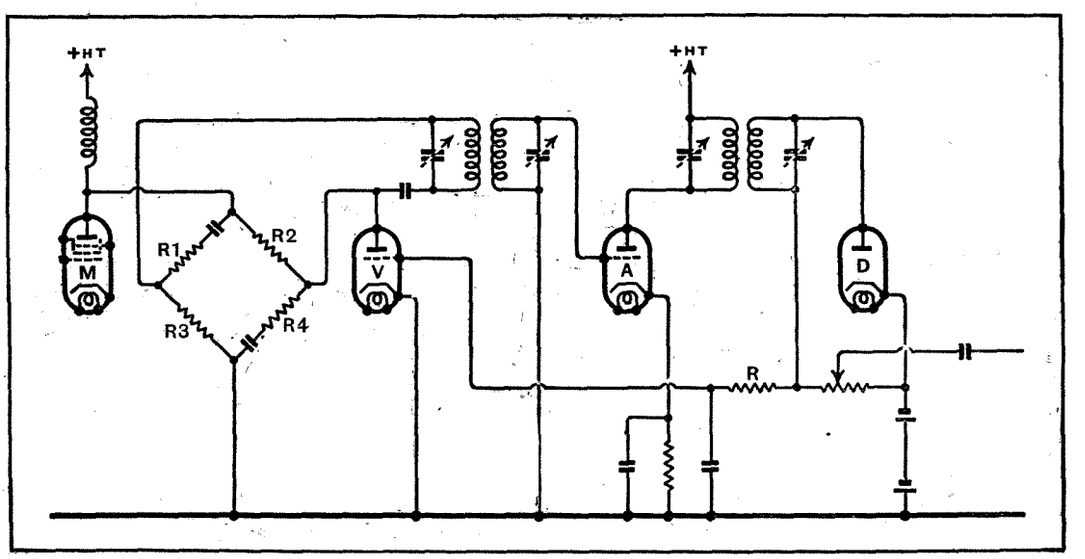
o o o o

WHEN televising a "dense" cinema film, or a poorly-lit scene, the photo-electric response is naturally weak, so that more intensive amplification of the signals is necessary than would be the case for a brighter scene. Owing to the limited amplitude range of the standard type of transmitter, this prevents the reproduction of all scenes in their true light-values, since the variation of light-values in nature is extremely wide.

The object of the invention is to overcome this limitation and to provide a system of gain-control which automatically adjusts the "high-lights" of any film, or indoor or outdoor scene, to a uniform or standard value. In this way the available range of contrast of the transmitter can be utilised to the full.

The control is such that for poorly-lighted scenes, or for a "dense" film, the gain of the amplifier is increased as compared with that used for "average" lighting, whilst for brilliantly lit scenes it is correspondingly reduced. The AVC voltage is developed by auxiliary valves interposed in the main amplifying channel of the transmitter, and is regulated by switches which are "set" in accordance with the prevailing light intensity.

Marconi's Wireless Telegraph Co., Ltd. (assignees of A. V. Bedford). Convention date (U.S.A.) August 29th, 1936. No. 486377.



An automatic volume control system in which the input to the amplifier depends on the unbalancing (by an auxiliary valve) of a bridge-type intervalve coupling.

The Wireless World

THE PRACTICAL RADIO JOURNAL

28th Year of Publication

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CONTENTS

EDITORIAL COMMENT

Television Distribution

Is There a Plan ?

A CONTRIBUTOR to the correspondence columns of this issue raises a very pertinent question regarding television's future. The letter can be read as an invitation to the B.B.C. to say whether or not any plan for the future distribution of television on a national scale has been devised.

We are, ourselves, inclined to doubt whether the B.B.C. is in a position to-day to state, if called upon to do so, what are their general intentions in the matter of distributing television during a development which may take place over, say, the next five years. Yet to invite manufacturers to build up a new industry without having first a positive plan prepared for a service to the public on a national scale would be a most unsatisfactory state of affairs. Does the B.B.C. yet know whether sufficient channels are available to meet the needs of the number of television stations with a radius of, say, 25 miles, which would be required to cover the country—or at least the more densely populated areas of it ? Have any conclusions been arrived at as to the possibility of using the same band for two or more stations, either for simultaneous or for separate television transmissions ? Must we assume that all television transmitters have to be linked together by means of coaxial cable or can this expensive method be replaced in some instances by a radio link if sufficient channels are available ? What are the possibilities of linking individual television transmitters with still shorter wavelength radio transmitters of the centimetre category, employing reflectors ?

Are we to suppose that the question of how this distribution is to be achieved beyond, say, the idea of a station at Birmingham linked by coaxial cable and perhaps another at Manchester is a project that is as yet unexplored ?

We cannot believe that this represents the position, yet conversations with a number of engineers who are deeply concerned brings to light no proper solution and in fact generally produce proposals which are contradictory, indicating that no generally accepted scheme has yet been formulated.

If, on the other hand, our misgivings, and those of our correspondent, are unfounded, and a more or less cut and dried plan has already been evolved, it is surely time that the nature of it should be disclosed in order that doubts and uncertainties may be removed and, more particularly, to enable the ideas of competent engineers to be focused on the right road so that the sum of their energies may be concentrated on the problem.

Patents

A Useful Service

IT very frequently happens that the inventor whose name appears upon a published patent specification does not remain the owner but assigns the patent to some other person or company. Patents may, in the course of years, change hands several times and it is important that those working in the same field of invention or who may wish to manufacture under licence should know who are the present owners. It does not seem to be generally known that application to the Patent Office with the payment of a nominal fee will enable an inquirer to obtain this information, which is recorded in a register of changes of ownership, particulars as to licences granted and much other relevant information.

"Single Signal"—and Why

A Study of Superheterodyne Selectivity

By S. K. LEWER, B.Sc. (G6LJ)

THE desirability of a high order of selectivity in the intermediate-frequency amplifier of a superheterodyne receiver is now fairly generally understood. Briefly, the main purpose of this high selectivity is to prevent interference from unwanted stations occupying channels adjacent to that of the station which it is desired to receive. The effect of extremely high selectivity in the IF amplifier in cutting the top frequencies of the audio modulation is also well understood, but the question of selectivity for CW reception, where a separate beat-oscillator is employed, has not received such close attention, or at least there is very little explanatory literature on the subject.

In the case of a straight CW receiver, using a self-oscillating detector, an audible heterodyne tone is heard on either side of the zero, or silent, point. The curve in Fig. 1 shows how the pitch varies with the tuning of the detector-oscillator. The strength of this heterodyne tone depends mainly on the characteristics of the telephones or loud speaker and of the ear. The variation of strength of this tone with the tuning adjustment is indicated by the depth of shading below the curve in the same figure. Heavy shading corresponds to a loud tone, and, conversely, light shading corresponds to a weak tone. The height of any point on the curve indicates the pitch. The diagram therefore gives both the pitch and the strength of the beat note, and their variation with the tuning adjustment. The same conventions are adopted in the explanation and in the drawings which follow.

Second-channel Interference

In a CW superheterodyne receiver not having a specially high degree of selectivity, exactly the same characteristics are found as in the case of a CW straight receiver. Moreover, if the selectivity of the RF circuits in the superheterodyne receiver is not sufficiently high to prevent second-channel interference, a second audio tone variation as shown in Fig. 1 will appear over the same small variation of the RF oscillator frequency when the RF oscillator is heterodyning another signal on the other side of the oscillator frequency, different from it by an amount equal to the optimum frequency of the IF amplifier. A true signal and an image of another signal may therefore occupy the same channel and be indistinguishable from one another. This is quite likely to occur on the short wavebands, because here the frequency discrimination of the tuned RF circuits ahead of the mixing valve is not very effective in preventing second-channel interference.

The occurrence of an audio tone on either side of the zero point is a serious disadvantage in that each CW station and the image of each CW station occupies twice as much space in the frequency spectrum as is necessary. If the audio tone were heard only on one side of the zero point, interference by other stations occupying neighbouring channels would be almost entirely prevented. This has been achieved by increasing the degree of selectivity in the IF amplifier to a much higher value than is permissible for good-quality telephony reception. This extra high selectivity in the IF amplifier does nothing to reduce second-channel interference. It is the selectivity of the RF circuits ahead of the mixing valve which determines the amount of image interference. The production of an audio tone variation on only one side of the zero point has been described as "single-signal" reception, the audio characteristics of which are shown in Fig. 2.

THE system described in this article is applicable only to the reception of continuous wave signals and not to telephony. A simple yet comprehensive explanation is given of the highly selective method described as "single-signal reception," in which the signal appears only at one side of "zero beat" of the local oscillator.

Exactly why only a single audio tone range is heard instead of two tone ranges on either side of the zero point, as in the receiver having ordinary selectivity (see Fig. 1), is not immediately obvious. In order to understand the action of the single-signal superheterodyne receiver, we must consider first the selectivity curve of the IF amplifier. Suppose the curve is not very sharp, as in the curve MON, Fig. 3. This curve shows the gain produced in the IF amplifier for frequencies on either side of the intermediate frequency. IFA is the peak, or optimum frequency for which the amplifier gain is greatest. The tuning circuits preceding the IF amplifier are adjusted to produce an IF signal having the frequency IFA. For CW reception, a beat-oscillator is provided, having a frequency slightly different from the frequency of the signal delivered by the IF amplifier—in this case, IFA.

The beat-oscillator frequency may be above or below IFA. Suppose it is on the low-frequency side, as at BOF in Fig. 3. The pitch of the audio tone produced by the beat-oscillator is given by the difference between IFA and BOF. If the RF oscillator is now moved slightly away from the original setting, the frequency of the oscillation passing through the IF amplifier—which we may call the IF signal—is slightly different from the original frequency IFA, say IFS. The beat-frequency oscillator frequency is considered in this discussion to remain fixed, so that the pitch of the audio tone is now different from what it was with the original setting, being (IFS – BOF) instead of (IFA – BOF). As IFS is made to vary, by tuning the RF oscillator, the pitch of the audio tone varies, going down to the silent point and rising again on the other side. This audio characteristic is shown by the curve ASB and the shaded area in Fig. 3, just as in Fig. 1. As indicated by the shading, the signal is heard at practically the same strength on either side of the zero point.

The IF selectivity curve MON is rather flat, so that the amplitude of the IF signal passed by the amplifier remains practically the same throughout the whole of the audio range of variation of ASB. If, however, the IF selectivity is now made much sharper, for instance, by incorporating a suitable amount of regeneration or a crystal filter, the audio characteristic is found to be quite different.

In Fig. 4, the curve MON represents a sharper selectivity curve for the IF amplifier than the corresponding curve shown in Fig. 3. As the RF oscillator tuning is varied, the amplitude of the IF signal, IFS, now becomes much smaller as its frequency moves away from the resonant frequency IFA of the amplifier. When it has moved away so far that it passes BOF, the audio tone then passing through the zero point, the amplitude on the other side of BOF is so much smaller that the audio tone produced by the heterodyne effect of the beat-oscillator is consequently much weaker. In practice, this effect appears as a strong audio tone on one side of the zero point and a very faint signal on the other side. Often the signal on the far side is inaudible, leaving only one audio tone range, which gives the name "single signal."

The next question to be discussed is the relation between the variation of the RF oscillator tuning and the pitch of the

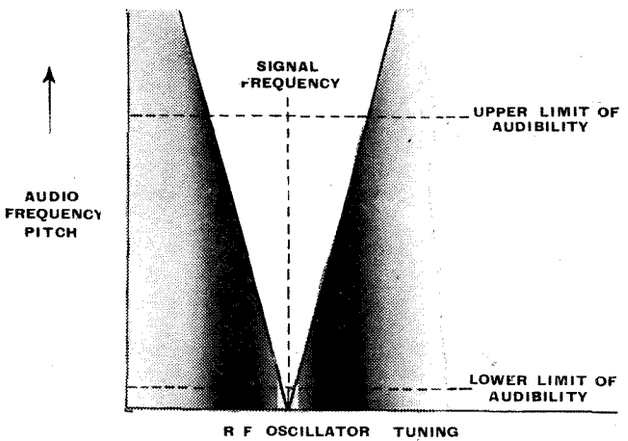


Fig. 1.—An audio tone is heard on either side of the zero point in a CW straight receiver or in a superheterodyne not having specially high selectivity.

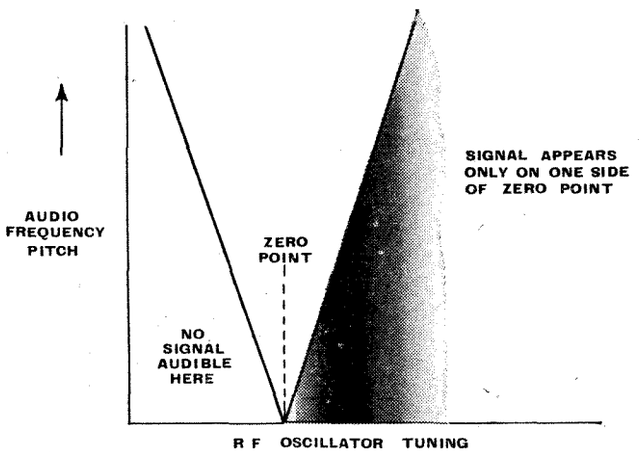


Fig. 2.—A graphical representation of "single-signal" reception, in which the signal appears only on one side of zero beat.

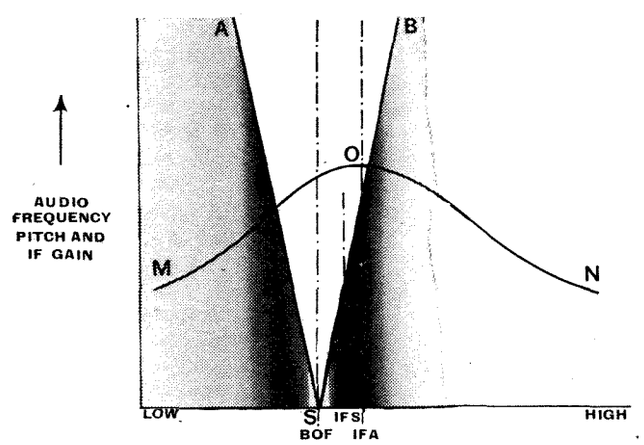


Fig. 3.—When the IF selectivity curve is not very sharp, a signal will be heard on either side of the zero point.

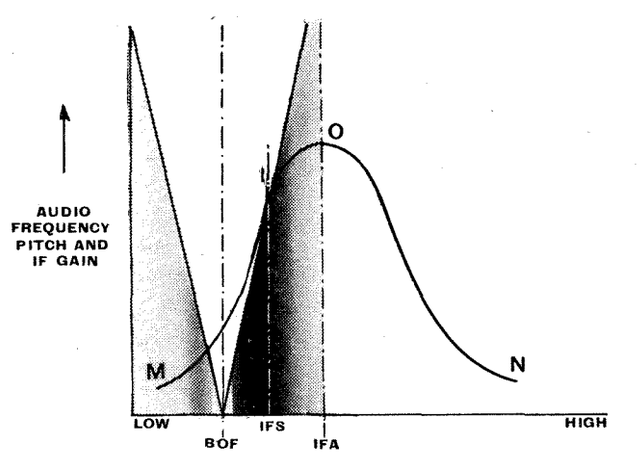


Fig. 4.—When the IF selectivity curve is sufficiently sharp, a signal will be heard only on one side of the zero point.

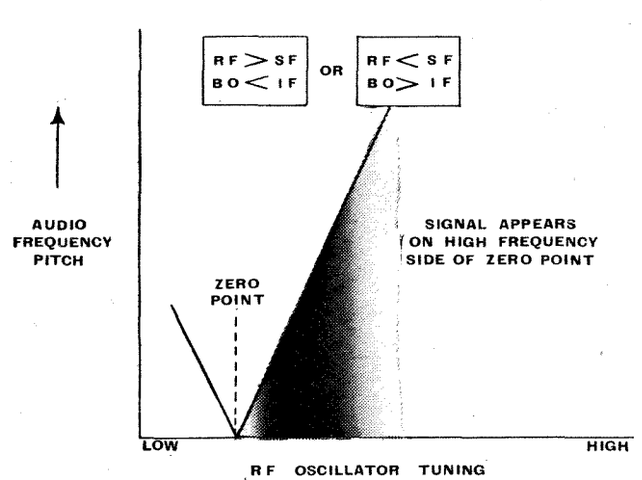


Fig. 5a.—The "single-signal" appears on the high-frequency side of the zero point when the RF oscillator has a higher frequency than the signal and the beat-oscillator has a lower frequency than the IF amplifier resonant frequency, or when both of these relationships are reversed.

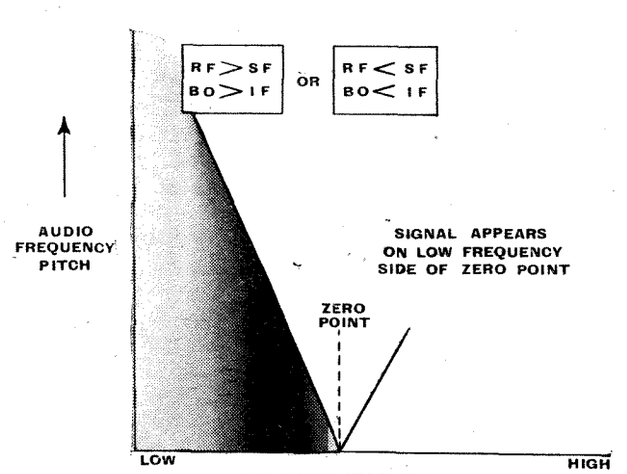


Fig. 5b.—The "single-signal" appears on the low-frequency side of the zero point when the RF oscillator has a higher frequency than the signal and the beat-oscillator has a higher frequency than the IF amplifier resonant frequency, or when both of these relationships are reversed.

"Single Signal"—and Why—

single-signal—always assuming that the frequency of the beat-oscillator is left constant. Does the pitch of the single-signal *rise* when the RF oscillator frequency rises, or does it *fall*? This depends on whether the beat-oscillator frequency lies above or below the resonant frequency of the IF amplifier and whether the RF oscillator is above or below the incoming signal frequency.

It the beat-oscillator frequency is higher than the resonant frequency of the IF amplifier, obviously the silent point will be reached when the IF signal is also higher than the resonant frequency, and if the IF signal is made to go still higher in frequency it loses amplitude quickly, due to the sharp selectivity characteristic of the amplifier, and the signal which is produced by the heterodyne effect of the beat-oscillator becomes much weaker, if not actually inaudible. Hence the audio tone which *is* heard falls in pitch as the frequency of the IF signal rises.

The IF signal is caused to rise in frequency, in the first place, by increasing the frequency difference between the RF oscillator and the incoming signal. Usually, the RF oscillator is on the ***higher*** side of the incoming signal frequency, so that in this case the IF signal frequency rises when the RF oscillator frequency *decreases*.

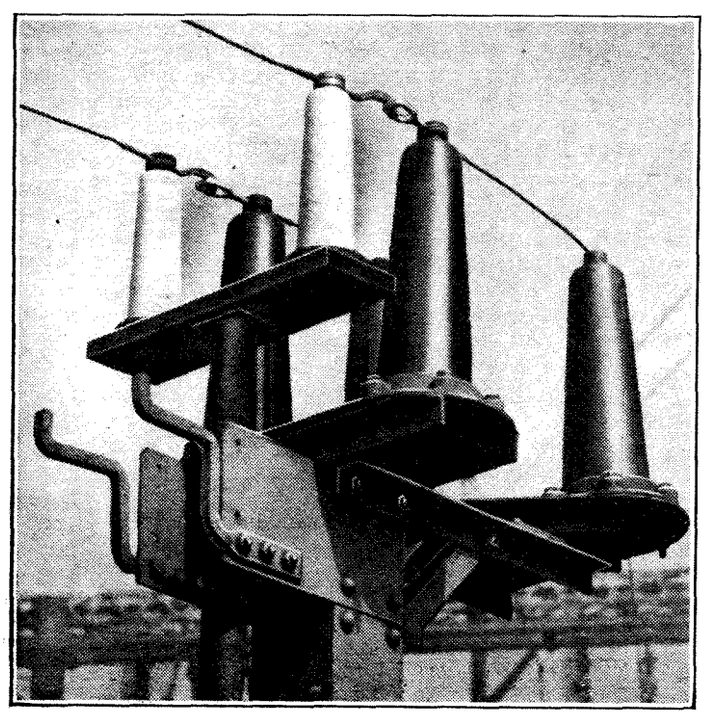
Audio-frequency Tone

Returning to the variation of the pitch of the audio tone, we find, therefore, that the pitch *falls* as the RF oscillator frequency *decreases*. This relation, which is indicated in Fig. 5(a), holds when the RF oscillator frequency is on the higher side of the signal frequency and when the beat-oscillator frequency is on the higher side of the IF amplifier resonant frequency. If *either* of these conditions is reversed, the audio tone will *rise* as the RF oscillator frequency decreases, as shown in Fig. 5(b). If *both* conditions are reversed, the first relation again holds.

This enables us to distinguish an image from a true signal. If, as is usually the case, the RF oscillator frequency is on the higher side of the incoming desired signal, it will be on the lower side of an incoming undesired signal which may be coming through at the image frequency. Particularly on the short-wave ranges the selectivity of the tuned circuits between the aerial and the mixing valve is rarely sufficient to prevent the appearance of such images. However, as the RF oscillator frequency is decreased, the pitch of the wanted signal will fall, while the pitch of the unwanted signal will rise—in the case where the beat-oscillator frequency is above the resonant frequency of the IF amplifier. The opposite variations will occur if the beat-oscillator frequency is on the lower side of the IF amplifier resonant frequency. It is therefore quite a simple matter to distinguish between the signal and the image of the unwanted station.

This discrimination between true signals and images is possible only when the IF amplifier is very sharply selective, for if it is unselective the double audio tone range, indicated in Fig. 1, will exist for both the true signals and images.

An understanding of the effects which have been discussed here should be very helpful in deciding whether sufficiently sharp selectivity has been achieved in the IF amplifier, and in adjusting the frequency of the beat-oscillator with reference to the resonant frequency of the IF amplifier.



THIS IS A SWITCH, though not the type usually associated with radio circuits. Known as a hook switch, it is employed at the Empire Short Wave Transmitter Station for aerial selection purposes.

Next Week's Issue

New Readers' Number

In addition to the usual features, *The Wireless World* of October 6th will contain several articles that will appeal especially to those who have not hitherto been regular readers of the journal, or have failed to keep abreast of recent developments.

Condenser "Shorts"

A DRASTIC CURE

THE self-explanatory kind of scraping noise which is heard in the loud speaker when a short-circuit occurs between the fixed and moving vanes of a ganged condenser would seem to suggest that the trouble should be easy to locate and cure. In practice, however, it is often a tedious and exasperating business, for having at length succeeded in determining in which of the sections the fault lies, it may still be impossible to see which plates are touching, or to detect any metal particle to account for the trouble.

If the gang is mounted in an inaccessible position, and for some reason it is suspected that it may have been accidentally damaged or distorted, then it is always advisable to remove the chassis from its cabinet in order to make sure that all of the fixed and moving vanes are quite clear of one another.

More usually the short is caused by tiny metallic splinters or "whiskers" adhering to the dusty surface of the vanes, and the simplest and quickest way of removing these is by deliberately burning them away by the application of a suitable HT voltage. This can be done quite easily by taking a lead from the most convenient available HT point of highest voltage and connecting it temporarily to the fixed-plate tag of the section in which the fault lies. (In a battery set it is as well to play for safety by first removing the valves.) The set is then switched on, and the tuning knob twisted backwards and forwards quickly in the vicinity of the shorting position; either there will be a series of little sparks to indicate the exact location of the short, or, more frequently, there will be a single momentary flash as the offending matter is completely burnt away.

THE WIRELESS INDUSTRY

A NEW series of Raytheon voltage regulators, with power outputs varying from 25 watts upwards, has been introduced by Claude Lyons, Ltd., 40, Buckingham Gate, London, S.W.1, from whom further particulars are available.

◇ ◇ ◇ ◇

Those responsible for the maintenance of large accumulator batteries will be interested in the Autostil electric water distiller introduced by Runbaken Electrical Products, 13-15, Liverpool Road, Deansgate, Manchester, 3. It is stated that, with current at ¾d. per unit, distilled water may be produced at about 3d. per gallon.

◇ ◇ ◇ ◇

Leaflets issued by the Eta Tool Co., 18, Metcalfe Street, Leicester, describe hand- and power-driven coil-winding machines of various types, including automatic and semi-automatic.

◇ ◇ ◇ ◇

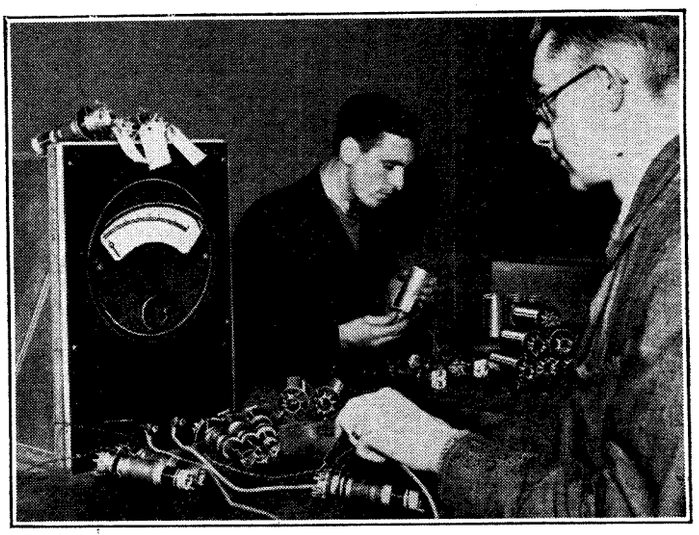
The Edison Swan Electric Co., Ltd., advise us that the price of the B.T.H. Minor Pick-up is 17s. 6d., and not 15s., as was incorrectly stated in a recent advertisement in this journal.

Tuning Coils in Production

HOW INDUCTANCE VALUES ARE MATCHED IN THE FACTORY

By "TEST ENGINEER"

IT is essential that the inductance values of RF and IF coils used in the modern receiver should be accurately matched; this article describes some of the methods used to this end in the commercial production of coils on a large scale.



Completed tuning coils, prior to their assembly in cans, being given a final continuity and insulation test at the Murphy Radio factory.

A MINOR tragedy in the test engineer's existence is the "Coil Test," a diabolical instrument with a proneness to breakdown which appears to increase in direct proportion to demands for output by the Production Department.

The problem of adjusting 4,000 coils daily is now a matter of tests and man-hours, though old hands can still barely repress a shudder at the thought. As one exasperated engineer phrased it: "The obvious symbol for inductance is just plain 'L'"!

There is a diversity of coil types to be considered, and each type usually requires different treatment. The inductance range is from the 1.5 microhenrys of a SW coil to the 1 henry of a whistle filter. Since tolerances also vary with types it is impracticable to adjust, say, an IF winding of 1,250 millihenrys ±3 per cent. on a test designed for oscillator coils of 130 mics. ±0.1 per cent.

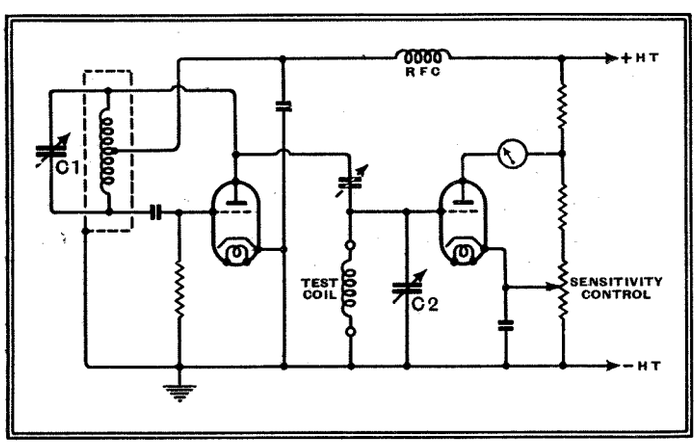


Fig. 1.—A simple coil test circuit of the oscillator-detector type. C1 is the calibrated oscillator tuning condenser, while C2 is calibrated in percentage inductance.

Early in the history of commercial radio it was held that the optimum test conditions for coils were those obtaining in the receiver. As an instance, IF transformers were tested "in can," suitably loaded with dummy "strays." A calibrated oscillator, variable over the IF band, provided a signal and the transformer was tuned and the band width determined before wiring into the chassis.

"Inductance tests" consisted of a local oscillator feeding an anode bend detector, the "test coil" in the detector grid circuit being tuned to resonance with a calibrated variable condenser. This arrangement is shown in Fig. 1. Occasionally the oscillator was wired to feed a bank of testing points along a production line, with unfortunate results when the frequency drifted.

"Beat-frequency" Coil Test

As a check against individual test variation, a maintenance engineer made a daily round with standard coils obtained from the laboratory. This practice mitigated one evil but introduced another, the inevitable "change of standard inductance" due to accident or natural depreciation.

Attempts to overcome these disadvantages produced the "beat-frequency" coil test, an ingenious adaptation of a familiar principle.

The method of operation is to connect

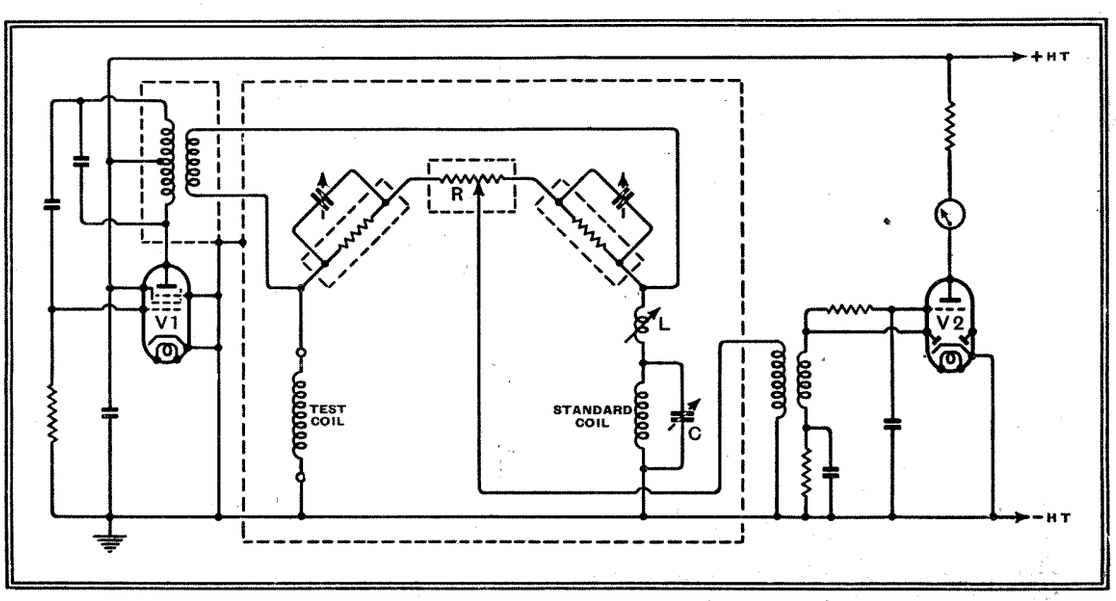


Fig. 2.—The radio-frequency bridge type of coil test circuit. V1 is the oscillator and V2 a double-diode-triode detector; L and C are pre-set to compensate for "strays" in wiring, etc. The elements of the potentiometer, which is calibrated in percentage inductance, are non-inductively wound on the Ayrton-Perry principle.

Tuning Coils in Production—

the test coil and a suitable standard into two separate oscillatory circuits. The "standard" circuit has fixed tuning, the "test" coil is tuned with a calibrated variable condenser. The signals from the two oscillators are "mixed" and rectified, and the resultant "beat-frequency," fed to a detector panel, usually a valve-voltmeter or cathode-ray tuning indicator.

It was originally anticipated that a discrimination of the order of two parts in a million would result from this instrument. Actually, taking into consideration such factors as frequency drift and temperature variation of circuit constants, the effective accuracy is lower than expected. An average daily "drift" of ±0.05 per cent. is commonly recorded.

In addition, the self-capacity of the coils materially affects the accuracy of matching, since resonance is the test condition rather than pure inductance balance.

An improvement on the "beat-frequency" method is the RF bridge (see Fig. 2). This instrument also requires standards for comparison, but is practically independent of small frequency variation.

The bridge circuits proper are excited from a local oscillator, the input frequency being consistent with the type of coils under test. Broadcast band signal coils are checked at 1 Mc/s, IF windings at 100 kc/s and whistle filter chokes at 10 kc/s. SW coils are "rough tested" at 10 Mc/s and adjusted in the receiver chassis.

Standard Inductances

Considerable attention is devoted to the design of bridge standards, the need for an inductance variable within narrow limits yet possessing high constancy producing many interesting designs. The use of formers of two materials with different expansion coefficients was much in favour at one time. Adjustment was effected by screwing a copper thimble along the axis of the coil. Later standards utilise iron dust cores with vernier adjustment, the windings being carried on a material having a negligible expansion coefficient.

Another school of thought favours the provision of standards exactly similar to the test coil, holding that temperature and humidity changes will result in equal inductance changes in both coils.

Perhaps the determining factor in satisfactory operation is the initial adjustment of standards.

The original coil supplied by the laboratory will have all leads and trimmers connected, and these must be removed since the production coils arrive for test "in the nude." Windings other than those being adjusted must be short-circuited or left as the receiver circuit indicates. Finally, the sub-standard must be adjusted to the laboratory model under exactly similar mechanical conditions.

The jigging for production coils also simulates the conditions of the receiver chassis. Each coil is cradled and screened, and each winding selected in turn by a switch which automatically brings in the correct standard coil at the same time.

The winding machines can be relied upon to 1 turn, so the inductance adjustment consists of spacing the end turns of a solenoid or of actual removal of turns in the case of a wave-winding. The practice of distorting wave-windings tends to cause loose wires and poor coils, and is "not done in the test circles."

For dust-core coils with a wide tolerance, the bridge control is set to ±0 per cent. and the dust core, smeared with fixative, is forced into the former till balance is obtained. The core is then waxed in position and the coil rechecked.

In the case of SW coils, conditions are more exacting. The inductance of the jigging may exceed that of the winding, and care is necessary to minimise "strays." Usually the coil is passed to a tolerance of ±0.5 per cent., the inductance being finally adjusted, again by sliding turns, when included in the receiver.

All coils are then wired to a "model," fixed in the can and passed to the galvo. line. Here continuity is checked, the DC resistance measured and the insulation resistance tested at a pressure in excess of that in the receiver.

Finally, the cans are coded and pass to the solderers for inclusion in the chassis, and on these stalwarts rests the final responsibility for receivers which "fall through" test, and those which have to be "squeezed."

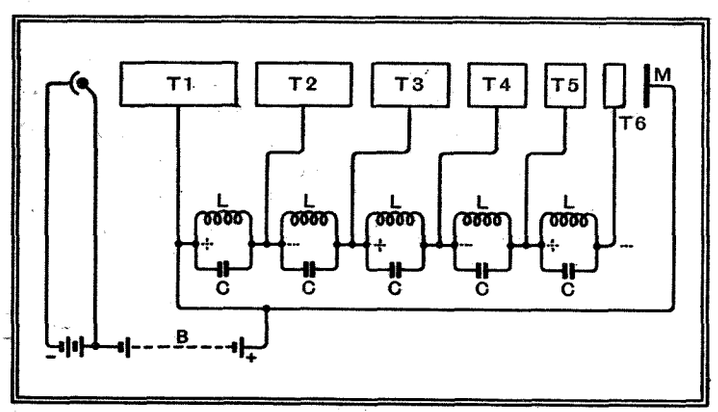
Ultra-Short-Wave Valves

"TAPPING" THE ELECTRON STREAM

THE spacing or "geometry" of the electrodes sets a definite limit to the performance of the ordinary valve as an amplifier or generator of ultra-short waves. The trouble starts with the increasing shunt capacity across the electrodes as the frequency rises, and reaches a climax when the distance between the cathode and anode becomes too much for the electrons to cover in the time available.

One remedy is to use a highly positive grid and a slightly negative anode, so that the electrons are made to "oscillate" about the grid. The efficiency of this so-called "braking-field" circuit is, however, limited to about 15 per cent. The split-anode magnetron, in which the electron stream is forced by an external magnetic field to follow a spiral path from cathode to anode, offers a second alternative, though here, too, the efficiency seldom exceeds 25 per cent. Theoretically it can be shown that all such "electronic oscillators" are limited to a maximum efficiency of 50 per cent.

The arrangement shown in the accompanying drawing (from Patent 488094) tackles the problem of generating ultra-short waves on novel lines, and in a way which at least offers the prospect of reaching a full 100 per cent. efficiency.



A "cascade" amplifying valve employing a series of tubular electrodes coupled together by tuned circuits.

The idea, in brief, is to "shoot" a stream of electrons through a series of tubular electrodes, which serve to tap-off the energy of the stream in the proper phase to build up a large output current.

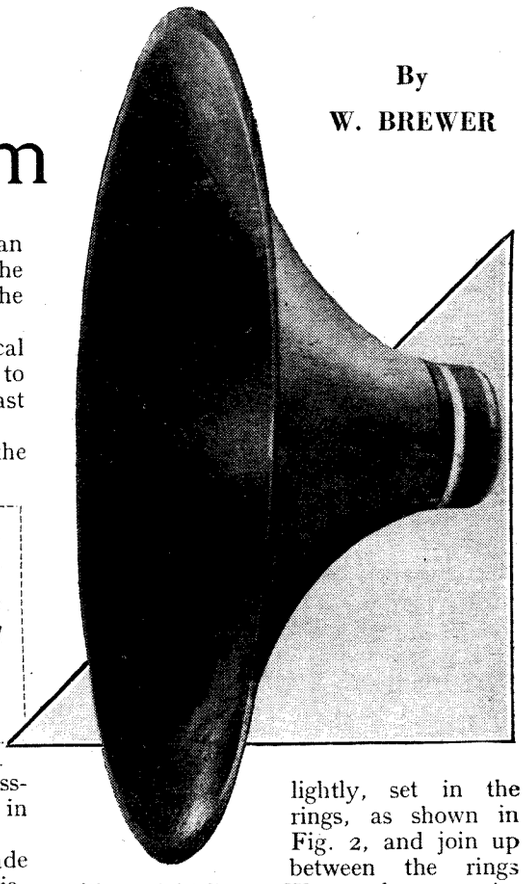
The process takes place in stages, as the electron stream travels through the valve, so that at the end of its travel the whole momentum of the stream has been transferred to the external circuits. Each of the tubular electrodes T1 . . . T6 is coupled to its neighbour by a circuit L, C which is tuned to the working wavelength. The electrodes are "graded" in length from one end of the tube to the other, so that in spite of the gradual retardation of the stream, as it loses energy, it takes the same time to pass through each. When the tube is operating at maximum efficiency, the electrons reach their destination, the final collecting electrode M, with zero velocity.

In addition to the steady biasing voltage applied to the electrodes from the HT source B, there will be an oscillating voltage from the tuned output circuits L, C, as shown by the dotted positive and negative signs. The alternating field should be at its maximum as the electrons pass from one electrode to the next. The fields then tend to oppose the motion of the electrons, and in overcoming this opposition energy is continuously transferred from the stream to build up in the external circuits.

Making a Curved Diaphragm

READER'S MODIFICATION OF A LOUD SPEAKER

By W. BREWER



THE writer describes the construction of a curved-sided speaker diaphragm in which a smooth surface of the desired contour is obtained by the expedient of glueing together a number of narrow paper rings.

THE merits of the curved-sided seamless diaphragm are now so well known that it is unnecessary to set them forth here. These diaphragms, however, are generally associated with speakers in the higher-priced class, and, so far as home construction is concerned, the amateur enthusiast has generally to content himself with a straight-sided seamed cone.

The writer, having among his treasures a large low-voltage pot-magnet which had done duty in a cinema, decided to investigate the possibilities of making a curved diaphragm to fit it.

After many trials and experiments the method to be described was decided upon, and this method of construction, if carefully carried out, results in a light, rigid diaphragm capable of giving good acoustic results.

This diaphragm consists of a number of narrow conical paper rings, each ring being carefully set out as regards shape, so that when the requisite number of rings is glued together a curved cone of the correct form is obtained.

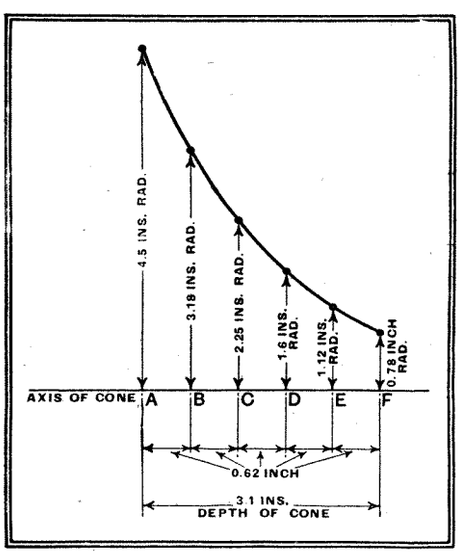


Fig. 1.—Section through one-half of the cone, showing method of laying out the dimensions.

Looking at the diagrams, the reader may conclude that the finished cone assumes a series of "straights," instead of a smooth curve. This is not so, and the constructor will find that the curve is as smooth as can be, each straight ring merging into its neighbour. This can be seen quite plainly in the photograph.

The following description relates to an actual diaphragm, of 9in. diameter, the material being cartridge paper of the variety known as "60 lb. weight."

Considerable accuracy in the geometrical layout is necessary if good results are to be obtained, but this is not in the least difficult.

In the diaphragm to be described, the curve of the cone is such that the cross-sectional area of the cone doubles itself in unit length along the axis.

The diameter at the mouth was made 9in. as already mentioned, whilst the diameter at the apex of 1.56in. was made to suit the pole-piece and gap. The depth of 3.1in. was chosen to suit an existing chassis.

The accompanying table shows the areas and diameters required, and on referring to Fig. 1, which is a diagram of half the cone about the axis, it will be seen that the depth of 3.1in., used as a base line, is divided into five equal parts, ordinates A, B, C, etc., being raised upon it.

Now, considering the table again, it will be seen that the area of the 9in. diameter mouth is 63.6 sq. in. (i.e., at ordinate A).

TABLE OF THROAT AREAS AND DIAMETERS.

Section ...	A	B	C	D	E	F	
Areas ...	63.6	31.8	15.9	7.95	3.97	1.98	Sq. ins.
Diameters ...	9.0	6.38	4.5	3.18	2.25	1.56	Ins.

At ordinate B the area is half this figure, namely, 31.8 sq. in., the diameter for this area being 6.38in. This process is carried through to the apex at F.

Having obtained these diameters, raise the ordinates A, B, C—F equal to the radii (as we are plotting half the cone only). Draw a smooth curve through these points, and we have the shape of the finished diaphragm (Fig. 1).

The number of rings provides the next question for consideration. It is better to use a large number of narrow rings in preference to few wide rings, as this will give a smoother curve. Also, the lap-joints between the rings give valuable stiffening to the cone. In this case seven rings were used, each ring being 0.44in. wide.

The next step is to draw the curve again, lightly, set in the rings, as shown in Fig. 2, and join up between the rings with straight lines. We now have a series of straight conical rings joined together.

The slope of each ring, 1-2, 2-3, etc., must be produced to join the axis at the points 0. Rings 1-2, 4-5 and 7-8 are drawn in heavy lines to show this point. Here the most careful setting-out is necessary if an accurate shape is to be obtained. It should be noted that no allowance for lap-jointing is shown in Fig. 3. This can be left till later.

It will avoid confusion if the whole diaphragm be drawn and alternate rings set out on opposite sides, thus, 1-2, 3-4, 5-6, 7-8 can be drawn on the top half, and 2-3, 4-5 and 6-7 on the bottom half.

All the rings may now be drawn out on the actual material preparatory to cutting out. Considering ring 1-2, an outer radius 0-1 will be struck from the diagram in Fig. 2, the inner radius of the ring being 0-2.

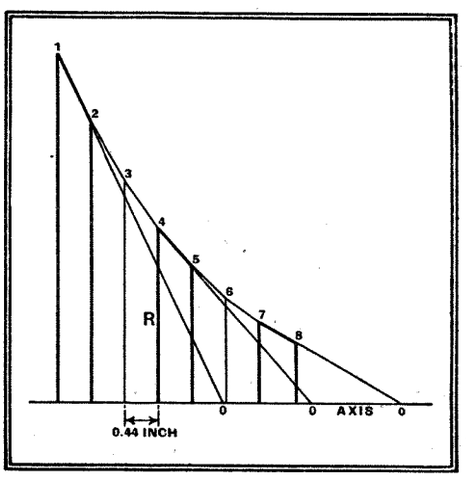


Fig. 2.—Dividing the diaphragm into sections, preparatory to marking out the rings.

Making a Curved Diaphragm—

This must, of course, be done for all the rings. Fig. 3 shows ring 4-5 as an example. The outer radius 0-4 is 6in., the inner radius 0-5 being 4.7in. An allowance of 0.1in. is added to the inside of each ring (except on 7-8) for jointing.

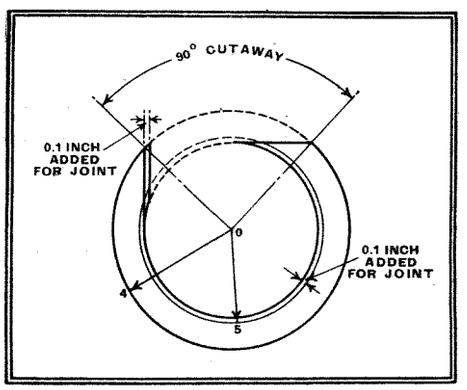


Fig. 3.—An example of the marking-out of one of the rings.

The angular cutaway is next marked out, and is, of course, $360-\frac{(R \times 360)}{0-4}$ degrees. A lap of 0.1in. is allowed on one edge for the joint.

It is a good scheme to make the joints in the rings tangential, as shown in Fig. 3, as this avoids a local "hard-spot," and gives more uniform pliability.

Having made up all the rings they must now be glued together to form the complete diaphragm. It is advisable to begin with the largest, adding rings toward the apex, each succeeding ring being glued inside its predecessor.

All the edges of the rings should be carefully rubbed down to a feather-edge with fine sandpaper so that the laps are unobtrusive. The glued joints should also be "squeegeed" with a smooth metal edge whilst they are still tacky.

The edge of the mouth of the diaphragm is stiffened with a $\frac{3}{16}$in. wide ring of 3-sheet Bristol board.

It is important that the rings be not assembled together with their lap-joints all in one vicinity. The joints should be spaced equally around the area of the cone. In this way the evils of the seamed diaphragm will be avoided.

When thoroughly dry the diaphragm should be treated with some damp-proof coating. Black cellulose lacquer, lightly sprayed on, is excellent. Should this be out of the question, however, perfectly good results can be obtained with hat dye applied with a scent-spray. Whatever medium is used, all heavily pigmented coatings should be avoided, as such add weight and deaden the diaphragm, with detriment to transient response.

Details of surround and speech-coil fixing have been omitted, as these can be carried out in any of the usual ways.

Some readers may care to try a variation of the above construction by using "Trefoil" bakelised paper, 0.005in. thick, for the first three rings at the apex. This improves the high-note response.

It should be noted that ordinary glue or seccotine is unsuitable as an adhesive for this paper. The writer has found Bostik No. 325 quite successful.

The diaphragm described above can be thoroughly recommended to amateur constructors in their search for quality.

"WORKING OUT TONE-CONTROL CIRCUITS"

IT is regretted that the second line of type was misplaced in para. 3, page 269, of last week's issue. The paragraph should read:

"Now the impedance of a condenser varies with frequency at exactly this rate. So if the amplification . . ."

SOUND RECORDING: A New Service

AMATEUR cinematographers or others using sub-standard films for amusement or profit are enabled by a new service inaugurated by Gaumont British Equipments to fit spoken commentaries or any other sound accompaniment to their silent films. For example, a 16 mm. silent film sent to the company will be returned as a sound print, ready for showing through any 16 mm. sound-on-film projector.

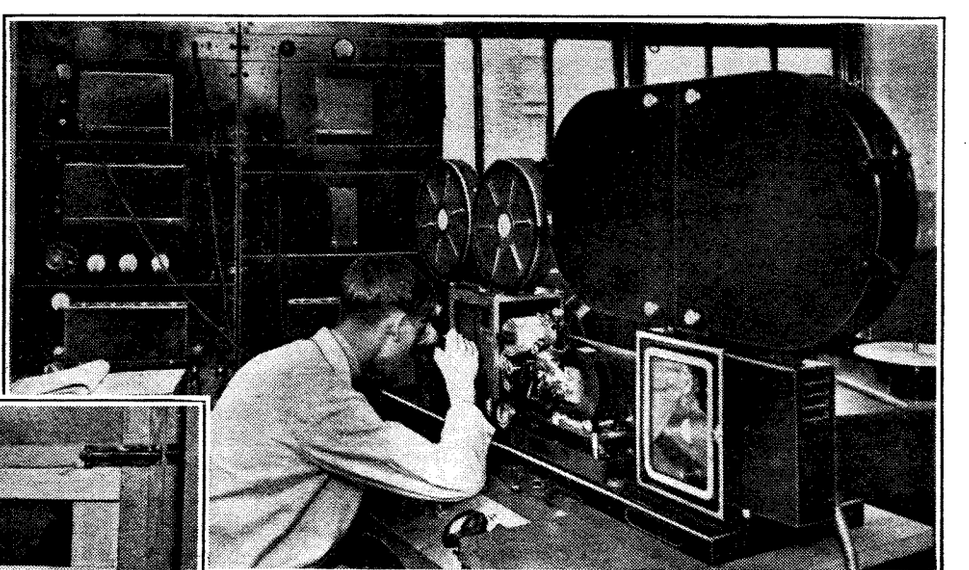
The simultaneous taking of the picture and recording of the sound is difficult to those without special facilities. The best method is to "shoot" the film silent and have it "post-scored," *i.e.*, a spoken commentary and sound effects are recorded afterwards. Indeed, this method is widely used for professional news-reels and similar films.

The owner of a film who wishes to take advantage of the new service, prepares a sound-script indicating any "effects" noises required and then writes a commentary, which he can read himself or have spoken for him by a commentator. An extensive library of sound effects is available.

This sub-standard recording work is carried out at the laboratories of British Acoustic Films, Ltd., at Shepherd's Bush, where this new unit has been fitted with the latest equipment for recording and processing film. When a sound track is added to 16 mm. film, space is found for it without reducing the size of a frame by omitting one set of sprocket holes down the side of the film. The sound track in this G.B.E. system is of the variable-area multi-type. The mixer panel has been designed to handle eight channels instead of the usual three.

A booklet giving fuller details of the service is obtainable from G.B.E. at Film House, Wardour Street, London, W.1.

D. W. A.



(Above) Sound camera with recordist watching the modulation of the film sound track. (On left) Engineer at mixing panel viewing screen through window looking into the adjacent studio where the film is being projected. In this way he ensures that the sound effects, which he controls are recorded at the right moment to coincide with the action.

Temperature and Humidity

THEIR EFFECTS ON COMPONENTS AND INSULATION

By A. W. SCOTT, Dip.E.E., M.Inst.R.E., (Aust.)

THE effect of changes in temperature and humidity on broadcast receivers have become increasingly important since the inclusion of automatic tuning and short-wave facilities. This article, based on a paper read at the recent World Radio Convention organised in Sydney, N.S.W. by the Australian Institution of Radio Engineers, deals with the nature and magnitude of these effects.

IN countries such as Australia, where a very high order of sensitivity and selectivity must, in many cases, be maintained to give even reasonable reception, it is highly important that there is no gradual deterioration in the performance of a receiver, because, although an abrupt failure may cause acute annoyance, a slow deterioration may easily escape detection by anyone accustomed to listening to a given receiver from day to day, and eventually result in dissatisfied ownership.

During the initial design of a receiver it is necessary that the engineer be fully conversant with the characteristics of the various components and materials he proposes to use, under all service conditions of temperature and humidity, so that the completed design will be as free as possible from instability or drift during the warming-up period, and so that the efficiency of the receiver will remain the same under any operating conditions for long periods. These problems in design have become more acute during the last few years, due to such reasons as the increased use of SW reception, the general improvement in selectivity and sensitivity, and the increasing use of high-efficiency components in tuning circuits.

Surprisingly little dependable information is available that is of much value to the design engineer in regard to the change in electrical characteristics of component parts and insulation material, due to temperature change and humidity penetration. It is usually necessary for the engineer to obtain his own data on the materials and components he proposes to use.

Changes in temperature, humidity, and the effect of mechanical vibration are the three major causes of failure of stability and permanence in radio receivers.

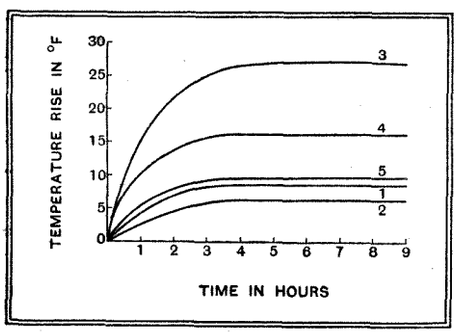


Fig. 1.—Temperature rise, measured in various positions, in a typical AC receiver placed one inch from a wall.

Changes of temperature operate in several ways, one of which is closely related to humidity effects. Temperature variations can cause minute mechanical movement and distortion of components, and they also cause changes in electrical properties, such as the dielectric constant and insulation resistance of materials. Some of these changes are caused by the removal of moisture from the component when the temperature rises.

These changes in characteristics of components and insulation material are usually quite small, but owing to the high order of accuracy necessary in circuit constants in modern receivers, very small changes are sufficient to cause serious alteration in efficiency and alignment of a complete receiver, as well as drift with temperature variation. One of the serious problems is that, in many cases, the properties of a component may vary slightly with increase in temperature, but will not vary the same amount when a corresponding decrease in temperature takes place. This means that a gradual deterioration in efficiency and performance will result as the components in the tuned circuits alter in value by different amounts and stay altered after the temperature has returned to normal.

Another problem which is chiefly caused by temperature changes is the drift, or change in tuning, that occurs with time during the warming-up period of a receiver. This drift can persist for an hour or more and necessitates alteration of the tuning control to keep the desired station in exact tune. This trouble is usually more pronounced in the higher frequency ranges of a receiver. It can be caused by gradual changes in the IF alignment of a superheterodyne or, what is more usual, changes in frequency of the oscillator section of a receiver. The noticeable amount of this warming-up drift depends to a certain extent on the selectivity characteristic of the IF amplifier. If this amplifier is of the sharp peaked variety, such as is used in many small receivers, this drift of the oscillator can be very objectionable, particularly in the SW bands. The use of a square-topped IF amplifier will help to reduce this objectionable effect, as a small shift of intermediate frequency from the centre of the square-topped curve will not be apparent, whereas it would be very noticeable with a sharply peaked amplifier.

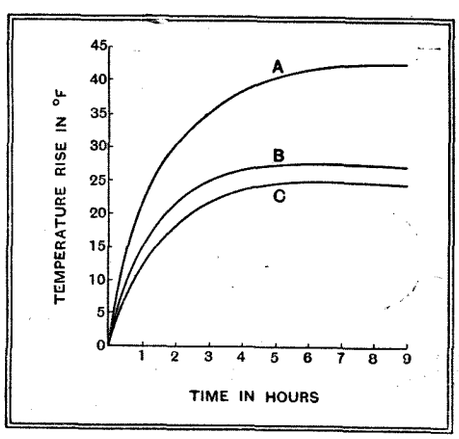


Fig. 2.—Temperature rise beneath the chassis, showing the need for allowing air to circulate for cooling. A, close to wall; B, one inch from wall; C, one foot from wall.

High temperatures and humidity also have a serious effect on other components in a receiver in addition to those used in the critically tuned circuits. Electrolytic condensers, paper condensers, audio transformers, power transformers, speaker cones, volume controls, as well as various lacquer and varnish finishes, including cabinet finishes, are all affected to some degree by any severe changes in weather conditions, the life of the component, or finish, usually being shortened by high temperature and humidity.

The effect of temperature can be considerably minimised if care is taken in regard to the selection, treatment and placing of component parts during the design of a receiver, and the effect of humidity can also be reduced by careful impregnation, preferably under vacuum, of material and component parts with waxes, oils, and varnishes or other moisture-resisting substances of suitable kind.

The design engineer must know the possible conditions under which his receiver is to operate and also he must know the actual temperature rise that occurs in the design he proposes to use, as well as the location of any hot pocket that may occur in that particular design. Knowing the operating conditions and the temperature rise, it is a comparatively simple matter to arrange a series of tests which will show him the suitability or otherwise of the various components and materials he proposes to use.

The determination of receiving temperature rise should be carried out with the chassis located in its cabinet, and the cabinet located in positions representative of those under which it is likely to be located in the average home.

The curves shown in Fig. 1 give some idea as to the temperature rise in various

Temperature and Humidity—

portions of a typical AC receiver, and shows the temperature rise in different parts of the set, namely:—

1. Inside the cabinet above the tuning unit.
2. Beneath the chassis near the tuning coil unit.
3. Beneath the centre of chassis.
4. Inside IF transformer can.
5. On gang condenser.

It will be noted that a reasonably stable condition was not arrived at until after $2\frac{1}{2}$ hours' operation.

Fig. 2 gives a comparison between results on the same receiver when it was placed at various distances from a wall.

The position when the receiver is located close to the wall represents the most severe conditions under which it is likely that it will operate.

From these results, which are fairly representative of average designs, it can be seen that the rise in temperature above ambient that can be expected is around 15 deg. F. to 20 deg. F. for the critical parts of the receiver. When located 1in. from a wall it must be realised, however, that these temperature rises will be considerably exceeded in the case of midget and table model receivers, which usually have poor ventilation.

In parts of New South Wales, the temperature during the summer months has an average figure of 85 deg. F., rising to 100 deg. F., with humidity around 60 per cent. to 80 per cent. In some parts of Queensland, the average summer temperature is 90 deg. F., with 90 per cent. humidity, for considerable periods. These figures, together with the receiver-temperature rise, give a basis for temperature and humidity tests on components. A temperature of 190 deg. F., with 95 per cent. relative humidity as test conditions on components and material, gives a reasonable margin of safety.

A measure of the amount of drift in the oscillator experienced during the warming-up period of a superheterodyne receiver can be obtained comparatively easily, and provided that certain precautions are taken it is possible to repeat measurements with a fair degree of accuracy, so giving a means of determining what effect alterations have had.

One satisfactory method of making this measurement is to beat the output of the receiver oscillator against the fundamental or harmonic of a crystal oscillator and measure the change in the beat frequency that takes place as the receiver warms up. The mains voltage fed to the receiver under test must be kept constant; the position of the receiver must be the same when tests are repeated, and readings for each test must be commenced at the same time after switching on; the temperature of the receiver at the commencement of each test must be as near as possible the same. It is usually necessary to cool the receiver for long periods before repeating tests.

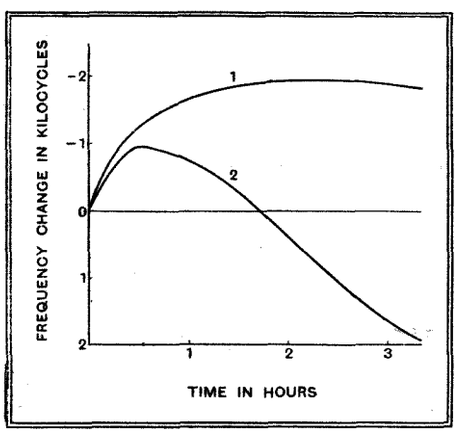


Fig. 3.—Measurements of oscillator drift.

Fig. 3, Curve No. 1, shows the result of a test run on the same receiver tested for the results of Fig. 1 and Fig. 2. The test was run for four hours; the time required for reasonable temperature stability to be reached. This particular check was run at an oscillator frequency of 1,800 kc/s, and it will be noted that the maximum drift was 1,900 cycles. As the IF channel of that receiver has a reasonably square top, the drift from switching on to a stable condition would not be noticeable, particularly as 42 per cent. of the total drift takes place in the first five minutes.

It will be seen that the drift was in the direction of lowering the oscillator frequency, indicating a probable increase of the circuit capacity of the oscillator. This is the usual direction for drift to take place.

TABLE 1.

FIXED CONDENSER DRIFT.

Type.	Initial Capacity (m-mfds.)	% Change 100 hrs. 120° F. 90% H.	% Change Cooling 12 hrs. at 150°.
A. Australian made Ceramic cased cond. ...	250	0.98	1.2
B. Same as "A" different make	103	0.3	3.2
C Silver plate mica, U.S.A.	102	0.48	−1.0
D. Silver plate Ceramic, German	103	0.3	−0.1
E. Bakelite case mica ...	248	3.6	4.2

Drifting Both Ways

Curve No. 2 on Fig. 3 shows an unusual case met with during development work. The oscillator frequency lowered by 900 cycles and then increased again up to 3,400 cycles on the high side of its initial setting, finally reaching a stable condition after about five hours.

Alteration to some of the materials used in the oscillator circuit and changes made components cured this condition.

When checking components such as fixed and variable condensers, coils and insulation material for changes in electrical properties, it has been found advisable to conduct runs for at least 100 hours when humidity effects are being determined, and for at least 12 hours when temperature effects only are being checked. It is also necessary to run cycles of heating and cooling, measurements being made during each cycle. These checks will usually show what can be expected of the components in service. The following curves and tables give the results of some tests conducted on a number of different components, all results are the average taken over a number of units. The tests were conducted in an insulated and sealed humidity chamber in which the temperature and humidity could be controlled. A fan blower was used to circulate the air around the chamber.

TABLE 2.

Type.	Initial Setting (m-mfds.)	100 hrs. at 150° F. 90% H.	Cooled then 12 hrs. at 150° F.
A. Air dielectric	20	−1.1	+0.5
B. Air dielectric	15	+2.5	+1.25
C. Air dielectric	10	+2.5	+1.25
D. Ceramic dielectric, German	160	+1.15	−1.5
E. Mica dielectric ...	50	−8	+9
F. Mica dielectric ...	120	+2	+2.2
G. Mica dielectric ...	20	+2.6	−3.3

Table 1 shows a few representative results obtained on fixed condensers of various manufacture, Australian, European and American. It will be seen that the most stable types of fixed condensers are those in which the plates are intimately associated with the dielectric, such as in the silver-plated mica condensers and the silver-coated ceramic condensers.

However, some of the stacked mica condensers, when proper precautions have been taken in manufacturing, such as running the condenser through heat cycles, are reasonably stable. It is of interest to note the wide variation that occurs on some of the older type bakelite-cased condensers, such as were universally used in Australia some few years ago.

Table 2 shows the results of a similar series of tests on trimming condensers, such as are used for alignment purposes. Air dielectric, ceramic dielectric, and mica dielectric condensers are shown. Again, the stability of the ceramic condenser is good. The fact that the adjustable range of the condenser is very small, most of the capacity being in a fixed unit, probably accounts for this.

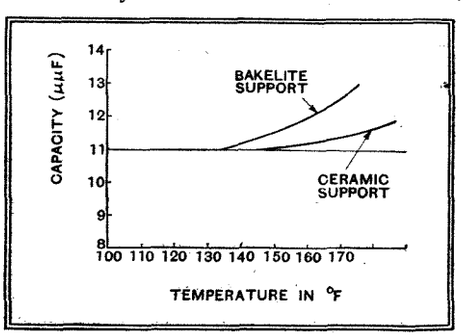


Fig. 4.—Ganged condenser tests; temperature kept constant for one hour before readings taken.

Three different designs of air-dielectric condensers are shown, Type "A" having ceramic supports for the high-potential plates, and types "B" and "C" having moulded material for this support. Type "C" was of European manufacture.

The remaining results shown were obtained from mica dielectric condensers. It will be seen that none of these types

Temperature and Humidity—tested were as stable as the other designs, although Type "G," in which special care was taken during manufacture, proved considerably better than the others.

Fig. 4 shows the result of tests on gang variable condensers. The tests shown are for the variation in the minimum capacity with temperature change on ceramic insulated condensers, and on bakelite insulated condensers.

Tests conducted on properly impregnated coils show very little alteration in inductance or "Q" factor, due to temperature and humidity. This alteration is so small, 0.1 per cent. or less—that it can be neglected when compared with the larger changes in the other components of the tuned circuits.

Table 3 shows the variations with temperature of the dielectric constant of some insulation material. Sample "A" is the insulation taken from a high grade of rubber-covered connecting wire. Sample "B" is ordinary commercial spaghetti, and "C" a special impregnated cotton insulation "push-back" wire.

The effects of the materials shown in Table 3 on initial warm-up drift, and on long-period stability are frequently overlooked, but when it is realised that at the high-frequency end of the tuning bands the stray capacities formed in these materials

TABLE 3.

Sample.	% Change in Dielectric Constant after subjected to 60° F. Rise, 24 hrs.
A. Rubber	−22
B. Spaghetti insulation ...	+16
C. Cotton insulation ...	−9.4

can be some 20 per cent. to 30 per cent. of the total circuit capacity, their importance will be appreciated.

A great deal of time and effort can be profitably spent on this important aspect of receiver design. Owing to the extremely small variations that can cause appreciable drift and cause deterioriation in performance, and the tendency towards the use of higher frequencies, it is clear that any contribution towards stability in commercially produced component parts will be welcomed in present and future receiver designs.

Mullard Test Gear

GANGING OSCILLATOR AND OSCILLOGRAPH

APPARATUS which gives a visual indication of the resonance curve of a receiver is becoming much more widely used with the increasing complexity of receivers. In essentials such apparatus consists of a frequency-modulated oscillator and cathode-ray tube with its time-base. The equipment marketed by the Mullard Wireless Service Co., Ltd., of 225, Tottenham Court Road, London, W.1, consists of three units—an oscilloscope, a signal generator and a frequency-modulating set.

The first two of these are of wide application apart from resonance curve indication; in fact, for all the purposes for which a signal generator or an oscilloscope are needed.

The oscillograph bears the type number GM3152, and is fitted with a 4in. hard tube which normally has a green screen. Other screens are available for special purposes. The linear time-base is of the hard-valve type, and has a frequency range of 10 c/s to 150 kc/s. It is continuously adjustable over this range by means of a potentiometer in conjunction with a 10-way switch. There is also a control for the sweep amplitude.

Another potentiometer controls the amplitude of the synchronising voltage applied to the time-base, and there is a switch which enables the time base to be synchronised from the work circuit or from the 50 c/s mains or from a separate external source. This same switch, which has six positions, also allows the internal time-base to be disconnected so that an external one can be used, and gives several methods of synchronising it.

On the work circuit the input can be applied directly to the deflecting plates or through one or two stages of amplification. The final stage is push-pull, and the voltage supply of the first stage is stabilised by a neon tube. The frequency response is flat within ±2 db over the range of 10 c/s to 1 Mc/s, and the total gain is 1,600 times. The sensitivities for the three conditions of no amplifier, one stage and two stages of amplification are given as 10 V RMS per cm., 100 mV RMS per cm., and 6 mV RMS per cm.

The equipment is enclosed in a metal container with all controls on the front panel. Most sockets for connections are also on the front, but rear terminals are also provided for direct connection to the deflecting plates so that the equipment can be used at ultra-short-waves with a minimum of loss.

The apparatus is extremely easy to handle when one has become accustomed to the controls, and gives a very good performance. Owing to the use of a hard tube and to the high gain and wide frequency response of the amplifier, it is especially suitable for television purposes.

The Service Signal Generator Type GM2880F is, like the oscillograph, mains-operated, and it covers the range of 21.5 Mc/s to 100 kc/s in six bands. By making use of harmonics, the range is easily extended to 60 Mc/s or even higher.

A triode oscillator of the Hartley type is used, and there is a separate triode AF oscillator of fixed frequency for providing internal modulation. In addition, there is a fixed frequency RF oscillator.

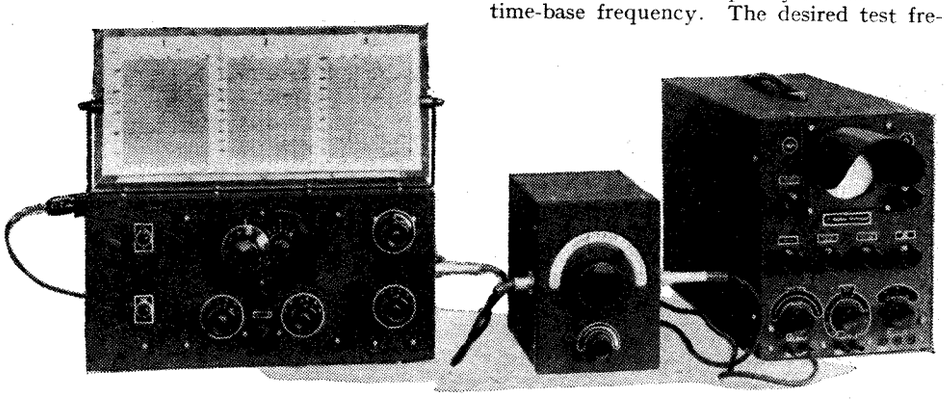
The Signal Generator

A single tuning control with a good reduction gear is fitted, and a chart permanently fixed to the top of the instrument carries the calibration curves for the six ranges. Naturally, the coils are built-in and controlled by a switch. In addition to this continuous range, five fixed frequencies can be obtained by means of switches. Modulation is fixed but can be switched on or off at will. The output is controllable in steps by a six-way switch and potentiometer.

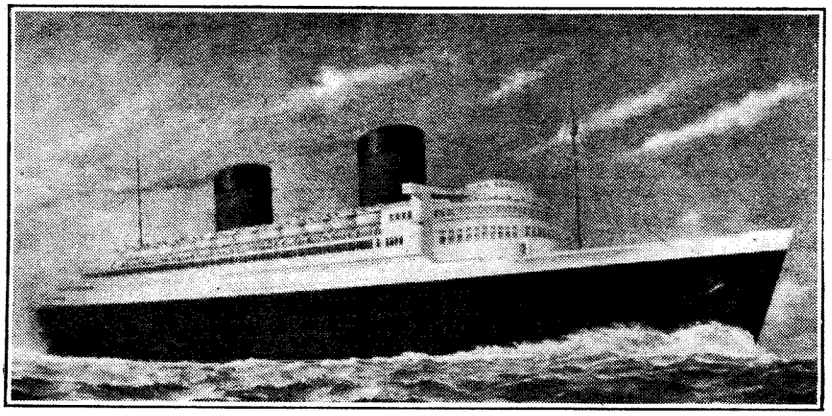
The fixed-frequency oscillator referred to above operates at some 350 metres, and is included so that, in conjunction with the detector of a receiver, the equipment forms a kind of beat-frequency oscillator. The receiver is tuned to the fixed oscillator, and then when the main oscillator control is rotated the familiar heterodyne whistle is heard. In this way some idea of the over-all-frequency response of a receiver can be obtained.

By using this signal generator in conjunction with the oscillograph it is possible to obtain a picture of the overall resonance curve of a receiver. An additional unit is needed containing two octode valves. This is connected to both generator and oscillograph. The unit contains a fixed-frequency oscillator which is frequency-modulated at time-base frequency. The desired test frequency for receiver testing is obtained by the superheterodyne principle, for the fixed oscillator beats with the generator output to give the desired output frequency.

On test the whole equipment proved extremely satisfactory, being easy to use and reliable in operation. For many applications, of course, only one or two of the units will be needed, but if all are used almost any kind of servicing can be tackled with confidence and also a large amount of design work.



The Mullard signal generator is shown on the left with the oscillograph on the right. The "wobbly" oscillator is in the centre.



NEWS OF

THE "QUEEN ELIZABETH"

Radio Installation for the New Liner

THE launching by Her Majesty the Queen of the new Cunard White Star liner *Queen Elizabeth* plunged into its natural element the largest ship ever made by man.

The radio equipment, as comprehensive as that of many a land station, will be supplied and operated by the International Marine Radio Company, and it will embody quite a number of detailed improvements based on the operating experience in the *Queen Mary*, which, incidentally, still holds the world record for the amount of radio traffic handled by a ship's installation.

Passengers will be able to speak from ordinary telephone sets in their cabins or in the telephone booths to subscribers in any part of the world without fear of eavesdropping. Arrangements will be made for the reception and rediffusion through the ship's PA installation of broadcasts from land stations. The playing of the ship's orchestra can be relayed to any of the public rooms. Wide-range microphones and amplifiers will be available for use in broadcasts from the ship through networks ashore.

The transmitters will be completely remote-controlled from the copper-lined control room situated some 400ft. away from the transmitter room, and it is stated that receivers of special design are in the course of construction. The power room, main transmitters, and control room are located in widely separated parts of the ship, and the whole of the radio equipment has been so designed that every facility will be duplicated somewhere in the station. A complete emergency station is located in the control room.

The radio installation will be arranged for multiplex working on short, medium, and long wavebands. Automatic high-speed telegraph transmission is planned, and extensive measures for the suppression of electrical interference are to be adopted.

Two of the lifeboats will carry I.M.R.C. radio installations of standard Board of Trade type, and, in addition, each of these boats will be equipped with a special radio-telephone set designed to withstand the rigours of the sea.

BROADCASTING AND A NATIONAL EMERGENCY

Need for a Stand-by Receiver

NOTWITHSTANDING rumours to the contrary, we are able to state that the B.B.C. has decided that *all* stations shall be available to transmit in time of national emergency. At one time it was considered that the work of keeping listeners informed on the progress of events might be confined to one of the more remote transmitters, such as Burghead or Belfast.

"An Essential Service"

The B.B.C. staff have been left in no doubt as to their position in case of national emergency. It has been made clear that broadcasting would be regarded as one of the essential services and the permanent staff have been given marching orders, i.e., instructions to report for duty or to await orders if their normal work is interrupted. Staff with military, naval or air obligations will be immediately released.

The aim of the Corporation will be to safeguard the lives of its staff and, as far as possible, to let the apparatus "look after itself." To counteract the possibility of a breakdown in the service, emergency microphone circuits have been introduced into the basement studio thirty feet below street-level, which by the turn of a switch would, as stated in last week's issue, link direct with the aerial output of each of the Regional stations. As each transmitter would be capable of a 100 per cent. power boost, it is extremely unlikely that any section of the population would be out of touch with broadcasting, and, as far as possible, normal programme working would be maintained.

Moral

With all these elaborate precautions for the benefit of listeners, those, however, who rely on the mains for operating their receivers would be left in the "dark" if there should be a failure of the electric power supply.

Moral: Have a battery-operated or crystal set as a stand-by.

NORTHERN RADIO EXHIBITION

No Television Exhibits

MANCHESTER'S annual radio exhibition, which is organised jointly by the *Manchester Evening Chronicle* and Provincial Exhibitions, was opened at the City Hall, Deansgate, Manchester, by Mr. John Coatman, B.B.C. North Regional Director, on Tuesday, and remains open until Saturday, October 8th. This year's show, the fifteenth in the series, aims at giving, as well as an exhibition of the wireless industry, a first-class entertainment three times a day, for which a theatre seating 1,500 is arranged.

There are, however, no television exhibits at this show. This is because of the gentleman's agreement between manufacturers of televisors that they will not show receivers at exhibitions outside the service area of the Alexandra Palace transmitter or where there is little likelihood of a service being introduced at present.

An interesting communications display with the co-operation of the R.A.F. is a feature of the show. Special arrangements have been made with the railway companies for the issue of cheap fare vouchers enabling visitors to have a return ticket for the single fare from any town within a radius of eighty miles of Manchester.

BROADCASTING HOUSE EXTENSION

No Television Studios

NO provision is being made for television studios in the addition to Broadcasting House. Although the sound and television services are now co-operating to a greater extent than formerly, it is felt that, on the technical side, they must always be two distinct entities. Moreover, there will be no space in Portland Place for the requirements of television; all the available room will be needed for sound studios and offices. All major television studio developments during the next few years will be at Alexandra Palace.

HIGH-POWER DEVELOPMENTS IN EUROPE

New Stations for 1939

NO more than 55,000 of Lithuania's 2½ million inhabitants are holders of wireless licences. This, the authorities have decided, points to an ineffective broadcast service, and so a contract has been placed with Standard Telephones and Cables for the erection of a new 120-kW transmitter to replace the present 7-kW 1,961-metre transmitter at Kaunas. The estimated cost of the project is £36,000, and the station will be completed next year. A 60-kW short-wave station is also approaching completion.

Norway

The Norwegian State broadcasting organisation, Norsk Rikskringkasting, has ordered a new 100-kW medium-wave transmitter from the Norsk Marconiselskap, Norwegian subsidiary of the Marconi Wireless Telegraph Company. The new high-power station will be erected on a site at Ullandhaug, near Stavanger.

Another 100-kW transmitter has also been ordered, this time from the Radio Corporation of America; it will replace the present 10-kW station at Vigra. Preparatory work on both of the new stations has been commenced, and it is hoped to complete the Stavanger transmitter by February next year, and the Vigra station a month or two later.

Finland

At a recent meeting of the directors of the Finnish Broadcasting organisation, Suomen Yleisradio, it was decided to replace the 600-watt 209.9 metre Abo transmitter by a 40-kW installation formerly employed at Lahti. Power of the 10-kW 569.3-metre station at Viborg is to be doubled and government permission is being awaited for the erection of a national 50-kW short-wave station.

France

The French State station, Limoges PTT, hitherto 1-kW relay nonentity, is to be replaced by a 100-kW transmitter which will work on 328.6 metres. Test transmissions are scheduled for the end of 1939.

THE WEEK

SUNSPOTS DEPART

Reception Conditions Will Steadily Improve

THE sunspots which have been causing so much interference with wireless transmission during the summer are now decreasing. In the first part of September a world-wide fade-out was recorded, culminating on the 14th and 15th of the month with an aurora display in New Zealand and also in Western Canada.

Reports received by the B.B.C. from many parts of the Empire a fortnight ago showed that reception was badly upset, with maximum disturbance at a time coinciding with the aurora. Engineers at Broadcasting House, however, failed to discover anything happening on the sun which would account for such widespread disturbance—not restricted to the 25-metre band, as at first thought, but affecting all wavelengths below 200 metres.

Despite the mystery, however, the engineers are optimistic enough to believe that reception conditions will steadily improve during the next month or two.

SOUND RECORDING AND REPRODUCTION

Discussions on the Gramophone and its Repertoire

A CONFERENCE is to be held at High Leigh, Hoddesdon, Herts, from November 4th to the 7th as an outcome of the annual general meeting of the National Federation of Gramophone Societies held in April. Its main object will be to discuss the gramophone and its repertoire.

Among the subjects for discussion are: "The place of the gramophone in modern life"; "Recorded music—is all well?" speaker, Dr. Percy Scholes, chairman on this occasion, Sir Adrian Boult, B.B.C. Director of Music; and "Modern developments in sound reproduction," which will include sound-on-film and wax recording.

The proposer of this conference, which is surely a very commendable idea, was Mr. William J. Johnson, Chairman of the N.F.D.S. and Educational Correspondent of our contemporary, *The Gramophone*. He will be pleased to give full details to those interested if they will write to him at 62, First Avenue, Gillingham, Kent.

WIRELESS INSTRUCTION

Broadcast Radio Technique

A COURSE of instruction in wireless technique is to be broadcast by the World-Wide Broadcasting Foundation from its short-wave station, W1XAL, at the University Club, Boston, Mass. Commencing on the first Friday in October the series, which is to be under the supervision of Dr. C. Davis Belcher and will continue for thirty-two successive weeks, will be heard at 10 p.m. (G.M.T.) on a frequency of 11.79 Mc/s.

The course is designed to attract both the beginner and the advanced pupil, and those wishing to make the most of the opportunity may apply to the station for supplementary literature designed to assist them in following the lectures as the course progresses.

It is pointed out that this is not an advertising or money-making venture, for the W.W.B.F. is a non-commercial enterprise, and its activities being purely altruistic all booklets are supplied at cost price.

LONG WAVES CONDEMNED IN SOUTH AFRICA

A COMBINATION of short- and medium-wave broadcasting is recommended for South Africa by the Technical Advisory Committee of the South African Broadcasting Corporation. Medium-wave stations, it is urged, should be used in thickly populated areas, but should be supplemented by short-wave stations to "fill in the gaps" in the country districts. For night transmissions wavelengths from 60 to 80 metres are recommended.

The Committee deplores the waste of money over "useless experiments" with long-wave transmitters, which are held to be quite unsuitable for conditions in South Africa.

STATION FOR ARCTIC REINDEER RESERVE

THE fifteen thousand square-mile reindeer preserve east of the mouth of the Mackenzie River, in the Canadian Arctic, is to be equipped with a radio station. This will eliminate the making of difficult journeys to the nearest radio station at Aklavik, when it is desired to communicate with Ottawa some 3,000 miles away.

The new station will also make it possible to keep in touch with the outside world during the six weeks of the autumn freeze-up and the spring ice break-up, when all transport is at a standstill.

The equipment consists of a transmitter which will operate on 4,324 kc/s, a receiver and wind-driven charger.

SYSTEMATIC RECEIVER OVERHAULS: With this neatly arranged and lavishly equipped service bench, shown by Philips at the recent Paris Radio Show, one could hardly be anything else but systematic (see the article "On System" elsewhere in this issue).

SEARCH FOR ORGANIST

THE choice of a successor to Reginald Foort, maestro of the B.B.C. Variety Organ, who leaves the B.B.C. on November 1st, is not proving easy. Some sixty applications have been received at Broadcasting House in response to the Corporation's advertisement, and these have been narrowed down to three or four possibles. It is understood that the B.B.C. is looking not only for an expert in the technique of organ playing, but for a man blessed with a fair measure of human understanding and common sense. In other words, the search is for another Reginald Foort.

DUTCH WAVELENGTH QUERY

THE article on the new K.R.O. studios which appeared in *The Wireless World* a few weeks ago has raised a query in the minds of some readers. It was stated in this that the Netherlands has two wavelengths only (1,875 and 301.5 metres), which are shared by the four main broadcasting organisations. The query is, "What of Jaarsveld's wavelength (415.4 m.)?"

This wavelength does not officially belong to Holland, but has been used by it to supplement the service of Hilversum. The 17-kW Jaarsveld station and the 150-kW long-wave Hilversum station broadcast the same programme so that the fact that the four broadcasting organisations share the two *official* wavelengths, thereby giving only half a week's programmes each, remains unchanged.

"WIRELESS" STATIONS

A MATHEMATICAL genius, who by now probably stands in need of a good holiday, has counted up the number of wires, and a few extras, in the N.B.C. studios at Radio City, New York. The following summarises the results of his research.

Approximately 10,000,000 assorted lengths of wire having 20,000,000 soldered connections. About 250 microphone points in 27 studios require some 1,250 miles of wire. The total mileage of cable, some with 40 strands, some with 20 and some with 10, is about 89. In all, copper cable and wire weigh about 110 tons. The master control desk contains roughly 3,700 lamps and keys.

A typical transmitter, like WJZ, has about 145 miles of copper ribbon in the earth system. Add the remaining 153 N.B.C. stations all over the country, connect them up with 23,750 miles of cable and . . . . the result may be a sick headache. Lines chartered for special occasions add up to a mere 75,000 miles in the course of a year.

FROM ALL QUARTERS

Stimulating Trade in Italy

E.I.A.R., the Italian broadcasting organisation, is granting free licences until the end of the year to all who have not previously held one on buying a set during the period from September 17th to October 31st. The scheme commenced on the opening day of the 10th National Radio Exhibition at Milan, which closed last Sunday, September 25th.

Acknowledgment to Popularity

THE number of wireless licence holders in Sweden increased by 100,000 during the first half of 1938, and it is estimated that licence returns will pass the 1,150,000 mark before the end of the year. As a result of this growing prosperity, the broadcasting organisation, Radiotjanst, is planning to increase its hours of transmission by over 300 hours

News of the Week—

per annum, and, in addition to a new 12-kW short-wave station recently completed at Motala, it is now proposed to build a still larger plant with an output of 50 kW. Equipped with a directional aerial system, this new station will be used to radiate special programmes to the U.S.A.

Pitcairn Island

IT will doubtless interest readers who may have tried to log Pitcairn, VR6AY, which works on approximately 14.3 Mc/s, that it can be heard almost any morning at about 8 (B.S.T.).

R.A.F. Recruits

AIR MARSHAL SIR WILLIAM C. S. MITCHELL announced last week that the R.A.F. is in urgent need of 3,300 wireless operators, 950 electricians, 450 instrument repairers, and 1,000 armourers.

Rabbit Holes in Portland Place

CERTAIN members of the B.B.C. staff, having contemplated such subjects as high explosive and A.R.P., are casting lingering glances at five mysterious rooms in the sub-basement at Broadcasting House. No one enters these rooms, and the doors, surmounted by a dim red light, are apparently locked in perpetuity. They are the echo rooms, each containing nothing more than a microphone and a loud speaker, but each has space for a camp bed or two and a plentiful supply of iron rations.

Loud Speaker Demonstrations

DEMONSTRATIONS of Voigt loud speakers are to be given at Forsyth's, 126-128, Deansgate, Manchester, during the last four days of the Manchester Radio Show (October 5th to 8th) between 3 and 10 p.m. Voigt speakers will also be demonstrated by Holiday and Hemmerdinger, who have provided a sound-proof room inside the Show building.

INTRODUCE YOUR FRIENDS

AT this time of the year *The Wireless World* makes the acquaintance of many new readers, large numbers of whom are introduced by regular readers of the journal. To assist these readers in making *The Wireless World* more widely known among their friends we are inserting a form in this issue to be filled in and sent to us, on receipt of which we shall be glad to post a free specimen copy to the address given.

We hope our readers will make full use of these forms, as we like to feel that they take an active interest in making the paper even more widely known.

A Louder Portugal

THE State station of Lisbon, Portugal, which works on a wavelength of 476.9 metres, is to raise its present power of 20 to 100 kilowatts.

New Broadcasting House—Oslo

THE foundation stone of Norway's new Broadcasting House at Oslo was recently laid by the Minister of Education.

Licence Figures

THE number of listeners in Palestine is now 33,000, an increase of 5,000 during the first half of the year.

The number of wireless licence holders in Finland is 259,548, an increase of 55,553 during the year.

Wireless in Church

CHURCHGOERS at Pipewell, a tiny Northants village, cannot always obtain the services of a minister, so they have installed a wireless set in the church to relay broadcast services. Its use has not yet been a complete success, but it is gaining favour.

Reunion Dinner

THE annual dinner of the Royal Flying Corps Wireless Operators' Old Comrades' Association is to be held on Saturday, October 22nd, at the Princes Restaurant, Piccadilly. Particulars may be obtained from the Hon. Secretary, 64, Arlington Road, London, N.14.

Exhibition in the East

THE Radio Club of Ceylon, which was founded in 1922, is to hold a wireless exhibition in October. The exhibition will receive official support from the Telecommunications and Electrical Undertakings Departments of the island.

Wireless Expedition

COMMANDER LEVICK, on his return from the seventh annual expedition of the Public Schools' Exploring Society into Newfoundland, paid tribute to the quality of the portable wireless sets constructed at Marlborough and worked by members of the Marlborough O.T.C.

No False Alarms

THE B.B.C. decided to cancel the broadcast of yesterday's air raid demonstration at Paddington in order to avoid the possibility of causing unnecessary public alarm in view of the present international situation.

Stalemate ?

ARE serial broadcasts worth while? Experience with the much-heralded chess match between the B.B.C. and Listeners suggests a negative answer. When the game opened between four and five hundred listeners rushed into the fray, but at the thirty-first move last week the number had dwindled to ninety-three.

Obituary

IT is with regret that *The Wireless World* records the death of Mr. D. F. C. van Eendenburg, who died as the result of a motoring accident on September 17th. He had been managing director of Philips Lamps since its formation in January, 1925, having joined the Philips organisation in 1909.

Wireless and the Air

PROGRESS in the air and progress in wireless go hand-in-hand, and recent news from territories such as Alaska, Canada, India, South Africa, and New Zealand states that additional wireless stations are to be erected in connection with the plan for providing new Imperial Airways aerodromes in these areas.

B.B.C. Entertains the Arctic

BROADCAST programmes from England are received more clearly in the Arctic than any others, according to Dr. R. G. Ellis, writing in the *Toronto Globe* of his recent experiences in the Polar regions. On stormy nights, it seems, London can be heard with extreme clarity; on fine, clear nights the radio is "dead."

Radio Technology Evening Classes

L.C.C. NORWOOD TECHNICAL INSTITUTE has evening classes providing courses of study in electrical engineering, radio technology, and television for the coming winter session. The courses prepare students for examinations for the National Certificate in Electrical Engineering (radio)—ordinary grade ("credit" passes in two electrical papers is approved as satisfying Pt. 1 of the Grad. I.E.E. exam.); the Institute of Wireless Technology and the Radio Service Work Certificate of the City and Guilds.

News in a Nutshell

"RADIO in Australia is fifty years ahead of England."—*Wireless Weekly*, Sydney.

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, SEPTEMBER 29th.

Nat., 7, "Royalty Racket," a satirical comedy with music. 8, "Old Devonshire House, Bloomsbury," the history of the house built for Lord Cavendish in 1667. 8.15, From the Promenade Concert.

Reg., 6.25, Bach recital by James Ching, pianoforte. 8, Jay Wilbur and his Band. 8.45, "Between Houses," a variety from the North. 9.30, "A Murder Has Been Arranged," a ghost story by Emlyn Williams

Abroad.

Lyons PTT, 8.30, "A Waltz Dream," operetta (Oscar Straus).

Rome Group, 9, "La Favorita," opera (Donizetti).

FRIDAY, SEPTEMBER 30th.

Nat., 7.20, B.B.C. Ballroom, with Stanley Barnett and his Band. 8, Restful Music played by Reginald Foort. 8.30, Horner's Corner. 9, "No. 47398 Airman Harry Hawk"; life in the R.A.F. 10.5, My Best Picture Story.

Reg., 6.45, Variety from the *Manchester Evening Chronicle* Radio Exhibition at The City Hall, Manchester. 8, Talk on the Troubles of an Early Motorist. 8.15, From the Promenade Concert.

Abroad.

Naples Group, 8.30, "The Black Pierrot," operetta (Hajos).

SATURDAY, OCTOBER 1st.

Nat., 12.45, 3 and 3.50, Commentaries on the International Grand Prix Motor Racing at Donington. 5, Carroll Gibbons and his Orchestra. 7.30, "Foort-Issimo." 8, Variety, including Nellie Wallace. 10.30, Bob Crosby and his Orchestra, relayed from Chicago.

Reg., 7, Ploughing Competitions at Moreton-in-the-Marsh. 8 and 9.45, Last night of the forty-fourth season of Promenade Concerts.

Abroad.

Deutschlandsender, 8.10, "The Dubarry," operetta (Millöcker-Mackeben).

Cologne, 8.10, Famous Waltzes from Opera.

SUNDAY, OCTOBER 2nd.

Nat., 2, Talk by C. H. Middleton. 3.15, Harold Sandler and his Viennese Opera. 6.30, Alfredo Campoli and his Salon Orchestra. 7.15, B.B.C. Theatre Organ. 9, Edward German's light opera, "Tom Jones."

Reg., 4, Medvedeff's Balalaika Orchestra. 6.30, The Growth of the Oxford Repertory Theatre. 7, Beethoven Sonata, played by Egon Petri. 9.35, "Barnum—The Greatest Show on Earth."

Abroad.

Warsaw, 7, "Ladies and Hussars," opera (Kamienski)—production from Poznan's Polish Music Festival.

Frankfurt, 7.15, First Symphony Concert of the season—Beethoven.

MONDAY, OCTOBER 3rd.

Nat., 7, "Mr. and Mrs. Neemo." 7.50, Men Talking, with Valentine Williams as Chairman. 8.25, Europe at Home—I. A relay illustrating life in the city of Lyons. 9.25, World Affairs.

Reg., 6.40, Angling on the Severn. 7.20, The Week on Wall Street, relayed from America. 7.15, A Jack Payne Production—"Jack in the Music Box." 9.45, German's "Tom Jones."

Abroad.

Lille PTT, 8.30, Rosenthal conducts a Symphony Concert from Paris.

TUESDAY, OCTOBER 4th.

Nat., 6.25, Talk on the new Factory Act. 7.30, An enquiry into "Class." 8.30, "Légionnaires"; Soldats de la Légion—Chantez! 9.25, International Lecture—Architecture in a Changing World.

Reg., 6.30, Tom Matthews and his Concert Orchestra. 7.30, Dance Music from Copenhagen. 8.30, The Under Twenty Club.

Abroad.

Deutschlandsender, 7.10, The Berlin Philharmonic, conducted by Clemens Krauss.

Paris PTT, 8.30, Acts I and II "Boris Godunov," four-act opera (Mussorgsky).

WEDNESDAY, OCTOBER 5th.

Nat., 6.20, "Whitehall Tour"—The Home Office. 7.30, "The World Goes By." 8, "Band Waggon." 9.35, The Henry Wood Jubilee Concert from the Albert Hall.

Reg., 6.30, Recital by the B.B.C. Singers. 8, "What Every Woman Knows," the play by Barrie. 9.20, "On and Off," or "Never Say Die," a musical burlesque.

Abroad.

Warsaw, 8, Chopin Recital by Wilkomirska, pianoforte.

Brussels I, 9, Schubert Concert by the I.N.R. Symphony Orchestra.

On "System"

STEP-BY-STEP *versus* HIT-OR-MISS

By "CATHODE RAY"

SYSTEMATIC action, as opposed to the haphazard or spasmodic, demands a certain amount of effort and discipline, and is to that extent distasteful to the British temperament, however natural it may be in certain Continental countries. My first excursions into experimental research (in Form II, I believe it was) were frankly for fun, and consisted in mixing together all the "chemical" substances I could lay hands on and boiling them up in an old tin over a candle. The result was invariably a revolting mess, with smell to match. I do remember going so far as solemnly to record this fact, in rather more scientific terms, in a "laboratory notebook." Compared with these "experiments," those carried out under official auspices in school were deplorably dull, the method being so much more emphasised than the result—for this was usually well known from the start. One turned eagerly from such systematic chemical experiments to the irregular one of persuading unsuspecting new boys to place calcium carbide in the ink; for, although the chemical reaction was never in doubt, there was always an exciting uncertainty with regard to the chances of not being found out.

"Cathode Ray's" Past

The same basic human desire to enliven the slow but sure results of strictly systematic work by a spice of chance was apparent at a later stage in life when with one or two others I was employed in a junior capacity in a radio laboratory. To prevent the afternoon from wearing away too dully it was customary during the lunch hour to introduce some obscure fault into the experimental circuit on which the head of the department was working, and to compare our individual forecasts with the time actually taken by him to clear it. Fortunately, it was not necessary for us to take a suspiciously intense interest in his work, because he was one of those people who give a running commentary on their own activities. So, in addition to a welcome amount of entertainment, the foundations were laid of my knowledge of systematic "trouble-shooting." Before the thing had time to develop into a regular sweepstake, the official concerned abandoned research in favour of administrative work.

This unsavoury past is made public only to show that, while advocating systematic methods in radio servicing and experimental work, I am not unconscious of the strong undercurrent of original sin that makes the yoke of discipline seem hard. Moreover, it is very galling when we are patiently running through the approved sequence of tests (you know the kind of thing—Page 1: No Sound From Loud Speaker. (*a*) Is the receiver connected? (*b*) Is it switched on? (*c*) Have you been cut off for non-payment of electricity account? . . . etc., etc.), and some non-technical person standing around watching asks whether it is right for one of the valves to be without its "hat."

Or when you cautiously admit that you don't know why "the wireless is making a funny noise" without carrying out a series of tests, and your rival gets away with a brilliant guess. It may really be guesswork, in which case he is bound to be found out sooner or later, or it may be systematic deduction speeded up by experience. Certainly it is possible to be a slave to system instead of being its master. But in the early stages, system must be rather severely emphasised, because it is only experience that enables the more elementary stages in the series to be short-circuited, and earns one the right to bend the system about a good deal in approaching different problems. A service engineer who hears of a fault, say, intermittent bursts of noise, which has many possible causes, may be able to make a probable diagnosis at once on being told the make of the set, for he knows from experience with that model that a condenser injudiciously placed near a voltage-adjusting resistor has been very liable to breakdown due to the heat. As nine out of ten such complaints in that particular type of receiver might be due to that cause it would obviously pay him to check it first before going on to the orthodox step-by-step system for the remaining one.

But when there is no very definite pointer like this, it may take more time trying things at random in the order of their probability (or of the smallness of effort involved) than to work to a system.

Unless the system is to be unendurably tedious, it must take some things for granted, at least at first; such things, for instance, as that conductors conduct and insulators insulate. But after the first quick round has failed to show the offender, one must start again on a more exhaustive scale. The detective stories have educated us into suspecting the least suspicious party, but in this work it is necessary to suspect everything. I remember in the old days being dreadfully puzzled by the absence of oscillation using a certain coil. As it was a Government job, the most expensive ebonite from the most sublimely reputable firm had been obtained on which to wind it. It was, so to speak, the old family solicitor who had been uninterruptedly under the eyes of judge, jury and public in court at the time of the crime. But in the end it turned out that the insulator was an excellent conductor, thanks to the tinfoil that had been used in manufacture to give the high-grade finish.

Self-deception

Even now there are occasional cases of apparently sound insulators that contain hidden flaws, and if one of them shorts a low-resistance tuning coil, where a DC test is helpless, it may be very difficult indeed to trace it. Sometimes one comes up against behaviour that is so baffling and apparently contrary to all known electrical principles that one becomes quite proud of telling people about its contrariness. The psychologists would say that this is an escape from having to admit that we are beaten by something normal. It is so much more self-satisfying to be the victim of something really supernatural and unknowable. So we delude ourselves into this idea, and, while searching for the fault, are really looking for further evidence of inexplicable behaviour, and are quite disappointed when it turns out to be something natural after all, especially if somebody else points it out.

But for really finding out, it is essential to adopt the attitude that, however contradictory the results of tests may appear, the explanation will be something quite simple when it is found, and it *can* be found by strictly logical and systematic attack. Although this systematic method may sometimes be tedious, in coming up against difficult problems it is also very comforting and assuring, by giving defi-

On "System"—

nite data on which to work, instead of speculations and assumptions based on a few haphazard tests. In the detective story it seems utterly impossible for a man to be in two places at the same time. But the explanation of this apparently occult event is quite tame when it is noticed that it is during the night when the change-over is made from B.S.T. to G.M.T. And so one must be reluctant to invoke some hitherto unknown electrical phenomenon to explain results of tests, for by systematically pursuing them farther it will almost certainly be explicable in terms of Ohm's Law and other familiarities.

A particularly good example of this recently appeared in *The Wireless Engineer*, under the name of "Buzz Effect." This is an unpleasant form of distortion of low notes, which might easily be due to a faulty loud speaker, or something loose in the set. One wonders how many loud speakers have been replaced in the effort to cure it! The real explanation, though unexpected and obscure, depends literally on Ohm's Law. When drawing the symbol for an output pentode we forget the metallic layer on the bulb due to the "getter" process in manufacture. It is liable to act as an extra electrode joined by a high resistance (leakage) to the anode. It is also prone to emit secondary electrons. In other words, all the conditions are right for it to act as a dynatron, which is a negative resistance, and is liable to cause tuned circuits to oscillate, or where (as in this case) there is only a resistance in circuit, sudden changes in potential are set up during each cycle of the low note being reproduced, and these are audible as a buzz. But, of course, as long as one assumes that a valve is only just as much of it as is usually taken into account, so long does such an effect remain inexplicable. A systematic investigation eliminates the items that are *proved* to be innocent, until only the guilty remains.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Crystal Band-pass Filters

AS a research worker who has been engaged in designing crystal filters for the last two years, I feel that I must point out some rather erroneous statements in the article, "Crystal Band-pass Filters," published in your issue of September 15th.

The article states that the crystal may be represented by a coil, condenser and resistance in series, the whole being shunted by another condenser. Now this circuit has a resonant frequency and an anti-resonant frequency, and the reactance characteristic is as shown in Fig. 1.

It will be noted here that below f_1 the crystal is capacitive; between f_1 and f_2 it is inductive, and above f_2 it is again capacitive.

Now, referring to Fig. 4 of the article, this bridge circuit can be redrawn as in my Fig. 2.

In such a bridge circuit all the fundamental properties of the section depend on the values of the two arms X1 and X2; and if X1 and X2 are crystals, the properties of the filter depend on the reactance characteristics of the two crystals. It is, therefore, impossible to get rid of the shunt capacity of one crystal by balancing it with the shunt capacity of the other crystal. If this were possible it would be equally possible to balance out the series inductance of the two crystals—the very property which the author relies on for obtaining his resonant frequencies.

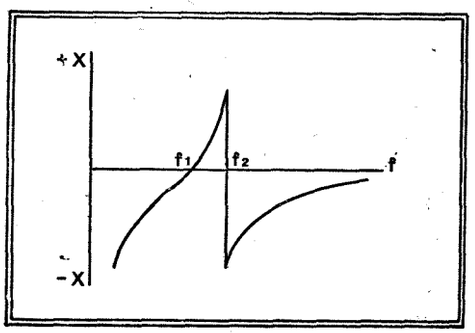


Fig. 1.

It is possible, however, to construct a filter of this type, but the shunt capacity which produces the anti-resonant frequency is just as important as the series elements. The criterions for a pass band and an attenuating range in a bridge filter are as follows:—

(1) *Attenuating Range.*—The arms X1 and X2 of the bridge must both be of the same sign. Infinite attenuation will occur if they are of the same sign and equal.

(2) *Pass Band.*—The reactances of the two arms X1 and X2 must be of opposite sign. Zero attenuation occurs when $X_1X_2 = -1$.

If two crystals are designed so that the resonant frequency of one arm coincides with the anti-resonant frequency of the other, as shown in my Fig. 3(a), then following the criterions for attenuation and pass ranges, as outlined above, a band filter of the type shown in Fig. 3(b) results. It will be seen that the result obtained is the same as that in the article, but I hope that the above makes it clear that the statement that the shunt capacity of one crystal balances out the shunt capacity of the other

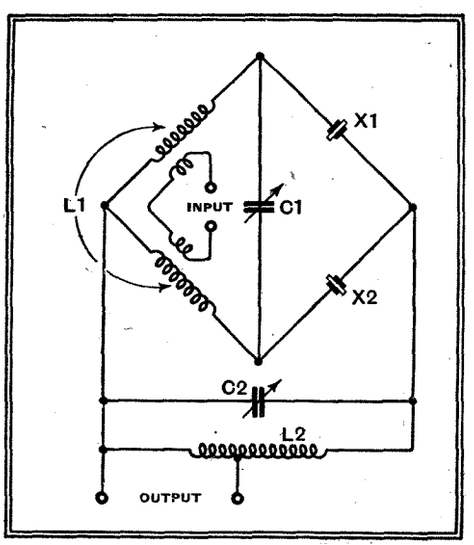


Fig. 2.

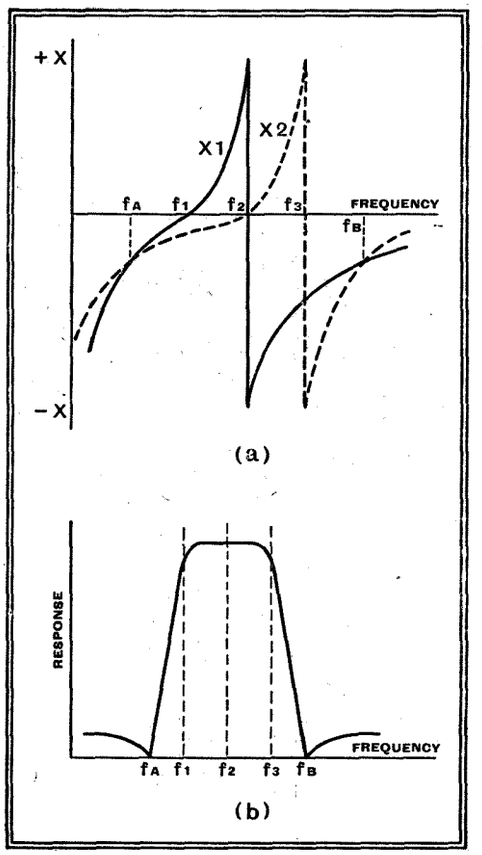


Fig. 3.

crystal is entirely erroneous. Actually it can be shown quite simply that it is the ratio of these capacities that determines the position of the frequencies of maximum attenuation. The great drawback of this shunt capacity is that it is so large that the anti-resonant frequency of the crystal can only be about 0.004.f higher than the resonant frequency, and this limits the band width of this type of filter to 0.008.f, where f is the mid-band frequency of the filter.

It is stated later in this article that for frequencies higher than the second cut-off frequency of the filter both crystals behave as inductances. This is incorrect, as it will be seen from the reactance characteristics of a crystal that in this range the crystal is capacitive.

I hope that these brief notes may help to clear up a rather difficult subject.

R. C. LEIGH, B.Sc.(Eng.).

Television Distribution

THERE can be no doubt that it is intended, if television is successful in London, to extend it to other centres and ultimately to provide television as a service all over the country.

As far as I am aware no plan has yet been devised for distribution nationally, nor have we any assurance that it can be done without incurring so great an expenditure as to make it quite unjustifiable.

Personally, I doubt if any plan has yet been devised, and it seems more than probable that the B.B.C. is hoping that some solution of the problem will be found as time goes on. Such a state of affairs can hardly be described as happy, and I should like to see a discussion in your correspondence columns on ways and means of achieving national distribution of television. Will someone start the ball rolling, please?

Manchester. G. F. S.

Television Topics

Adjusting Television IF Amplifiers

IT has often been pointed out in *The Wireless World* that if maximum amplification is to be obtained from a television IF amplifier the circuit capacity must be kept at a minimum. For a given band-width the gain per stage is, in fact, inversely proportional to the capacity. The use of trimming condensers is consequently inadmissible in normal circumstances, for they inevitably add quite an appreciable amount of capacity to the tuned circuits.

With a tuned anode coupling, for instance, the total capacity is made up of the anode-cathode capacity of one valve, the grid-cathode capacity of the next, the self-capacity of the coil, and wiring capacities. The total value depends upon the valves, coil and wiring, but is often about 30 $\mu\mu$F. Now, if a trimmer is added, its minimum capacity will not be less than 3 $\mu\mu$F., and if it is to be of value in permitting an adequate range of tuning, it cannot normally be used at a setting adding less than about 7 $\mu\mu$F. more.

The normal capacity will thus be 40 $\mu\mu$F., and the trimmer will permit the capacity to be reduced to 33 $\mu\mu$F., so that the change in the resonance frequency is only 10 per cent. Only a small range of adjustment is thus obtainable, but the capacity increase reduces the gain per stage to only 75 per cent. of its normal value. There are often three IF stages with four couplings, so that the overall gain is reduced to $0.75^4 = 0.315$ of the value obtainable without trimmers. This is a serious reduction, and it can be seen that if trimmers are used it is necessary to include one extra IF stage to make up for the loss of gain which they introduce in the average case.

Spade Tuning

This is usually undesirable, and there is no doubt that the ideal trimming system is one which enables the coil inductance to be varied instead of the capacity. The simplest arrangement is a form of spade tuning which, as old hands will remember, was quite widely used about 1922. The coil is wound to a higher inductance than the value needed to tune the circuit, and its inductance is then reduced as required by bringing a metal plate or spade near it. Fairly tight coupling of coil and spade is necessary, and the best results are often secured with a basket-type coil against which a copper disc can be brought.

The disc can be mounted at a fixed small distance from the coil and pivoted at a point near its edge so that it can be swung over the coil as desired. Alternatively, the coil and disc can be mounted parallel to one another on the same axis and the distance between them varied.

With single-layer coils of fairly large diameter a disc arranged to slide inside the coil can be used to give a small change of inductance. In general, however, it is necessary to use a copper or brass plunger inside the coil. This should be nearly as long as the coil and be a snug fit inside the coil former. This probably gives the easiest construction save for one thing—it is not as easy to terminate the ends of the coil, since the wire can no longer pass through holes in the former. With this form of coil the former can be as small as desired—0.5in. is usually suitable.

With spade tuning the movement of the spade not only affects the inductance but also the capacity. In general, a decrease in inductance is accompanied by an increase of capacity, but the inductance effect greatly predominates. The capacity effect is unwanted and should be kept as small as possible. The aim should be to make the initial inductance of the coil only a little higher than the final value, so that the spade can be loosely coupled, and the spade should be arranged to approach the "earthy" end of the coil.

The three most useful forms of spade tuning are sketched in Fig. 1, and in general the pivoted disc (*a*) is likely to give the highest capacity, and is, therefore, the least suitable. It may be remarked that spade tuning is, in general, inapplicable to coupled circuits where the coupling is by the mutual inductance between the coils, for an adjustment to one spade will affect the inductance of both circuits in some degree. It is, of course, quite satisfactory when other methods of coupling are adopted, such as "bottom-" or "top-end" capacity.

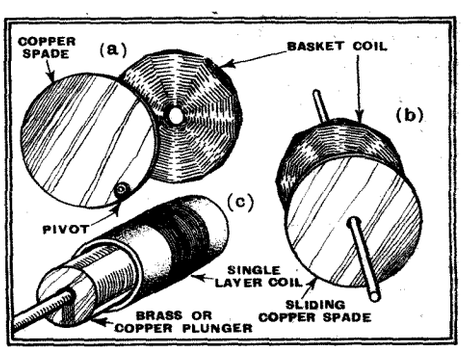


Fig. 1.—The sketches (a) and (b) show basket coils with different arrangements of spades and (c) shows a single layer coil with internal metal plunger for tuning.

Tuning in a television amplifier is so flat, however, that there are many cases where trimmers are unnecessary, and it is satisfactory to adjust the circuits by stripping turns off the coils. This can be quite a difficult process if it is not tackled on the right lines, but it is quite easy, though perhaps tedious, if done correctly. The tools required are a calibrated test oscillator with adjustable output, some form of valve voltmeter (it need not be calibrated), a low-range milliammeter, and a 500-ohm resistance terminated in crocodile clips.

Two IF stages and detector of a typical circuit with coupled pairs of circuits for the coupling are shown in Fig. 2. Connect the milliammeter, which should preferably be of the 0-1 mA. type, in series with the earthy end of R. Remove R3 and R4 and connect the oscillator output to the grid of V2, naturally after removing the lead to L2. Then clip the 500-ohm resistance directly across L3. (The resistance should be mounted straight on the clips so that the leads are as short as possible.) The can will, of course, have been removed from this coupling so that the coils can be got at.

Adjusting Coil Inductance

Now set the oscillator for large output and swing it over a wide range of frequencies while watching the detector meter. There will be one frequency giving maximum output; this is the resonance frequency of L4 with its stray capacities. The procedure is now to strip turns off L4 until the required resonance frequency is obtained.

The observed resonance is due to the secondary, because only L3 and L4 are in circuit and L3 is very heavily damped by the 500-ohm resistance. If this were not so the primary resonance would obscure the true secondary resonance.

The next step is to adjust the primary, and this is done in exactly the same way, but the 500-ohm resistance is now connected across L4. When it has been tuned correctly the 500-ohm resistance is removed and R3 and R4 replaced. The characteristics of the circuit can then be checked by swinging the oscillator over a range of frequencies about resonance.

The earlier circuits are done in exactly the same way, but a new difficulty comes in—the provision of a suitable indicator of resonance. Taking L1, L2 as a typical example of an early coupling, we can no longer use the detector meter as an indicator because L3 and L4 will be operative and their resonance frequencies will tend to mask that of the circuit we are adjusting. On the other hand, we cannot dis-

Television Topics—

connect V2 and replace it by a valve voltmeter because we cannot guarantee that the voltmeter with its connecting leads will have exactly the same input capacity as V2.

The way out is to connect the valve voltmeter to the *anode* circuit of V2 by a resistance-capacity coupling. Break the anode lead at X and connect R5, R6, and C as shown dotted; R5 can well be 1,000 ohms, with R6 about 100,000 ohms and C some 0.001 μF. The values are not critical, and large changes can be made without affecting the results.

With the oscillator connected to V1 the adjustment of L1 and L2 can proceed exactly as before but using the valve voltmeter as an indicator. V2 will provide the correct conditions for L2 as long as it is a screen-grid or RF pentode valve; of course, if it is a valve with appreciable grid-anode capacity the change in the anode circuit will affect the input capacity, and the course adopted will no longer be correct. Normally, however, only screened valves are used and no difficulty arises.

The writer has adjusted many amplifiers in this way and has never met with any difficulty. The process is admittedly tedious. At first it will probably take about an hour to adjust a pair of circuits, but when facility in the process has been secured, this time can be halved.

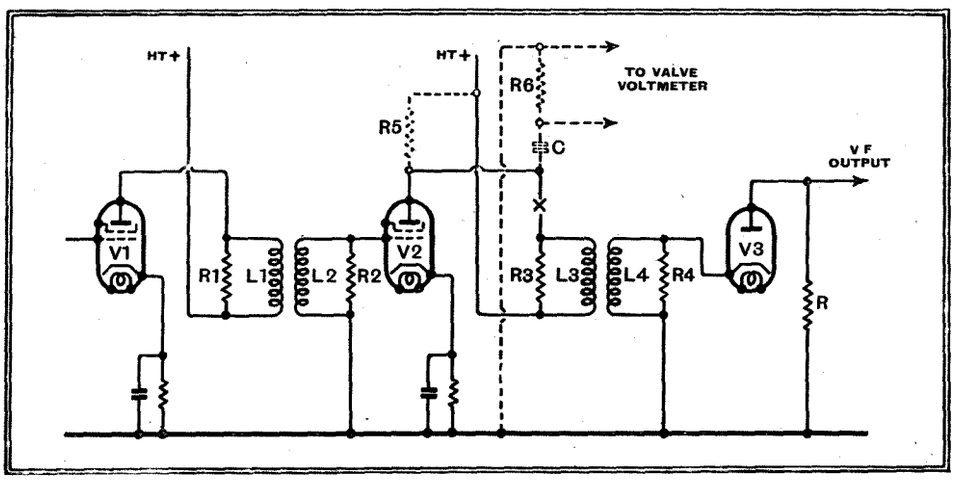


Fig. 2.—When adjusting the first IF transformer the connections of V2 should be modified in the manner shown dotted.

Random Radiations

By "DIALLIST"

Really Coming

ON the best of authority I learn that the drafting of the new Wireless Communications Bill, or whatever it's going to be called, is very nearly completed. It contains clauses dealing with interference which should prove effective provided that vested interests, which have had so long now to dig themselves firmly in, don't succeed in whittling it down too much during its passage through Parliament. Interference nowadays is quite beyond a joke, and in not a few places it has been growing steadily worse for some little time.

Larning 'Em

Lately I've come across quite a few cases of owners of interference-producing appliances of one kind or another who have refused point blank to do anything about it when their attention was politely called to the nuisance that they were causing and the hardships that they were inflicting upon others. Even though their victims offered to pay for the necessary suppressing devices, and though it was guaranteed that the efficiency of the offending apparatus in its proper sphere would be in no wise impaired, a deaf ear was turned to blandishments and persuasion. Nothing will show such selfish folk the error of their ways but legislation making it an offence to cause interference by radiation and imposing sharp penalties on those who continue to do so after due warning.

Automatic SOS for 'Planes

A RECENT issue of *Flight* contained particulars of a most ingenious transmitter for aircraft use, designed to transmit the SOS call automatically in the event of an accident of almost any nature. The two-valve instrument, which is made to send out the distress call and the call sign of the 'plane by the rotation of an electrically driven studded drum, is designed to be proof against the shock of a crash, against fire and against immersion in water. The cabinet containing it is suspended by rubber cords inside a watertight, asbestos-lined inner case. This is itself suspended in the same way in an outer case, also watertight and asbestos-lined, which houses the batteries. At the top of the outer case there is an air chamber, to ensure buoyancy if the 'plane comes down into the sea, and the case is fixed to the fuselage by special mountings, which dissolve in water and allow it to float free. Should the undercarriage of the 'plane be damaged in a crash, or should the engine stop with the ignition switch still on, circuits are broken and the transmitter at once comes into action. It works on about 70 metres, and a smaller model is projected for 5 metres. This almost-anything-proof transmitter is the invention of Mr. R. V. Wrightson.

It's Surprising

IF there's one thing more than another that surprises me about broadcast listeners it's the ancient, decrepit, distorting and noisy receivers with which so many of them put up. And it isn't just those who can't afford to replace ancient sets who make do with out-of-date instruments. Perhaps more often than not those who seem to be content to get the worst out of wireless are folk who could write a cheque for the most expensive receiver or radiogram as lightly as you and I put down our sixpence for a packet of cigarettes. Here's a true story about one such—he doesn't read *The Wireless World*, and if he did he wouldn't mind, for he is a great friend of mine. When I was dining with him the other night he told me not to let him forget to tune in the third news bulletin. I gave him a reminder about five minutes before it was due, and he went over to a radiogram standing in a corner of the room. He switched on and shortly my ears were assailed by one of the most imposing hums that I have ever heard. Meantime, he was juggling with knobs and presently succeeded in picking up the local Regional. Lengthy adjustments seemed to be necessary, but even when he had done his best with these, speech was not at all easy to follow.

A Seven-year-old

When the bulletin was over I suggested mildly that I seemed to have noticed just the faintest trace (!) of hum. "Yes," he replied, "it's been like that for some time. I really must get it seen to." I learnt, also, that the instrument was used a good deal, particularly for receiving concerts of good music and for playing records from his large stock. Crossing the room I examined it with some interest. It proved to be a 1931 —— model. It hadn't been re-valved in the whole of its seven years' service and generous use had to be made of reaction (yes, reaction!) to bring in even the local station. After he had given me a lift home in a car about the size of a pantechnicon I let him hear my set. He has now, I think, decided that seven-year-old radiograms leave something to be desired.

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Every Little Helps

WHEN you read this I shall be in the midst of the chaos of a move to a new house. Yes, I have succeeded in finding one where I should be able to explore the short-wave bands without the constant interference from motor ignition systems that has hitherto been my lot. I need quite a few electrical bits and pieces for my new abode, and I am absolutely refusing to buy anything until I have satisfied myself that it is non-radiating. I don't suppose that this stand of mine will have much effect by itself, but if every reader of *The Wireless World* would do likewise when purchasing this or that piece of domestic electrical apparatus, those who are still making and selling appliances which play havoc with broadcast reception might begin to sit up and take notice.

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India's Short-wave Scheme

WITH the opening of the 10-kilowatt station at Calcutta the first stage of India's short-wave broadcasting service is completed. The country now possesses one station at Bombay, one at Calcutta, one at Madras and a twin-wave station at Delhi. India is, I believe, the only country in the

world to make use of the short waves for the provision of an internal broadcasting service. In every other country which has short-wave broadcasting stations, these are used for maintaining touch with distant places beyond the frontiers. But India's position is unique. Here is a great sub-continent whose area is as large as Europe's, with comparatively few large towns, with thousands upon thousands of small and scattered villages, and with only a comparatively small sum available to provide a broadcasting service. Three hundred thousand pounds wouldn't have gone very far if an attempt had been made to serve the country with medium-wave transmitters only. But by the judicious use of short-wave stations as well as medium wave and by the careful choice of sites for transmitters, it has gone a long way towards providing a good broadcasting service in this huge land, despite the many difficulties raised by climatic and geographical conditions.

TELEVISION PROGRAMMES

An hour's special film transmission intended for demonstration purposes will be given from 11 a.m. to 12 noon each week-day.

THURSDAY, SEPTEMBER 29th.

3, Jack Hylton and his Band. **3.30,** Gaumont-British News. **3.40,** 177th edition of Picture Page.

8, Promenade Concert (sound only). **9,** "Look in and Laugh," light entertainment including Queenie Leonard and Wendy Toye. **9.25,** British Movietonews. **9.35,** 178th edition of Picture Page. **10,** Interval Music. **10.25,** News.

FRIDAY, SEPTEMBER 30th.

3, O.B. from Imber Court; Police Horse Training. **3.30,** Jack Jackson and his Band.

8, Promenade Concert (sound only). **9,** Gaumont-British News. **9.10,** "Parnell," the play by Elsie T. Schauffler. Cast includes Margaretta Scott and Wyndham Goldie. **10.45,** News.

SATURDAY, OCTOBER 1st.

3, "Look in and Laugh" (as on Thursday at 9 p.m.). **3.25,** "Stairway to Heaven"—film. **3.45-4.20,** "St. Simeon Stylites," a play by Sladen Smith.

8, Promenade Concert (sound only). **9,** Cabaret. **9.35,** British Movietonews. **9.45,** "The Dear Departed," a one-act comedy. **10.10,** Interval Music. **10.25,** News.

SUNDAY, OCTOBER 2nd.

8.50, News. **9.5,** Film. **9.15-10.30,** "Laugh With Me," a comedy by Adelaide Philpotts—played by the Birmingham Repertory Company.

MONDAY, OCTOBER 3rd.

3, Jam Session. **3.25,** Gaumont-British News. **3.35,** Cartoon Film. **3.40,** "Fruits of Remembrance," a comedy by Pirandello.

9, George Robey in Cabaret. **9.30,** Boxing O.B. from Earl's Court on the occasion of the meeting of the National Sporting Club. **10.25,** News.

TUESDAY, OCTOBER 4th.

3-4.30, "Parnell," (as on Friday at 9.10 p.m.).

9, Starlight. **9.10,** Talk on Murals. **9.25,** Cartoon Film. **9.30,** Gaumont-British News. **9.40,** "Fruits of Remembrance" (as on Monday at 3.40 p.m.). **10.5,** News.

WEDNESDAY, OCTOBER 5th.

3, Ord Hamilton at the piano. **3.5,** Cartoon Film. **3.10,** Forecast of Fashion. **3.25,** Gaumont-British News. **3.35,** "The Dear Departed" (as on Saturday at 9.45 p.m.).

9, Grosvenor House Cabaret. **9.30,** British Movietonews. **9.40,** Arthur Bryant "Speaking Personally." **9.50,** Cartoon Film. **10,** Music Makers. **10.5,** News.

Radio Laboratory Handbook. By M. G. Scroggie, B.Sc., A.M.I.E.E. Pp. 384+x. Published by Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1. Price 8s. 6d.

IN the early chapters of this book the author discusses the various ends to which measurements are made and shows how they affect the type and class of apparatus to be considered when setting up a laboratory. The different requirements of both amateur and professional are treated and this is notably obvious in the discussion of laboratory premises.

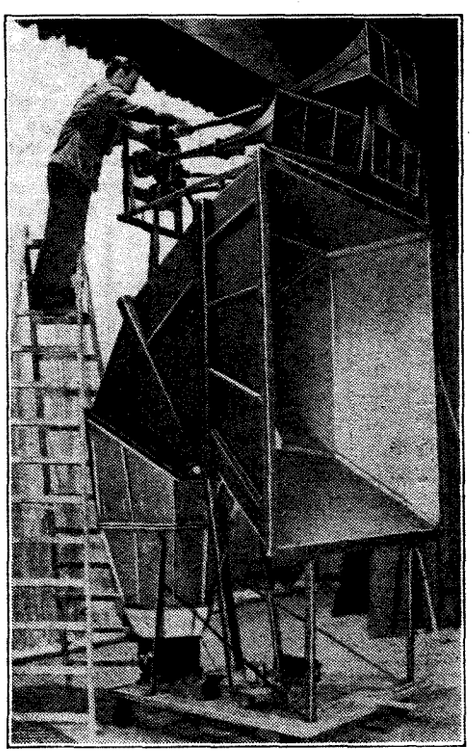
After these necessary preliminaries, sources of power and signals are discussed, especial emphasis being laid on the dynatron oscillator. Then comes a chapter on indicators, among which are included not only milliammeters and voltmeters, but valve voltmeters and cathode-ray gear. The next chapter, "Standards of Comparison," covers a much wider range than its title would suggest. As one would expect, standard resistances, inductances, and capacities are discussed, but, in addition, there is a large amount of information on bridges and attenuators, and, furthermore, cathode-ray methods of comparing frequency are discussed.

Chapters on the measurement of components and sets follow, and ultra-short wave apparatus is not overlooked. The book concludes with a chapter "For Reference." Here are to be found wire tables, giving useful information not always to be found in the usual tables, common symbols, basic formulæ, etc.

Throughout the book great emphasis is laid upon methods which as far as possible isolate the particular quality to be measured and which ensure the safety of the measuring equipment in the event of accidents. The book is eminently practical and many circuit diagrams which show values of components are given, and will be of great assistance to those contemplating the construction of their own apparatus. The author is not content with describing methods of measurement, he also points out the difficulties likely to be encountered and warns the reader of many of the pitfalls which lie in wait for the unwary.

The book covers a very wide range and is unusually free from errors. It can be confidently recommended to the amateur or professional who is taking his first steps in the path of measurement—a path which is beset with many more difficulties than the beginner expects. The anticipation of these difficulties which this book will give him will remove some of them and render the others easier to overcome. It is not only the beginner who will gain from a perusal of this book, however, for there is much in it of value to his more experienced brethren.

W. T. C.



GARGANTUAN LOUD SPEAKER. This huge Euronar sound projector, which has been designed in the U.S.A. to overcome acoustic shortcomings of many halls, is thirteen feet high, and weighs 1,433lb. The flare of the large horn is 6ft. 7in. square. There are also four smaller directionally adjustable horns, the flares of each of these are subdivided by two vertical partitions to facilitate the even distribution of high notes.

Club News

London Transmitting Society

Headquarters: 40, Raeburn Road, Edgware.
Meetings: Sundays at 11 a.m.; Thursdays at 8 p.m.
Hon. Sec.: Mr. G. Yale, 40, Raeburn Road, Edgware.

On October 6th at 8 p.m. a junk sale of transmitting gear will be held. The Society's new "Ham Shack" has a collection of all the latest equipment which holders of transmitting licences are invited to inspect.

Surrey Radio Contact Club

Headquarters: The Alhambra, Wellesley Road, Croydon.
Meetings: First Tuesday in the month at 8 p.m.
Hon. Sec.: Mr. A. B. Willsher, 14, Lytton Gardens, Wallington.

At the last meeting Mr. Stuart Davis, of Croydon, lectured on high fidelity recording and reproduction. He used *The Wireless World* pre-tuned quality receiver feeding into a 30-watt class AB amplifier. This amplifier consisted of a 6C5 phase-reverser feeding into two 6L6 valves in class AB low-loading push-pull. A separate voltage stabiliser circuit employing the "Partridge" method was used.

The recording apparatus was a "Simplat" V.G. recorder, the discs used being the "Simplat" glass base type, in which the groove is of a V shape.

Mr. Davis then dealt with his microphone pre-amplifier with which a ribbon velocity type mike is employed. An extremely low hum level was obtained, due to the enclosure of the mains and line transformers in a "Mu-metal" box.

Oxford University Wireless Society

Secretary: Mr. Martin Ryle, Christchurch College, Oxford.

As was stated in the Correspondence columns last week, a Society has been formed for the purpose of encouraging interest in amateur radio amongst members of the University. The Headquarters are at the electrical laboratory, where the transmitting station (G3MM) has been installed.

Thames Valley Amateur Radio and Television Society

Headquarters: The Albany Hotel, Twickenham.
Meetings: Wednesday evenings at 8.15 p.m.
Hon. Sec.: L. Cooper, 3, Summer Avenue, East Molesey.

At the last meeting Mr. S. R. Wilkins, of the Automatic Coil Winder Co., lectured on the Avo range of instruments.

On September 17th sixteen of the Club members visited the B.B.C.'s checking station at Tatsfield.

The annual general meeting of the Club will be held on October 12th. An interesting addition to the season's programme is a lecture on television by Mr. G. Parr, of the Ediswan Co. This will be given on December 15th.

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

TIME-BASE CIRCUITS

A VALVE of the so-called "beam" type is used to control the charge and discharge of a condenser for generating saw-toothed oscillations suitable for television scanning. An advantage of the arrangement is that it can be "driven" by comparatively powerful synchronising impulses of the standard type, or be made self-acting, or subject to the control of impulses of small amplitude, according as a control switch S is moved to the left or right.

The valve V produces a "beam" of electrons which is deflected by lateral "control" electrodes D, D1, D2 so as to fall either upon an anode A, or through a central aperture in that anode on to a second anode A1.

The main condensers C, C1 are charged up through a resistance R, during the time the electron stream is concentrated on the anode A. As the condenser voltage rises, so does the charge on the deflector plate D1 until the stream begins to pass through the central aperture in anode A on to the anode A1. This opens up a conducting path for the condensers C, C1 to discharge along the electron stream through the valve. Simultaneously a voltage impulse passes from the anode A through a condenser C2 to the deflector electrode D2, and serves to maintain the new position of the stream. As the voltage of the main condensers C, C1 falls, the stream reverts to its original position and the cycle is repeated.

In these conditions a very small synchronising voltage, applied to the deflector plate D, is sufficient to "trigger" the stream on to the anode A1. If the switch S is moved over to its left-hand contact, a larger synchronising impulse will be required, because the deflecting voltage on D1 is now derived from the resistance R1.

Marconi's Wireless Telegraph Co., Ltd.; D. L. Plaistowe and D. J. Fewings. Application date November 30th, 1936. No. 486041.

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DIRECTIONAL AERIALS

THE frame aerial used for direction-finding is usually mounted outside the fuselage of an all-metal aeroplane. This prevents it from being screened by the metal walls, but, on the other hand, as an external object, it introduces a certain amount of extra air-resistance which exerts an undesirable drag on the speed of the craft.

It has already been proposed to enclose an external frame aerial in a closely fitting tubular casing having a streamlined profile, but since the casing and aerial both turn together when taking bearings, the advantage of the streamlining will not in such circumstances be effective at all settings. By contrast, according to the invention, a frame aerial of comparatively small dimensions is arranged to be rotated bodily inside a casing which is fixed to the outside of the fuselage and is streamlined along the fore-and-aft line of the machine. The air-resistance of the structure as a whole therefore remains constant, no matter in what direction the inside loop may be rotated in the process of taking bearings.

E. J. Hefele. Convention date (U.S.A.), October 2nd, 1935. No. 486576.

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VOLUME COMPRESSORS OR EXPANDERS

IN applying the principle of volume expansion or contraction to a low-frequency amplifier, the well-known fact that the response of the human ear to "loudness" follows a logarithmic law must be taken into account. In other words, the relation between the input and output of the amplifier is a straight line, only when drawn to logarithmic co-ordinates.

It is sometimes necessary to apply different degrees of contraction or expansion, when preparing different types of programme for recording or broadcasting. This is indicated by the various sloping lines 1 - - 4 in the Figure (*a*), which is drawn to logarithmic co-ordinates. It will be observed that the curve 4 does not utilise the maximum possible alternating output voltage from the amplifier, though this can be remedied by varying the point at which the control bias is applied as shown in the Figure (*b*).

The logarithmic control bias is derived from a number of asymmetric or dry-contact rectifiers, which are arranged in series across the output of a rectifying valve, so as to form a "logarithmic potentiometer," from which tappings can be made to secure the results shown in (*a*). Simultaneously, a separate volume control in the main amplifying-channel is operated to secure the readjustment shown in (*b*).

Telefunken Ges für drahtlose Telegraphie m.b.h. Convention date (Germany) December 10th, 1935. No. 486870.

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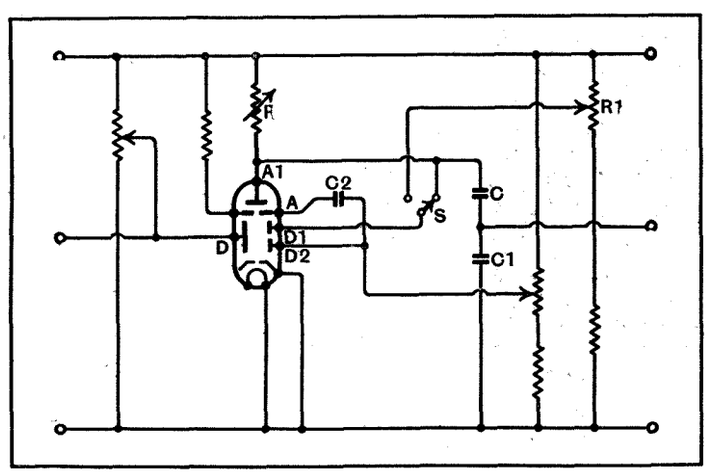
AIR NAVIGATION

A "GUIDE LINE" for pilots can be marked out in the air, particularly in foggy weather, by the intersection of two overlapping wireless beams, which are modulated in such a way that the pilot hears an "unbroken" note only along the centre line of the two beams. A well-known method of producing this effect is to use a central energised aerial backed by two reflectors, which are keyed alternately so as to throw the main direction of radiation first in one direction and then in a second direction at an angle to the first, so as to produce the effect of two overlapping beams.

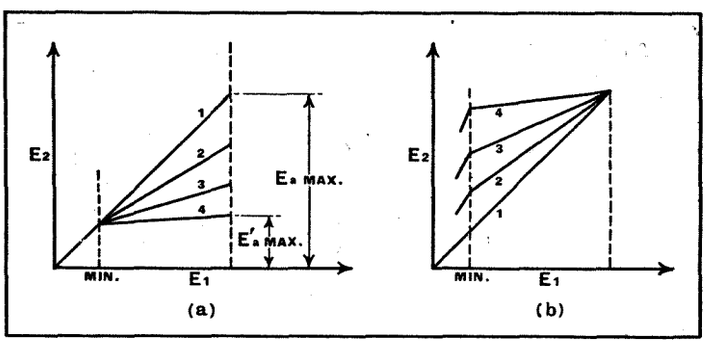
The operation of keying the two reflectors in this way presents some difficulty. In the first place, the switching or keying must be accurately synchronised, whilst in the second place it is desirable not to use any metallic leads or other apparatus for controlling the keying, since this would tend to distort the radiated field.

To overcome these difficulties, the keying contacts of the two reflecting dipoles are interconnected by a push-rod of insulating material, which is vibrated to-and-fro, so as alternately to open and close the contacts, by a link and relay located behind the screen at the back of the aerial system.

C. Lorenz Akt. Convention date (Germany), November 28th, 1936. No. 486652.



Use of a "beam" valve in a time-base circuit.



Performance of amplifier with variable volume expansion : input E1 ; output E2 ; Ea MAX, maximum available output.

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INCANDESCENT TELEVISION PICTURES

IN television receivers of the type in which the picture is reproduced by incandescent, as distinct from fluorescent light, it is important to prevent the heat produced by the impact of the electron stream from spreading from one point on the projection screen to the next, since this would "blur" the picture detail.

Woven or knitted screens of fine-gauge wire have already been used to promote loss of heat by radiation instead of by conduction, from point to point. This object is furthered, according to the invention, by a construction of screen in which each elementary area consists of a short spiral of extremely-fine refractory wire, less than a thousandth of an inch in diameter, which extends a short distance above and at right angles to the base-plate. After being fixed in position, the wires are subjected to the action of hot sodium nitrate which greatly reduces their original diameter, so that they become extremely sensitive to heat and are rapidly raised to incandescence by the bombardment of the scanning stream of electrons.

Farnsworth Television Inc. Convention date (U.S.A.) August 18th, 1936. No. 486373.