The Wireless World

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

EDITORIAL COMMENT

Canned Broadcasting

B.B.C. Deception Fails

WE have in the past on various occasions complimented the B.B.C. on their guarded use of recording as a means of providing programme items. We do not, of course, refer to the use of records of the type which are on sale to the public, but to recordings of items arranged by the B.B.C. with their own recording facilities and subsequently employed as programme material.

Whilst we have felt that such material has been cautiously and intelligently employed in the past as a means of enhancing the effect of programmes or supplying items which it would have been impossible to obtain direct, recording has of late been introduced, we believe, to a far greater extent than hitherto, and the recordings themselves have not kept pace with technical progress in other directions.

Records which the B.B.C. are accumulating in their library must, as time goes on, prove extraordinarily valuable for repeating some performance or item which is no longer available direct, and there are many other occasions on which recording can be legitimately used. It is, however, deplorable that the B.B.C. should put out complete recorded musical items with apparently no real justification for their use instead of direct performance. When these recordings are definitely bad, so that the fact that they are recordings is apparent throughout the broadcast (although they are not so announced), then it is surely time to ask the B.B.C. what justification there is for using recorded material in such cases and why the recordings themselves should be, from a technical point of view, so lamentably poor by comparison with the B.B.C.'s technical standards in every other direction.

If we are to have an extension of recordings introduced into the programmes, then first the B.B.C. should bring these up to a better standard, which is unquestionably obtainable, and they should, in addition, see to it that recordings are used only for such items where high quality of reproduction is not important, except in instances where direct performance cannot be given. The public should then be told, both at the time of the broadcast and in the published programmes, exactly when recording is in use. This would suffice to remove any unpleasant feeling that the B.B.C. were practising a deception on listeners.

New Ionised Layers

THE discovery, discussed elsewhere in this issue, of ionised layers well below the hitherto recognised limits of the ionosphere is an event of first importance not only to investigators into ultra-short-wave transmission, but to those responsible for the establishment of a television service.

Since ultra-short-waves have come into everyday use cases of anomalous long-distance transmission and fading have been steadily accumulating. While many of these are to some extent explained on an optical basis by diffraction and atmospheric refraction, the explanation has been by no means complete.

With this new knowledge at our disposal a fresh field of investigation is opened up in which the amateur can play a valuable part by being on the alert to take note of any ultra-short-wave transmissions which appear to be of unusual character.

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Wireless and the

"LOW LEVEL" IONISED LAYERS—THEIR LOCATION AND SIGNIFICANCE

By R. A. WATSON WATT

NEW ionised layers, which have escaped detection by the usual methods of exploration, have been discovered—some within the range of human flight. Their possible effects on the propagation of television and other ultra-short wave signals are discussed.

IT has, happily, become necessary to add a new chapter to the story of "Wireless and the Atmosphere" which was so admirably told by Dr. Beatty in these columns two years ago, but this chapter cannot be so neatly parcelled off as were his, where the troposphere, the stratosphere and the ionosphere made separate appearances. The troposphere figured as the domain of wind and rain, of clouds and of thunderstorms. The stratosphere had then no very well-marked role in the radio drama, the ionosphere claimed all the ultra-violet limelight, figuring as the sole authentic agency for the return to earth of escaping radio waves.

In this chapter the ionosphere has new rivals lodging in the stratosphere, while the troposphere and its thunderstorms reappear as important elements in the working out of the story.

Two years ago the story of how radio waves came back to earth could already include the subdivision of the ionosphere into two main regions E and F, and the subdivision of each of these into sub-regions E1 E2, F1 F2. It could include some account of the "intense-E" phenomena which sent back to earth on frequent, if sporadic, occasions waves of such high frequency that they would otherwise have penetrated the "normal" E region and the F region. It could touch, a little indefinitely, on the D region, supposed to lie between 40 and 60 miles up, which was mainly of importance because the collisional friction of electron motion in this region of short free-path caused absorption of radio waves, but which was also capable, as Hollingsworth and Appleton showed at different times and in different ways, of returning long and medium waves to earth.

But the story of that date was bound to take it as very improbable indeed that radio waves could be turned vertically downwards, after being shot vertically upwards, by the action of any electrified regions that might exist below the forty-mile level. Actually, at the very moment when Dr. Beatty was writing the outlines of that story for *Wireless World* readers it was being drastically amended by N.P.L. workers.

It is unnecessary to linger over the details of the way in which an attempt to learn more about E region resulted in the discovery, in May, 1935, of a whole series of new electrified layers in the atmosphere. The discovery was so unexpected, and produced so many difficulties of explanation, that observations were maintained over a whole year to ensure that the phenomena observed were neither spurious nor transient, but real, systematic and sustained.

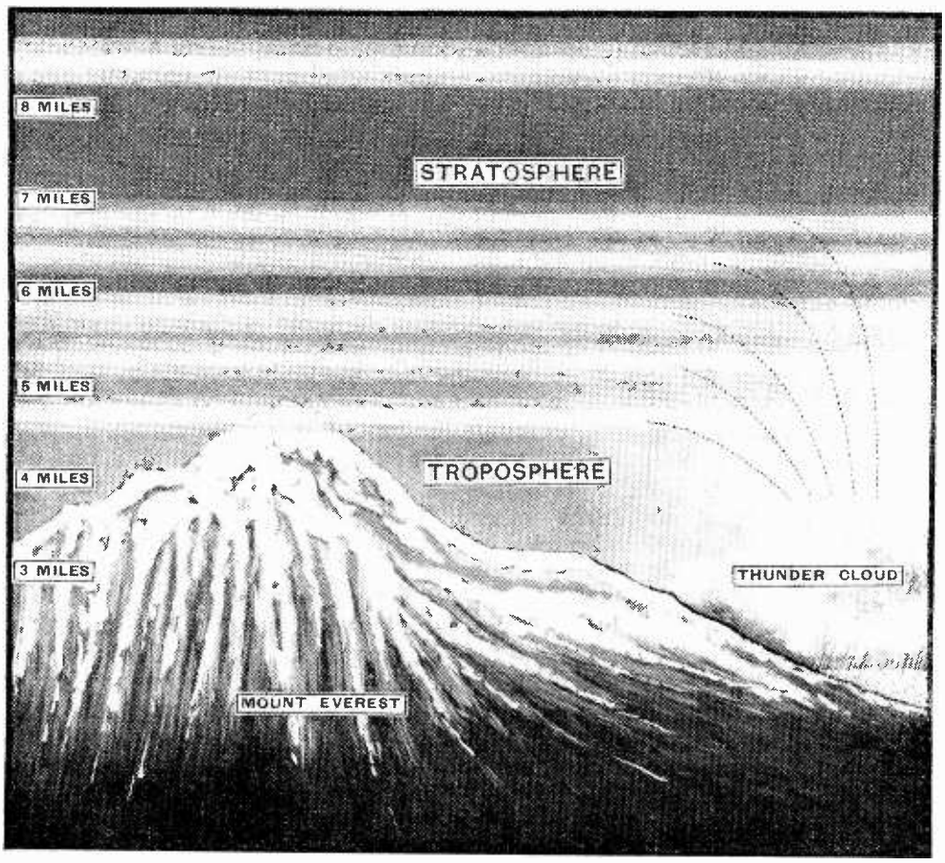

Fig. 1—Some of the newly discovered ionised layers are situated in the region of the tropopause or boundary between the troposphere and stratosphere. There is evidence that thunderstorms play an important part in replenishing the electrons in these layers.

Echo Patterns

The facts which emerged from this stringent trial can be briefly summarised. Pulses of radio energy, on a wavelength of about 50 metres, were found to be returned vertically to a receiver within a hundred yards or so of the emitting aerial, from levels which at first sight seemed to be fairly evenly distributed between five miles and sixty miles up. The returned echoes were so closely spaced in time that they overlapped in the receiver and gave a continually varying fading pattern of which the peaks, with a few notable exceptions, lay on an approximately exponential decay curve.

Detailed analysis showed that the pattern was produced by the mixture of multiple reflections from a limited but substantial number of layers, of which the heights could be measured with some accuracy. These layers fell into three groups, one group between 4 and 9 miles up, one between 20 and 30 miles up, and a third corresponded to Appleton's D region with its base at 40 miles and extending up to the base of the E region at 60 miles. Of the D region it will suffice to say that photographic records were obtained showing diffuse return of

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Atmosphere—A NEW CHAPTER

waves at vertical incidence from the whole of the 20-mile-thick region, and showing a sharp base at 40 miles. The other regions require fuller discussion, since they are more surprising and were more fully studied.

The lowest group lay in the upper portion of the troposphere and the lower portion of the stratosphere, which are, as is well known, separated by a surface called the tropopause, at which the fall of the temperature with height ceases or may even be temporarily reversed.

The greater part of the echo-pattern, made up of echoes which had travelled distances of 10 to 120 miles, could be resolved into six sets. Each set corresponded to pulses which had travelled the path, earth-to-layer and again to earth, once, twice up to ten times, i.e., they were echoes produced by multiple reflection between the practically perfectly reflecting earth and a reflecting atmospheric layer. If

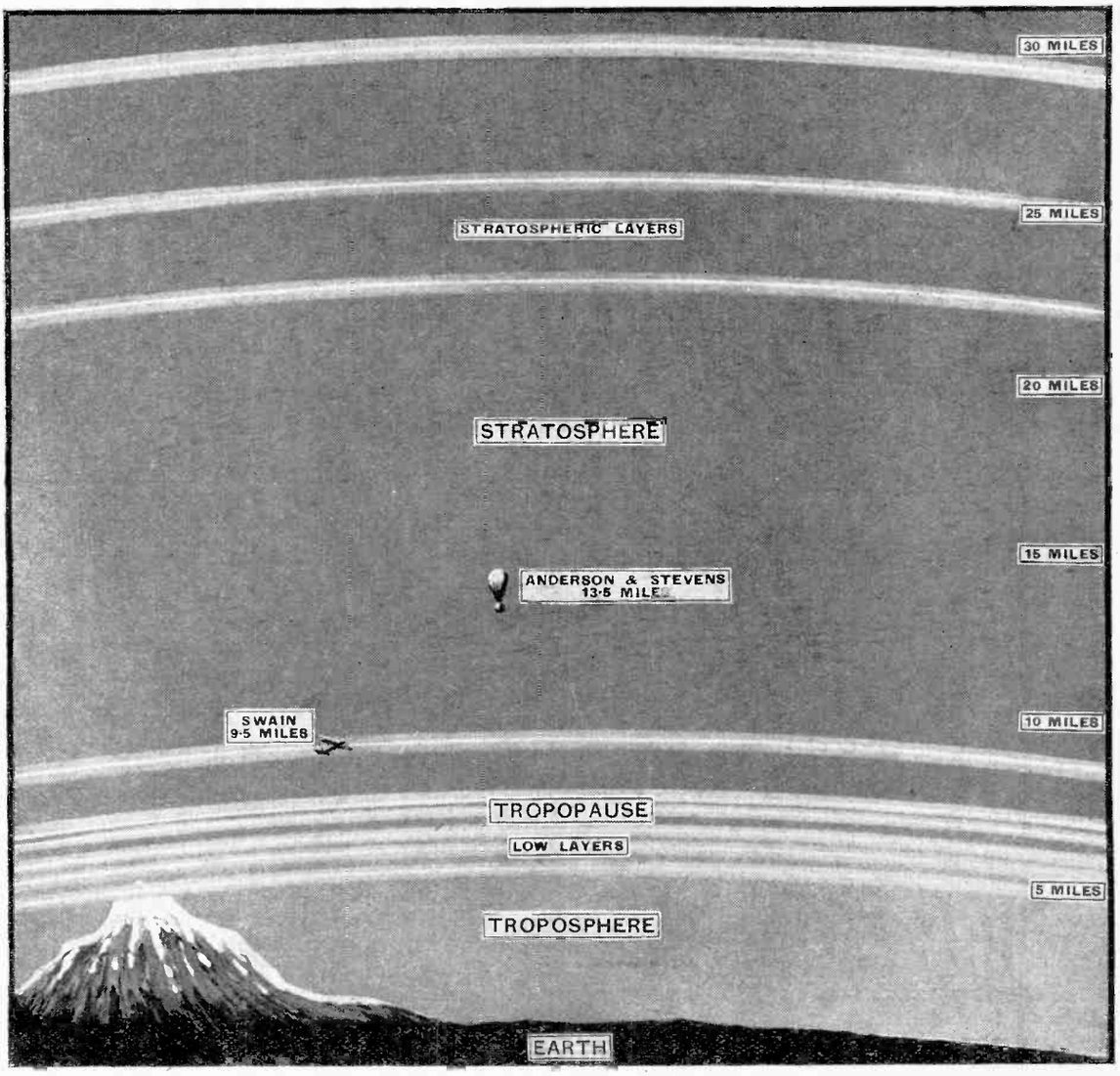

Fig. 2.—The new layers in relation to established "landmarks" in the atmosphere.

the equivalent height of the layer were h_a the paths travelled would be

$$2\,h_a,\ 4\,h_a,\ 6\,h_a \ldots\ldots\ldots 2n\,h_a.$$

The reflection coefficient, the amplitude of the $(m+1)^{th}$ echo expressed as a percentage of that of the m^{th}, would be expected to be constant in any one series.

On the average of samples taken throughout a whole year the six separate layers lay at heights of 4.7, 5.3, 5.8, 6.4, 6.8 and 8.5 miles. Random samples in early and midsummer, early winter, and late spring showed no departure as great as 0.2 mile from the heights between 5 and 7 miles, and a departure of 0.25 miles from the 8.5 mile mean.

The reflection coefficients for all these layers, as calculated from the second to the higher order reflections, were all of the order of 70%. This relatively high coefficient was sufficiently clearly indicated by the presence of sixth and higher order reflections, since a small coefficient would have given high order reflections too small in amplitude to be observed.

Exploration by Aeroplane

It will be seen that all these closely packed and relatively fixed layers are accessible to manned flight, and it is one of the difficulties raised by the new evidence that there has been no trace of them in the older evidence from aeroplane, manned balloon or registering balloon ascents in which the electrical state of the atmosphere has been measured. That the layers are thin is shown by the fact that they can be measured as separate entities, and it may be that the mere presence or the rate of ascent of the sounding craft, with its comparatively sluggish instruments, prevented the identification of the layers. As Professor Blackett has suggested, renewed exploration by aeroplane is now desirable.

In addition to this group of layers in the region of the tropopause there is, as indicated above, a further group beyond the present reach of manned flight. We have not yet analysed them in such detail as the lower layers, so that meanwhile it is only possible to say that they have been observed at different heights between 20 and 30 miles, and that we have yet to learn whether there are several layers comparable in permanence with those below or whether there is a single region of which the base varies in level from time to time.

These stratospheric layers are frequently prominent when the lower layers are not giving many multiple reflections.

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Wireless and the Atmosphere—

At times, however, there is some little difficulty in disentangling the evidence about these regions because it is mixed up with that provided by higher order echoes from the low layers. In a few cases the separate existence of a layer at 29 miles was established only by the fact that its second order reflection was much in excess of that of the tenth order reflection from the 5.8-mile layer, on which it was superposed, the first order reflection was similarly superposed on the fifth from the lower layer; the two together gave a 30% reflection coefficient for the 29-mile layer. This layer was observed on other occasions, once in company with a layer at 25 miles, but on another occasion a single reflection from 22 miles only was obtained.

The mode of replenishment, against a rate of capture of free electrons by molecules and molecular ions which must be very high, of the high ionisation densities required for these reflection phenomena, is the major puzzle of those posed by the new regions. It seems possible that thunderstorms at substantial distances may feed electrons into these zones, and there is definite evidence of a considerable effect of local thunderstorms on the layers around 10 to 20 miles.

The most direct indications of this kind were obtained when two thunderstorms passed over the observing station three hours apart, out of a clear sky. When the first storm centre was some fifteen miles from the station a well-defined layer appeared, for the first time, at 12½ miles up, and as the centre approached, the whole echo-system from some 6 to 12 miles up increased very much in intensity. When the centre had passed some ten miles beyond the station reflection from the 10 to 12½ mile region ceased. The sky then cleared, but a second thunderstorm three hours later brought an almost identical sequence of events in the stratosphere.

"Runaway Electrons"

It is to be remembered that these thunderstorm effects cannot be regarded as belonging to what we may call the direct working parts of the thunderstorm machine. For, as Dr. Beatty pointed out in his first chapter, the thunderstorm is confined to the troposphere, its cloud head may reach six miles up but certainly not ten. The electrons which replenish the stratospheric layers must spray out from the top of the cloud in the manner outlined by Professor C. T. R. Wilson; they are probably his "runaway electrons."

The new layers have very great interest for the meteorologist, and for the student of the physics of the atmosphere in general. It seems not improbable that they may be directly useful to the meteorologist as indices of the state of the atmosphere at heights which he cannot sufficiently easily and quickly sound in any other way. He may find it worth keeping a nearly continuous watch on their ionisation densities and their reflection coefficients. Such potentialities of direct usefulness are less obvious in the radio field. It is true that the discovery of these regions helps to explain some otherwise obscure phenomena in the propagation of waves, especially of ultra-short waves. But they merely reveal the source of the troubles without contributing more to a cure than that knowledge of the cause which is an ingredient in any sound cure.

Television Effects

There are three phenomena in the travel of television signals which were more or less obscure until the new regions offered themselves for inspection. These were:—

(*a*) Multiple image in the television picture within the service area of the television transmitter.

(*b*) Fading of ultra-short-wave signals at moderate distances from the transmitter.

(*c*) The propagation of ultra-short-wave signals to unexpected distances.

These effects are worth looking at, in turn, in relation to the new regions.

The presence of a ground-ray signal and one propagated via the new regions would be expected to give double-image effects, one or more copies of the transmitted picture appearing superposed, but slightly displaced one from the other. Professor Appleton has dealt with such effects on medium-wave television as affected by the ionosphere proper, but the low reflecting layers would give much smaller relative displacements. It is—for the investigators—gratifying to record that double-image effects corresponding to a ground ray and a ray reflected at 4½ miles have been seen on reception in the Home Counties of television from Alexandra Palace. Many of those interested in television can assure us that they have never had such effects, and the reason is at once clear and in accordance with expectation. For the sending and receiving aerials alike in television are designed with great care in the sending case, with some care and not a little contribution by accident in the receiving case, to concentrate the emitted energy into the lowest angles of elevation and to collect energy from these low angles in preference to the higher angles. This concentration at low angles is done for economy of energy, to give a good signal-to-noise ratio by making the best use of the emitted energy and refusing to accept interfering signals from aloft, but it is clearly exactly what is required to reduce the energy falling on the reflecting regions overhead and also to reduce the amount of reflected energy accepted at the receiver. For these reasons alone multiple image in the service area is not likely to be a very prominent phenomenon.

The argument as to the effect of the new regions in producing fading runs on the same lines, save that a much smaller path difference is required to produce fading than that required for multiple image. To explain the well-established facts about ultra-short-wave fading, it had been necessary to have recourse to ideas on atmospheric refraction which had to be forced somewhat vigorously towards fitting the facts, and which obstinately refused to be a good fit. *Mutatis mutandis*, the new regions give a theory of ultra-short-wave fading parallel to that for the ionosphere and short to medium waves.

There are three different orders of distance which must be considered in the discussion of abnormal ranges on ultra-short waves. These are exemplified by: (1) the reception of American police signals in England and of London television signals in South Africa; (2) the reception of German aerodrome signals in London and of London television signals in Berlin; and (3) the reception of ultra-short-wave signals well beyond, but not *very* far beyond "optical range." Propagation of type (1) seems to me to be effected by way of F region, of which the density is rapidly increasing with increasing solar activity towards the maximum of 1939 or thereabouts; propagation of type (2) I believe to be effected by way of "intense E region"; while that part of (3) which cannot be explained by the far from negligible effects of diffraction can, especially when fading is prominent, fairly be ascribed to the return of ultra-short waves of large angles of incidence (approaching grazing incidence) from these recently discovered reflecting layers in troposphere and stratosphere which have necessitated this first skeleton of a new chapter in the story of "Wireless and the Atmosphere."

Cult of the Miniature Camera

IT may be said without contradiction that one of the most popular innovations of late years was the introduction of the miniature camera. From a hobby of the few it has become the cult of tens of thousands of amateur photographers.

To-day there is a very wide choice of these fascinating little instruments at prices to suit all pockets. How wide is the choice may be gleaned from the special Miniature Camera number, on sale March 10th, of *The Amateur Photographer*, which, incidentally, features in every issue "Miniature Notes" devoted entirely to the use and description of tiny cameras.

Wireless Weather Messages, 1937. Tenth edition; by authority of the Meteorological Committee. Air Ministry publication No. M.O.252.

THIS booklet contains essential information on the dissemination by wireless of meteorological data and forecasts from official stations in Great Britain and Ireland, Gibraltar, Malta, the Middle East and Iraq.

Much of the information, in particular that relating to the transmission and coding of telegraphic messages, is mainly of interest to the serious meteorologist and to those concerned with sea and air navigation. Telephonic bulletins, on the other hand, are of more general interest, and the frequent "Weather London" transmissions from the Borough Hill Station often serve as a useful supplement to the better-known Droitwich forecasts. Pp. 82, with map. Published by H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 1s. 6d., postage extra.

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Current Topics

NEWS OF THE WEEK IN BRIEF REVIEW

Paris Wireless Show

THE fourteenth Wireless Salon, organised by the French Radio Manufacturers' and Traders' Association, will be open from May 14th to the 30th. The exhibition will be held in the Palais du Neo Parnasse in the Boulevard Raspail. It is open to foreign exhibitors, who must, however, be members of a recognised trade or industrial association. Full details may be had by writing to the Secretary of the S.P.I.R., 18, Rue Godot-de-Mauroy, Paris.

Amateurs Honoured

TWO well-known wireless amateurs have been honoured. Mr. H. B. Old (G2VQ), of Nottingham, has received the M.B.E. in recognition of the valuable work which he has done towards equipping the Nottingham and Midlands police with radio. The other amateur to receive recognition is Commander R. J. B. Hippisley (G2CW), of Bath.

Dishonest Servicemen Prosecuted

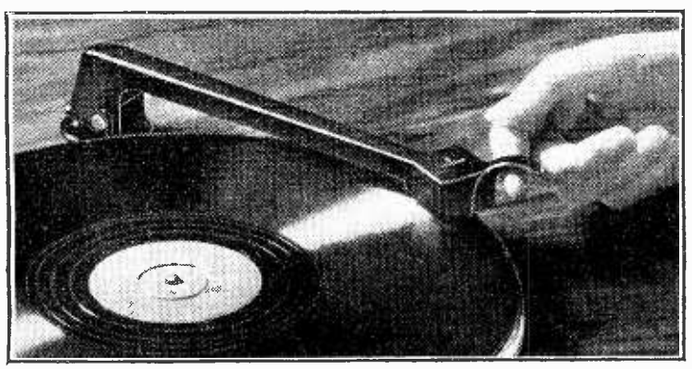
AS a direct result of a report which recently appeared in *The Wireless World* concerning dishonest radio servicemen in New York, the editor of *Radiobranchen*, a Danish wireless journal, commenced enquiries to find out whether such abuses existed in Denmark. Judging by his discoveries, Hamlet might well have been thinking of this sort of thing when he delivered his famous judgment on the state of affairs in his native country. The results of the investigation were communicated to the proper authorities, who acted very promptly. Already several wireless dealers have been brought to court and convicted for certain misdemeanours in the matter of servicing, and charges of fraud are now pending against three important Copenhagen firms.

Russian Developments

A CHAIN of 57 meteorological stations, all equipped with wireless, has just been completed by the Government of the U.S.S.R. All these stations are on the Arctic Coast, and are part of the Government plan for developing the Northern Areas of Siberia.

French Television Decision

THE setting up of a definite television standard in this country seems to have led the French Government to adopt a somewhat similar scheme for use across the Channel. Recent conversations between the French Ministry and representatives of the S.P.I.R., which roughly corresponds to the R.M.A. in this country, has resulted in an important decision. Sponsors of various television standards are to be allowed to try them out during the next few months, using the best possible aerial mast in the country, namely, the Eiffel Tower. The Government experts do not bind themselves to choose any of these systems as the French National standard; this might conceivably leave the way open for some foreign standard to be adopted, should it prove better than any of the native ones. It is hoped, however, that a definite decision regarding the standard for French transmitters will be reached by the middle of the present year.



"PERMANENT" PICK-UP. Weighing only 25 grams, this pick-up, recently introduced by Siemens in Germany, is fitted with a sapphire needle capable of playing 5,000 single sides of 12-inch records without deterioration of frequency response. The output level of 40 millivolts is maintained up to at least 10,000 cycles.

Palestine's P.M.G. Retires

AFTER 17 years' service as P.M.G. Colonel Hudson has left the Holy Land. He was one of the pioneers of broadcasting in Palestine, and first arrived there with the Army in 1917. Before leaving he gave a farewell broadcast.

U.S. Follows Britain

A MOVE is being made in the U.S.A. for radio manufacturers to fix the retail price of receivers and other goods, as in this country. Fifteen States, representing 57 per cent. of America's retail business, have passed laws permitting manufacturers to decide the price which the public must pay for their goods.

Broadcasting Programmes in Finland

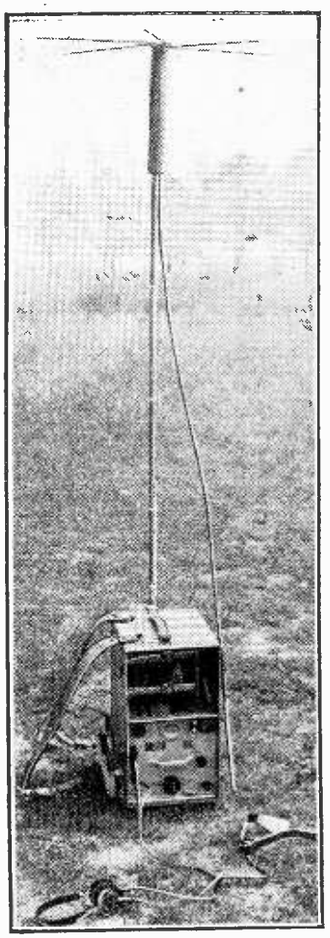
IMPORTANT public events which are the subject of special broadcasts, such as national elections, invariably give a great impetus to wireless licence figures. This fact has just been once more brought out, this time in Finland, where the recent presidential election resulted in a great increase in the number of licence holders. The total number of licences in Finland at the end of 1936 was 176,723. This was increased by 14,000 during January.

B.B.C. Station Plan

THE new North-Eastern Regional station which is at present being erected at Stagshaw will be opened during the autumn, according to a statement made by the P.M.G. in the House of Commons. In answer to a question, the P.M.G. said that negotiations for the purchase of a site in South Devon for the South-Western Regional station were approaching completion, and tests at several possible sites for a relay station were being made in the neighbourhood of the Bristol Channel.

A Station for Stornaway ?

AN application has been made to the Board of Trade by the Stornaway Town Council for the erection of a wireless station in the locality. The Council state that during the present winter the lifeboat has been called out to make several fruitless journeys, sometimes of over 100 miles, because ships cannot communicate quickly with Stornaway.



ONE-MAN BROADCASTING STATION. Complete short-wave transmitting and receiving equipment that can be carried on the back. Designed by the Telefunken Co., the apparatus, which weighs approximately 42 lb., has an effective broadcast range of just over three miles.

Broadcasting Causes Boom in Wives

WIRELESS sets are now being used for buying wives in Uganda. In pre-broadcasting days the cost of a wife was two oxen, but times have changed. Nowadays, fathers are demanding an up-to-date wireless set in exchange for their daughters. For an especially attractive girl, a radiogramophone will be demanded. Wireless sets are by no means common in Uganda at present, however, and prospective sons-in-law have to pay a high price for them in the form of many heads of oxen. Actually, therefore, the coming of broadcasting has caused a great increase in the market value of wives.

Photocells Control Street Lights

IN Indianapolis, U.S.A., they are now using photo-electric cells to turn the street lamps on and off, according to the state of visibility. The same principle was employed in this country some fifteen years ago to operate certain harbour navigation lights.

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The Interaction of Radio Waves

COMPARISON OF THEORY WITH OBSERVATION

(Concluded from page 205 of last week's issue.)

By V. A. BAILEY, M.A., D.Phil. (Oxon), F.Inst.P.

Professor of Experimental Physics, University of Sydney

AFTER the theory was published observations were made by Drs. van der Pol and van der Mark jointly at Eindhoven, by members of the World Radio Research League in Europe and North America under the guidance of Professor E. V. Appleton and Mr. Ralph Stranger, by the "Radio-Klub Zurich" and the "Schweizerischen Radioverband" jointly in Switzerland, and by many other observers. Unfortunately there have been so far no stations in Australia powerful enough to enable Bailey and Martyn to observe and study interaction there, and so these two experimental physicists have had to be content in this matter to play the role of theoretical physicists.

As far as the available published information allows us to do so, a list is given in Table 1 of stations which appear with good probability to have given interaction-backgrounds to various wanted stations; in the second and third columns are given their rated wavelengths and powers.

In order to compare the first theoretical characteristic mentioned last week with observation we may consider the extent to which the stations given in Table 1 may be regarded as powerful ones, and also whether the most frequent occurrences of interaction are due to the most powerful stations. According to a list of European stations, published in April, 1935, of 44 stations whose wavelengths lie in the range 470 to 1935 metres, there are 20 stations with powers exceeding or equal to 50 kW and 24 with powers less than 50 kW. Of the more powerful group 16 stations, or 80 per cent., are to found in our table of interaction-producing stations, and none of the weaker group. Thus the interactions produced by powerful emitters are more easily observed than those produced by the weaker ones. This is also strongly suggested by the fact that in Europe the most commonly reported interactions are those due to Luxembourg and Droitwich, each of which has a power of 150 kW; geographical and other factors easily explain why Moscow I, the only more powerful station, is not more frequently reported.

TABLE 1.

STATIONS WHICH HAVE CAUSED INTERACTION.

Reported by Butt, Tellegen, van der Pol and van der Mark, members of the W.R.R.L., and members of the Schweizerischen Radioverband.

Inferfering Station.	Wavelength in metres.	Power in kW.
Athlone	531	60
Beromünster	539.6	100
Cincinnati	428	500
Deutschlandsender ...	1571	60
Droitwich	1500	150
Hilversum	1875	100
Kalundborg	1261	60
Konigswusterhausen ...	1635	60
Leningrad	1224	100
Luxembourg	1304*	150
Moscow I.	1744	500
Motala	1389	150
Oslo	1153.8	60
Prague	470.2	120
Radio-Paris	1648*	80
Vienna	506.8	100
Warsaw	1339	120

* The original wavelength used by Luxembourg was 1191 m. and that used by Radio-Paris was 1725 m.

IN the preceding part of this article the author outlined the theoretical basis of the "Luxembourg effect." He shows here the close agreement of experimental results with the predictions of theory and indicates possible applications of the effect in exploring the upper atmosphere.

In order to consider the second characteristic we may construct a map on which lines are drawn joining the receiving stations (*R*) and the wanted stations (*w*) corresponding to each observation of interaction caused by a specified station (*L*), whose position is also shown. It is interesting to record that such a map was first published by Dr. Martyn, in the issue of the *Radio Review of Australia* for May, 1934; but for our purpose it is better to use a map like those prepared, on the suggestion of Professor Appleton, by Mr. Ralph Stranger, from observations made by the W.R.R.L., and published in the issues of *World Radio* for December 7, 1934, and March 1, 1935 (p. 17).* On this map only the midpoint of each of the lines joining (*R*) and (*w*) is shown, for this usually gives the approximate position (in plan) of that part of the ionosphere at which (*w*) is reflected and which may therefore be disturbed by the interfering station (*L*). It is clear from the map in Fig. 3 that the midpoints corresponding to interference from Luxembourg, Droitwich and Warsaw are grouped around their respective stations; the few results for Athlone also show a tendency to such grouping. Moreover, the proportion of each group which lies within 300 kilometres of that group's station is 95 per cent. for Luxembourg, 70 per cent. for Droitwich and 92 per cent. for Warsaw. Finally, it may be mentioned that van der Pol and van der Mark report that in all the observations collected by them, which covered the five interfering stations, Konigswusterhausen, Kootwijk, Luxembourg, Radio-Paris and Prague, the phenomenon only occurs when the great circle joining the wanted station and the receiver passes the interfering station at a distance not exceeding 300 kms.

With regard to the third characteristic, van der Pol and van der Mark found that the observed depth of the modulation impressed on Beromunster by Luxembourg, at a frequency of 200 cycles/second, was proportional to the depth of modulation of the latter, in agreement with our theoretical anticipation.

The fourth characteristic, namely, that interaction is most easily observed when the interfering station has a long wavelength, is demonstrated by considering the numbers given in the second column of Table 1 under the heading "Wavelength," taken along with the following facts. According to the list of European stations previously mentioned, of 39 stations with powers exceeding or equal to 50 kW there were 20 whose wavelengths exceed 470 m. and 19 whose wavelengths are less than 470 m. But according to our Table 1, of the former group 80 per cent. were found to produce interaction and of the latter group none at all. It is also interesting to note that the station with the shortest wavelength, namely, Cincinnati (428m.), despite its possession of the highest power (500 kW) used anywhere, emerged surprisingly late in the history of our subject as a producer of radio-interaction.

* Reproduced in Fig. 3 by kind permission of the Editor of *World Radio*.

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The Interaction of Radio Waves—

The fifth characteristic, that a station like Luxembourg can produce *perceptible* interaction, is, of course, exemplified by the fact that interaction *is observed* from the stations Droitwich, Leningrad, Moscow I, Radio-Paris and Warsaw.

Frequency Distortion

We now come to the remarkable sixth characteristic, namely, the distortion of the programme which favours the low notes and suppresses the high ones. It is interesting to recall that this distortion was apparently unnoticed by the early observers, but after the letter was published in which Bailey and Martyn drew attention to its theoretical existence it was noticed and reported by many observers, including Drs. van der Pol and van der Mark and members of the W.R.R.L. The two Eindhoven physicists, in co-operation with the organisations which controlled the Luxembourg and Beromunster stations, made several quantitative observations at Eindhoven of the depth of modulation impressed on Beromunster by Luxembourg, with the former providing a constant unmodulated carrier wave and the latter emitting waves at constant full power and with different constant frequencies F and depths of modulation M. They obtained the following numbers for the impressed depth of modulation M when the modulation frequency F alone was varied.

Frequency F, in cycles/sec.	100	200	400	800	1600–6400
Modulation depth M, per cent.	7.5	3.7	3.3	1.2	unobservable

These results are represented graphically by the full dots in the curve shown in Fig. 2 of the previous instalment. It is clear from the latter that the variation theoretically predicted by means of the curve is strikingly confirmed by the facts represented by the dots. Finally, Mr. Ralph Stranger reported in *World Radio* for February 8th, 1935, an instance of interaction produced by a Morse station, and from his description of the distortion, both in that journal and in private conversation with me, it appears that his observation constitutes an example of the predicted distortion of Morse.

We may now summarise our conclusions as follows: The reports of various observers of radio-interaction, covering six different characteristics, show with a high degree of probability that it is identical with the radio phenomenon whose existence was deduced theoretically from previously accepted knowledge.

Besides the characteristics hitherto mentioned there have been a number observed which had not been explicitly considered in the original exposition of the theory. These are the effects of fading on interaction relatively to the stations involved, the superposition simultaneously of two or three interacting stations (L) on the wanted one (w) and the relative weakness of interaction during the summer.

Some of the members of the W.R.R.L. reported that the programmes of the two stations (L) and (w) faded together, others that they faded independently and one or two reports appeared to indicate that when (w) faded the programme of (L) came in more loudly. Also van der Pol and van der Mark, in their work already cited, found some evidence that interaction is greater at "periods of weak signal of the wanted station." These results are not necessarily mutually contradictory, for they can all be explained by considering along with the theory of interaction two of the possible theoretical modes of ordinary fading. In the first mode it is supposed that as a result of some change in the ionosphere the wave (w) from the wanted station is interfered with in the usual optical sense by another wave (w') from the same station, which may be either a ground wave or one that is reflected twice from the ionosphere, and in either case possesses no component with impressed modulation. When such a situation arises then clearly the wanted programme must appear to fade. But the effect on the background (which is theoretically proportional to v^2) may be increased, unaltered or decreased ac-

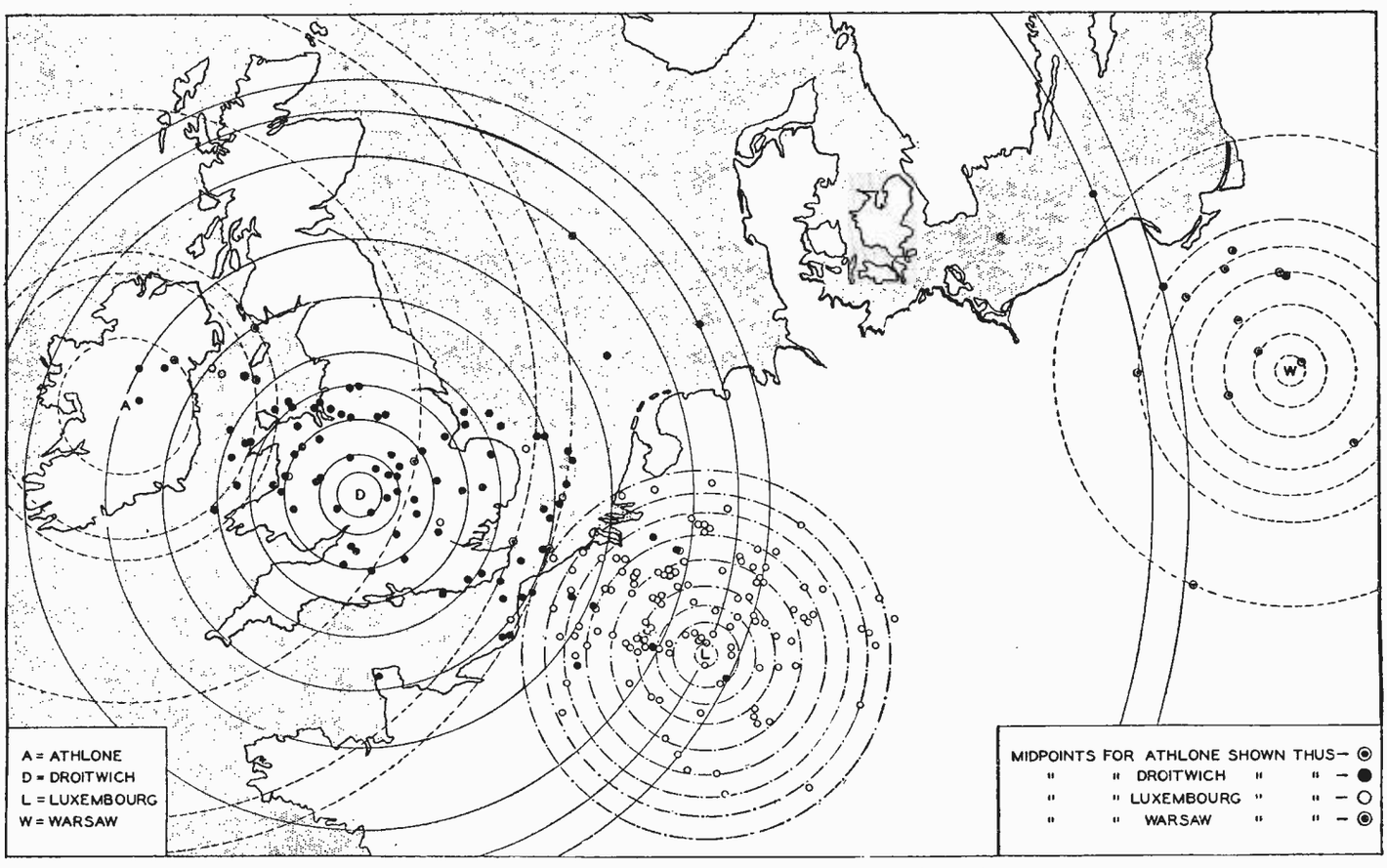

Fig. 3.—Map showing positions of receiving stations which have reported interaction interference from the powerful European transmitters. For each station the majority of reports come from places within a radius of 300 kilometres.

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The Interaction of Radio Waves—

cording as the change in the ionosphere causes the path of *(w)* to pass to regions where the electrons have greater, the same or less collision-frequency ν. In the second theoretical mode of fading it is supposed that an ionospheric change by sending the path of the wave *(w)* to regions where ν is larger causes it to be more absorbed in this part of the path and so produces fading. With this type of fading the interaction increases with ν and so the background increases in strength *relatively* to the wanted programme; but in absolute magnitude it may increase or decrease according as the wanted wave *(w)* is weakly or strongly absorbed by the ionosphere, that is, mainly according as *(w)* has a shorter or longer wavelength.

Since the question about the absolute strength of the background may not always be unambiguously answered by means of observations with receivers having automatic volume control, we see how desirable it is for the study of interaction-fading that whenever possible this type of control should be absent.

Multiple Interaction

In the issue of *World Radio* for February 22nd, 1935, Mr. Stranger cites a report from Newrath, Waterford (I.F.S.) that Droitwich and Luxembourg backgrounds were present simultaneously in the wave from Munich, and in the issue for May 10th Mr. Stranger reports that British observers had found double backgrounds of Radio-Paris and Luxembourg in the wave from Beromunster during the special tests organised by the "Schweizerische Radioverband" when Beromunster emitted a constant unmodulated wave for a whole hour; at times even a triple background was observed. These facts are in general accord with our views on interaction, but the detailed application of the theory to multiple interaction is still in process of development.

The data on the relative weakness of interaction in summer are insufficient to justify discussion here.

Besides the characteristics enumerated last week, the theory of radio-interaction also predicted the following:—

The interaction background contains, besides the fundamental component a first harmonic component whose amplitude is from 10 to 20 per cent. of the amplitude of the fundamental component, and is more distorted than the latter. This component is, of course, one octave higher than the fundamental one.

The interaction is least at night and increases towards sunrise; if signals due to the downcoming wave *(w)* are audible in the daytime the interaction is strongest around noon and decreases again towards sunset. These are approximate local times for the geographical situations of the midpoints between the receiver *(R)* and the wanted station *(w)*.

The phases of the impressed modulations of different frequencies are displaced by different amounts which depend in a simple way on these frequencies.

The interaction may involve transient effects which are damped out in a manner assigned by the theory.

Electric storms may interact with radio-waves, giving rise to atmospherics of a special type which may be recognised by means of the following two tests: they appear and disappear with the wanted station, but do not appear when the receiver is tuned to another station of similar wavelength and lying in a different geographical situation.

Under sufficiently favourable circumstances observable interaction may be produced by powerful stations of medium or long wavelength acting on wanted stations of any wavelength in the broadcasting band, but it occurs most notably when the interfering station has a longer wavelength than the wanted station.

The sky wave received from a powerful, long-waved station like Luxembourg or Droitwich appears to have its own modulation distorted in favour of the high notes, which is a distortion opposite to that occurring in the interaction of two waves. This self-distortion increases with the power and wavelength of the station, and should be greater when daytime exists at the region of ionospheric reflection than when night-time exists.

Of the seven theoretical characteristics of radio-interaction just given, only for the last but one (concerning wavelengths) has there been published any conclusive evidence of its having been observed. "Interaction atmospherics" might be singled out for the further attention of listeners.

Scientific and Other Applications of Radio-Interaction

The study of radio-interaction gives promise of supplying some of the most effective methods for extending our knowledge of the upper atmosphere. For example, by observing accurately the way in which either the impressed depth of modulation or the phase displacement varies with the modulation frequency, or else by observing the rate of damping of transients, it is possible in principle to determine the nature of the gas existing in the region of interaction. As a partial illustration of the first of these three methods we may consider the observations shown by the full dots in Fig. 2.

According to the theory these points should lie approximately on a curve whose equation, in cartesian co-ordinates, is—

$$y = \frac{A}{\sqrt{B^2 + x^2}}$$

where A and B^2 are constants, and $x = 2\pi F$.

So we first determine those values of A and B for which this equation yields a curve which passes as nearly as possible through all the full dots. This leads to the values—

$$A = 6700, \qquad B = 780.$$

This theory also shows that B is equal to the product $G\nu$ where ν is the collision frequency and G is a constant characteristic of the gas in which the interaction takes place and its temperature. We may therefore now set $G\nu = 780$.

The value of ν can be determined by other known methods, such, for example, as those of D. F. Martyn and other workers, depending on observations of the reflection-coefficients of waves with different frequencies; in this way it has been found that, for regions of the ionosphere such as that under consideration, the value of ν is about 300,000.

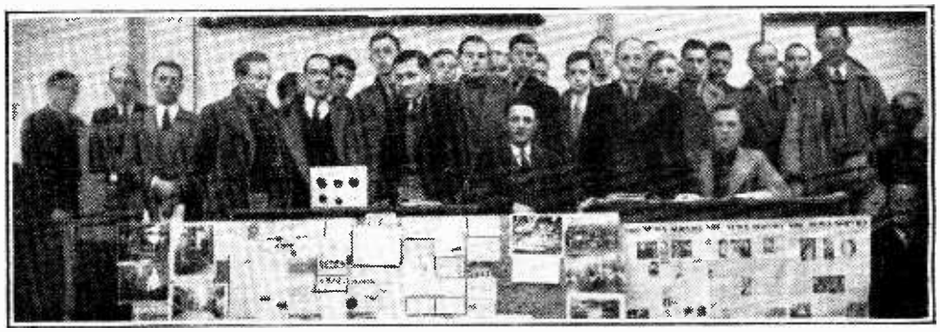
We thus conclude that *G* is equal to 780 divided by 300,000, that is—

$$G = 0.0026.$$

The observations of Townsend and Tizard on electrons in air at ordinary temperatures lead to the value 0.0026 for *G* and those of Townsend and Bailey on electrons in hydrogen lead to the value 0.0031. Other gases like argon, helium and carbon-dioxide lead to values very different from these.

We may therefore conclude that the observations are consistent with the view that the gas in which the interaction occurs is either air or hydrogen at ordinary temperatures. Dr. Martyn, who has made a special study of such matters, informs me that hydrogen is completely excluded by the observations on polar and non-polar auroræ of Vegard and Cabannes. Hence we are left with air as the only gas which may be supposed present at ordinary temperatures in the region of interaction.

Another application of the theory is likely to be made in the design of new high-powered stations, for these in the future will presumably have to avoid notably interfering by interaction with other stations.



THE INTERNATIONAL SHORT WAVE CLUB. A group of members of the Brighton Chapter held at the Technical College.

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Recent Inventions

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of patents issued in U.S.A. is also included.

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

AUTOMATIC TUNING

WHEN a receiving set is fitted with means for automatically correcting an initial error in the setting of the tuning-control, so that the circuits are always forced to work "on resonance," difficulties will arise in calibrating the set, since the exact wavelength to which the receiver is tuned does not depend solely on the manual setting.

According to the invention the amount of the "automatic" adjustment is indicated positively in each case. An ordinary indicator scale is provided, but the indicator needle, though moved by the manual-tuning control, is not rigidly coupled to it, but is so arranged that the subsequent readjustment due to the "automatic" control is made visible. The scale then records the exact wavelength or frequency to which the circuits are in tune. There is accordingly no necessity, so far as calibration is concerned, to switch off the "automatic" regulation during the process of tuning.

Murphy Radio, Ltd., G. B. Baker, and G. F. Hawkins. Application date August 23rd, 1935. No. 456928.

o o o o

NOISE-SUPPRESSOR CIRCUITS

IN a mains-operated receiver it is a comparatively simple matter to provide, say, a 30-volt biasing-voltage for suppressing "noise" at inter-station settings of the tuning knob. But with a battery-operated set the voltages available are more limited.

The object of the invention is to cut out inter-station noise in a battery-driven receiver with the aid of comparatively low muting voltages. As shown in the drawing, when the switch arm S is on the point A, normal grid bias from the resistance R is supplied to the frequency-changing valve V, and to the intermediate-frequency valve V1, and the muting arrangement is inoperative. When the switch arm is on contact B the grids of both the valves are made slightly positive, and this causes the receiver to be muted.

When a signal is tuned in, high-frequency currents are applied from the plate circuit of the rectifier V2 through a condenser C to the diode-electrode D, and the rectified voltage so produced is applied through a choke K of low impedance to direct current. This produces a fall of voltage at the point P. At a certain signal strength this becomes sufficient to remove the muting. Subsequently the diode D supplies automatic volume-control bias in the ordinary way.

E. K. Cole, Ltd., and G. Bradfield. Application date April 8th, 1935. No. 456519.

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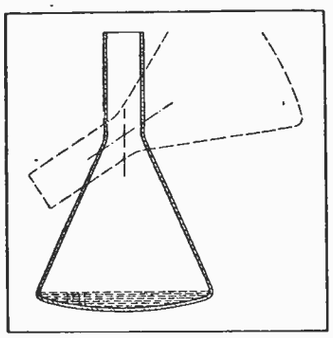
PREPARING FLUORESCENT SCREENS

PARTICLES of a fluorescent material, such as Willemite, are ground to a sufficient fineness to pass through a 400-mesh screen, and are then suspended in an electrolyte such as a solution of ammonium carbonate. The solution is poured into a cathode-ray tube "blank" so that it covers the bottom of the bulb, as shown in the figure. In course of time the particles settle to the bottom and cover the surface of the glass with a uniform coating of fluorescent material. The superfluous liquid is then decanted off by slowly rotating the tube into the position shown in dotted lines. The use of an electrolyte solution—in place of water—as a settling solution is of importance in producing a homogeneous distribution of the fluorescent material on the glass surface of the bulb.



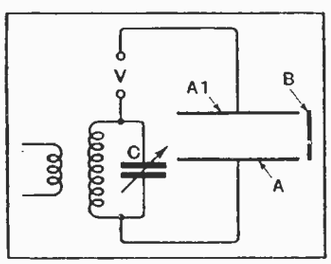
Method of forming fluorescent screen in cathode-ray tube.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of H. W. Leverenz). Convention date (U.S.A.) May 23rd, 1934. No. 456755.

o o o o

ELECTRON MULTIPLIERS

A COLD-CATHODE amplifier or electron-multiplier consists of a pair of flat parallel plates A, A1, of which A is coated with a sensitised layer, whilst A1 carries a high positive voltage and acts as an accelerator. The output or collector electrode is shown at B. In addition to the fixed positive voltage from the source V an alternating component is applied to the plates A, A1 from a tuned circuit C, whilst a fixed magnetic field is applied across the space between the two plates so as to cause electrons liberated from the plate A to travel in a curved path which terminates on the same plate. The frequency of the circuit C is so adjusted, in relation to the "time of flight" of the electrons, that the fluctuating voltage on the plate A1 increases the velocity of impact upon the plate A, and therefore the amount of secondary emission produced. Actually, if the electrons are assumed to be emitted in a continuous stream, half of them will have their energy increased in this way.



Electrode assembly in a cold-cathode electron-multiplier device.

Marconi's Wireless Telegraph Co., Ltd., and E. W. B. Gill. Application date May 24th, 1935. No. 456991.

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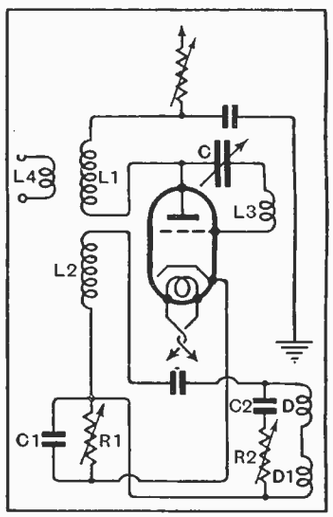
TIME-BASES FOR TELEVISION

THE grid and anode of a saw-toothed oscillator valve, of the highly evacuated type, are back-coupled through coils L1, L2. Both coils are wound on a common magnetic core, which is provided with an air-gap to determine the fly-back period of the electron beam over the fluorescent screen of the cathode-ray tube. This period may be regulated by the coil L3 and condenser C. An adjustable biasing resistance R1, shunted by a condenser C1, is inserted between the coil L2 and the cathode of the valve, and serves to determine the frequency of the saw-toothed oscillations supplied to the deflecting coils D, D1.

For synchronising, "locking" impulses are applied through a coil L4, which is wound on the same magnetic core as the coils L1, L2. In order to prevent undesirable "ripples," which are liable to occur at the commencement of the linear rise or fall of the current in the grid circuit, a condenser C2, in series with an adjustable resistance R2, is shunted across the deflecting coils D, D1. The resistance R2 also allows the amplitude of the deflecting voltage to be varied over a range of from 10 to 15 per cent.



Saw-toothed oscillator circuit for use in television apparatus.

G. R. Tingley, D. W. Pugh, and Baird Television, Ltd. Application date May 17th, 1935. No. 456666.

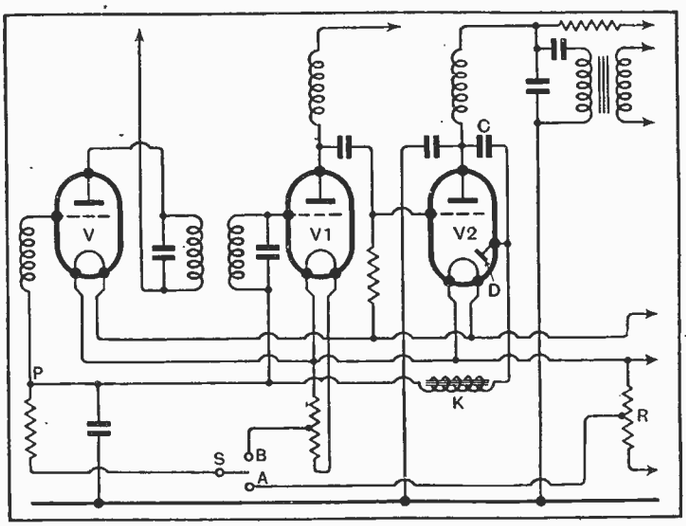
o o o o

SINGLE-KNOB CONTROL

IN certain kinds of sets it is particularly useful to make the tuning control as simple as possible, as, for instance, in a motor car, where the receiver is usually tucked away out of sight under the scuttle, and the operating knobs and switch are separately mounted on a small panel on the instrument board for single-handed operation by the driver.

According to the invention, all the necessary controls are embodied in a single rod which can be pushed in and out, to one or other of several spring-controlled positions in order to switch the set on and to change the wavelength. In addition, the rod is splined or grooved so that it will engage and drive a variable condenser in any of its axial positions, so as to tune the set to any required station.

K. H. Kerr and S. B. Smith. Application date May 21st, 1935. No. 457116.



Method of embodying muting in a battery-operated receiver.

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Broadcast Brevities

NEWS FROM PORTLAND PLACE

Last of the Mohicans

LAST week's Parliamentary announcement that North-East Regional—or, more politely, Stagshaw—will open in the autumn sounds the knell of the last of the original broadcasting stations opened in 1922.

Newcastle was actually the fourth station to begin a broadcasting service in this country, being heard for the first time on Christmas Eve, 1922. It was preceded by 2LO on November 14th and Birmingham and Manchester a day later, but these three all faded out long ago.

Once a Main Station

Newcastle, on the other hand, starting up with a Marconi "Q" type transmitter of 1½ kilowatts, is still going strong on the same power rating. It is difficult to imagine that it once enjoyed the status of a "main station."

Cardiff was not opened till March, 1923. Aberdeen and Bournemouth started up within a week of each other in October of the same year. All of them were "main" stations, with a rating of 1½ kilowatts. In these days of 100 kW. transmitters we are no longer impressed.

An Empire Tour

J. B. CLARK, Director of the Empire Service, will have the interesting experience of listening to his own programmes in Malta during Coronation week. He starts on an Empire tour on May 7th, landing at Malta on May 11th. From there he will proceed by easy stages to Ceylon, Australia, Fiji, New Zealand, Malaya and back by way of India, Palestine and Gibraltar.

Probing Listener Reaction

He will be the first B.B.C. official to probe "listener reaction" in the Empire since Malcolm Frost blazed the trail six years ago. Like Frost, too, he omits Canada from his itinerary. Less than two years ago Mr. Cecil Graves, now Controller of Programmes, visited Newfoundland in an official capacity and was able to advise the Government on the formation of the new broadcasting organisation. And more recently Mr. Gladstone Murray also tendered advice to Canada on behalf of the B.B.C.

Varied Noises

MODERN radio sets are fairly tough, which is a good thing, considering the varied assortment of noises they now have to cope with in the course of an evening's entertainment.

Take Thursday of last week, for instance, and single out the contribution of Styx Gibling, who with Phil Park accompanied Reginald Foort's theatre organ programme of rhythmic music.

Rhythm as Well

Mr. Gibling, who is drummer of the B.B.C.'s Variety Orchestra, operated:

Seven tom-toms, fourteen Chinese temple blocks, four different types of cymbals, a pair of hula rattles, a Zulu war drum, three Chinese drums, a Chinese piccolo tom-tom, an Indian gong, a large Turkish gong, sea effects, steamer sirens, a snake charmer's drum, angle bells, and horses' hooves clattering on a marble slab.

"There was rhythm as well," says Mr. Gibling.

And Now a Harp

IF the B.B.C. Military Band takes part in the Coronation procession—and why not?—two instruments may offer a curious problem. First, there is the double bass, which has been introduced in this brass band to give pep to the low notes. Will dignity be preserved if it and its player are pushed along on a suitably draped trolley?

Secondly, there is the harp, which was co-opted for the first time in the Regional programme on Saturday and promises to become a permanent addition. How *does* one perambulate with a harp?

When the B.B.C. Did Not Fail

MANY a shaft of bitter satire is aimed at Broadcasting House, just to show that the B.B.C. is "in the wrong again." The second World Concert from the Argentine, for example, due to be broadcast on the Regional wavelength on a recent Sunday. Said the B.B.C.: "The telephone circuit is not satisfactory and the relay cannot go on." Said a radio critic: "Yet I picked it up very nicely via Germany on 16 and 19 metres." Thus it was made to appear that Germany succeeded where Britain failed. But the B.B.C. engineers chuckled; for the Germans were taking the programme from the B.B.C.'s receiving station at Tatsfield.

Televising a Bank Holiday Fair

ALTHOUGH the Alexandra Palace site was chosen for television because of its ideal situation for ultra-short wave transmission, the B.B.C. is extraordinarily lucky in having to hand all kinds of ready-made entertainment. In addition to the railway station, there is a roller skating rink, the concert hall with its facilities for boxing, an ornamental lake, a racecourse, a park, and, last but not least, a fairground.

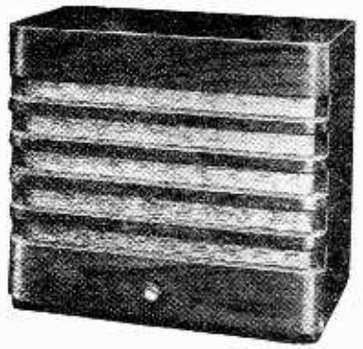
The last-named will probably be the venue of one of the most striking actuality television broadcasts yet attempted.

Overhead Co-axial

According to present plans, the fair will be televised on Easter Monday. The ground is not more than 100 yards from the control room, so distance offers no problem, but the arrangement of the co-axial cable certainly does. Not even a good-natured English crowd on "benk 'oliday" could be relied upon to "step over the cable please" all the afternoon, so the cable must be lowered to the camera from overhead, and this may call for as much engineering ingenuity as the camera cradle which was suspended over the Alexandra Palace boxing ring a few weeks ago.

Probably the camera men will wear protective padding of the anti-coconut variety.

Concerning The ROLA 'REX' UNIVERSAL EXTENSION SPEAKER



Good Tone and Good Taste

Frankly, the Rola "Rex" is an Extension Speaker for those whose critical faculties are well developed . . . whose ears are quick to catch the slightest variation from true fidelity . . . who feel that the outward appearance of a speaker plays an effective part in completing their enjoyment. It is for these, who appreciate both good tone and good taste, that the Rola "Rex" and its cabinet have been designed. It can be matched to any receiver. For 49s. 6d. you can ensure years of unblemished radio entertainment.

BRIEF SPECIFICATION

SPEAKER — 8" Diameter. Special Nickel Aluminium Cobalt Magnet. Ten alternative impedance settings.

CABINET — Beautifully grained Walnut. Size 14" × 16" × 9". Volume control mounted on front of cabinet.

Ask your dealer to demonstrate or write to-day for leaflet AA.

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Letters to the Editor

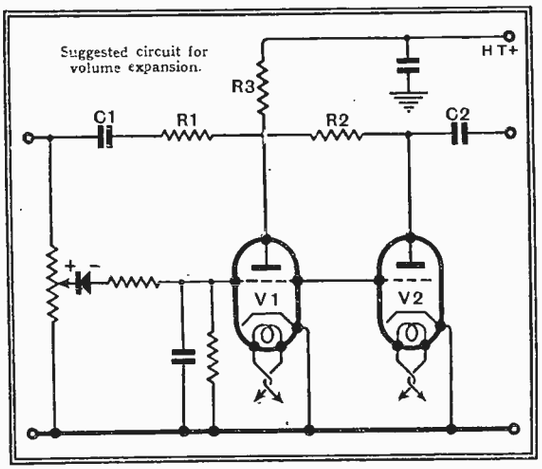
The Editor does not hold himself responsible for the opinions of his correspondents.

Broadcasting on Ultra-short Waves

I WILL take this opportunity of saying that I have been interested by your Editorial suggestion that broadcasts of the sound variety will be, or should be, carried out by means of the ultra-short wavelengths. I consider, however, that the improvement in reproduction could hardly make up for the upset occasioned by the change-over, as in that case medium- and long-wave receivers would in their millions become largely obsolete, since, naturally, foreign stations would follow suit also. Incidentally, reception of foreigners would be severely curtailed, for I understand that the range of the ultra-short waves is limited. What is wanted in the radio industry more than anything else is quietude and standardisation (allowing, of course, for individuality in the various makes of receiver), and this is impossible to get with all this alteration in wavelengths and other changes. The benefits are surely not worth the great upheaval which your suggestion would cause, if acted on, although I agree that good reproduction, the best possible in fact, is the ideal to be aimed at. But don't good sets get close to this ideal of perfection in transmission and reproduction as it is?

T. J. E. WARBURTON.

East Molesey, Surrey.



Unusual Reception

PERHAPS some of your readers would be interested in the following occurrence, and those more technically minded than myself may be able to furnish me with some explanation, for which I should be very grateful.

While flying at about 6,000 feet, about five miles from Gibraltar, a pilot noticed that it was possible to overhear with perfect clarity, though faintly, telephone conversations between persons in Gibraltar, which were later corroborated. These were heard on the machine's receiving gear in the form of untunable interference in the neighbourhood of 15 metres, the exact wavelength, unfortunately, not being noted.

The telephone system in question was of perfectly orthodox pattern, though separate from the public exchange, and known to have employed no radio link.

E. C. E. SHATTOCK.

Farnham, Surrey.

Boston on 6.9 Metres

YOU may be interested to have details of the continued reception of Boston on a 6.9-metre signal here. The facts are these:—

The new 200in. telescope is to be erected on Mount Palomar, 60 miles from San Diego, California, in order to be away from the lights of greater Los Angeles.

The grinding of the mirror and the general supervising is being done here, at the California Institute of Technology. There has been established a 43 Mc/s short-wave line between Pasadena and Mount Palomar, a distance of about 125 miles. However, the reception has not been particularly good. During November and December consistent reception of Boston (Mass) was reported by both stations with a regularity far superior to that achieved over the shorter distance from here to Palomar.

I have just read of Mr. O'Heffernan's achievement in spanning the Atlantic on 5 metres—I congratulate him.

CHRISTOPHER DYKES.

Pasadena, California.

Volume Expansion

THE subject of volume expansion is intriguing, but it is unfortunate that all methods at present in use appear to produce distortion.

The accompanying circuit diagram represents an attempt to reduce this distortion to a minimum and at the same time obtain a large expansion range.

Signals flow through C1, R1, R2 and C2 to the output terminal, but R1 and V1 form a potentiometer which divides the signal. R2 and V2 do the same to what is left of it. Assuming the signal is weak, V1 and V2 will be unbiased and of low resistance, therefore very little AF will reach the output, but when a strong signal is applied to the input, the Westector will rectify sufficient current to develop a biasing voltage on both valve grids, so increasing their anode-cathode resistances.

R3 is of high resistance (1 megohm or so) to avoid by-passing signals to earth.

It is obvious that R2-V2 will amplify the contrast already obtained from R1-V1. I think it should be possible to obtain almost any desired amount of expansion by careful choice of valves and resistance values.

I have not yet tried this arrangement, but perhaps it would interest *Wireless World* readers.

W. K. LLOYD.

Maidstone.

Service

I WAS interested by "Alter Ego's" letter in the February 12th issue of *The Wireless World* dealing with Service, and wish to draw attention to another aspect of this important subject. In October, 1936, I left an accumulator in the hands of a firm which, inappropriately, includes this word "Service" in the sign over the doors of its various branches. I am still without my property, which the firm in question has either lost or damaged beyond repair. Verbally, they assured me of their intention to make good the loss, but in practice put me off with prevarication, etc. They did not answer my letters, and I was unable even to obtain the address of their head office (if any)! So I have had to write off the accumulator as a dead loss. That a concern should be so petty in these competitive times seems almost incredible, but there it is, and what I want to know is—what protection has the customer against such unscrupulous firms when he gives them, ignorant of their methods, an accumulator to be recharged? Or, indeed, for that matter, a set to be repaired? Must he demand a written, dated and signed receipt for even the smallest thing?

T. J. E. WARBURTON.

East Molesey, Surrey.

Television Programmes

Transmission times are from 3-4 and 9-10 daily.

Vision	Sound
45 Mc/s.	41.5 Mc/s.

FRIDAY, MARCH 5th.

3, The Composer at the Piano: Billy Mayerl. **3.10,** Models and costumes from Shakespeare Exhibition in aid of Shoreditch Housing Association. **3.25,** Gaumont-British News. **3.35,** Theatre Parade: Diana Wynyard and Louis Borell in scenes from the Shaftesbury production of "Heart's Content."

9, Starlight: June Clyde. **9.10,** Repetition of 3.10 programme. **9.25,** British Movietonews. **9.35,** Ballroom Dancing demonstrated by Alex Moore and Pat Kilpatrick. **9.50,** "A Ton of Fun."

SATURDAY, MARCH 6th.

3, O.B. of rolling stock from L.N.E.R. Exhibition at Alexandra Palace Station. **3.20,** Conjuring: Russell Swann. **3.30,** British Movietonews. **3.40,** Lisa Minghetti (violin) and The Television Orchestra.

9, Topical Item. **9.20,** Gaumont-British News. **9.30,** Repetition of 3.40 and 3.20 programmes.

MONDAY, MARCH 8th.

3, Leslie Jefferies (violin). **3.10,** British Movietonews. **3.20,** The World of Women. **3.35,** Theatre Parade: Extracts from Aldwych Theatre production of "Jane Eyre."

9, Music Makers: Adela Fachiri (violin). **9.10,** Gaumont-British News. **9.20,** Repetition of 3.20 and 3.35 programmes.

TUESDAY, MARCH 9th.

3, A Fashion Parade. **3.15,** Gaumont-British News. **3.25,** The White Coons Concert Party presented by Harry S. Pepper.

9, Repetition of 3 programme. **9.15,** British Movietonews. **9.25,** Repetition of 3.25 programme.

WEDNESDAY, MARCH 10th.

3, Hella Kurthy: Viennese Songs. **3.5,** London Galleries: Fourth of series of talks on pictures and sculpture at London exhibitions. **3.20,** British Movietonews. **3.30,** Thirty-fifth Picture Page.

9, Betty Huntley-Wright: Songs. **9.5,** London Galleries: fifth talk of series. **9.20,** Gaumont-British News. **9.30,** Thirty-sixth Picture Page.

THURSDAY, MARCH 11th.

3, Musical Act. **3.5,** Home Affairs: Discussion on food and health between John Hilton and Sir Kingsley Wood. **3.20,** Gaumont-British News. **3.30,** The Vic-Wells Ballet Company: Casse-Noisette (Act 3).

9, Musical Act. **9.5,** Repetition of 3.5 programme. **9.20,** British Movietonews. **9.30,** Repetition of 3.30 programme.

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On the Short Waves

SUB-SECTION 7 of Section 1 of the Wireless Telegraphy Act of 1904 (4 Edw. 7 c. 24 ss 1. (7).) states: "The expression 'wireless telegraphy' means any system of communication as defined in the Telegraph Acts of 1863 to 1904, without the aid of any wire connecting the points from and at which the messages or other communications are sent and received: Provided that nothing in this Act shall prevent any person from making or using electrical apparatus for actuating machinery or for any purpose other than the transmission[1] of messages."

The interpretation of this particular section of the now famous Act is becoming daily of more and more importance to both the radio industry and the general listening public, since, with the great increase in the use of short-wave receivers and transmitters during the past few years, the problem of "interference" is becoming acute.

In addition to interference from domestic appliances and trolley buses, etc., recently a new and possibly more serious one has arisen, namely, radiation from electro-therapeutical or diathermy apparatus, which, unlike the more homely vacuum cleaner, with its limited sphere of influence, can cause severe interference difficulties at ranges in excess of several thousand miles.

In fact, a recent rebroadcast in Canada of a speech by Mr. Stanley Baldwin, it is reported in the Press, was severely marred by interference of this type, all listening points being similarly affected.

All of which brings us to the Wireless Telegraphy Act of 1904, since the question which is now being asked is "Can the Post Office take steps to control these 'transmissions' and so regulate or diminish the amount of interference which is being caused to authorised services, in the same way in which it licenses and controls amateur and other radio stations?"

The answer is, apparently, that it is unable legally to do so, since the Act says "nothing in this Act shall prevent any person from making or using electrical apparatus for actuating machinery, or for any purpose *other than the transmission (or reception) of messages.*"

The point is, of course, that diathermy apparatus, even though it radiates several kilowatts of raw AC carrier on, say, 11 Mc/s, is not being used for the transmission of messages, presumably also included under this provision come (1) test oscillators, (2) oscillators which may be used for the transmission of power by radio, and possibly (3) wireless transmitters used for "actuating machinery" at a distance, i.e., remote control, and perhaps others.

In fairness to the Post Office it should, of course, be stated that they do everything possible to eliminate interference troubles of any kind, and, in fact, their very valuable service in this respect to the general public does not really receive the credit it deserves. The question of eliminating diathermy interference is, however, a very difficult problem even for the P.O. engineers, especially when it is realised that the source of the interference may lay in some doctor's portable outfit in the U.S.A. or Canada (in which case the signal will probably be modulated at 60 cycles instead of at 50 cycles).

It seems, therefore, that this is an international problem which must be settled by legislation promoted by the countries concerned.

In closing the discussion on this particular subject it would be as well to add that the effect of diathermy interference on television is particularly distressing.

Turning now to our fortnightly study of short-wave conditions, we are not surprised to find, following the 27-day solar cycle, that sunspot activity was again strongly marked during the last week in February, as predicted in my last notes.

The effect of the vast stream of sun spots now visible has been even more marked than was the effect of the large January group, and during the past few days—February 22nd-24th—reception has been consistently good from the U.S. on the very high "apex" band of 35.6 Mc/s until 8 p.m. in the evening. Not many would have cared to predict "winter" night-time reception on 8 metres from the U.S.A. even twelve months ago! The two outstanding stations on 35.6 Mc/s were, of course, W3XES and the Boston police transmitter W1XAO.

It adds interest to this no longer freak reception on the ultra-short waves to record that it is the opinion of the experts that the coming sunspot maximum will be more intense than that of 1927-28!

To consider a detailed report of the past fortnight we find that on Friday, February 12th, W3XES Baltimore on 35.6 Mc/s was very good between 2 and 3 p.m., evidently due to a "G" region hangover from the "January" sunspot group, with W2XAD strong but fluttery in the evening at 7 p.m.

On the Saturday, W2XE was fairly good on 21 Mc/s in the afternoon, and later in the evening W1XAL Boston on 11.79 Mc/s was somewhat better than W2XAF at 10.45 p.m.

Ionisation levels seemed to be definitely lower on Monday, February 15th, but W1XAL and W2XAF again lived up to reputation at 11 p.m., though little was to be heard on the higher frequencies.

On Tuesday it was interesting to note excellent reception of LSY on 18,115 Mc/s at 7 p.m. with the 28 Mc/s U.S. amateurs, W3XAL and W2XAD also very good.

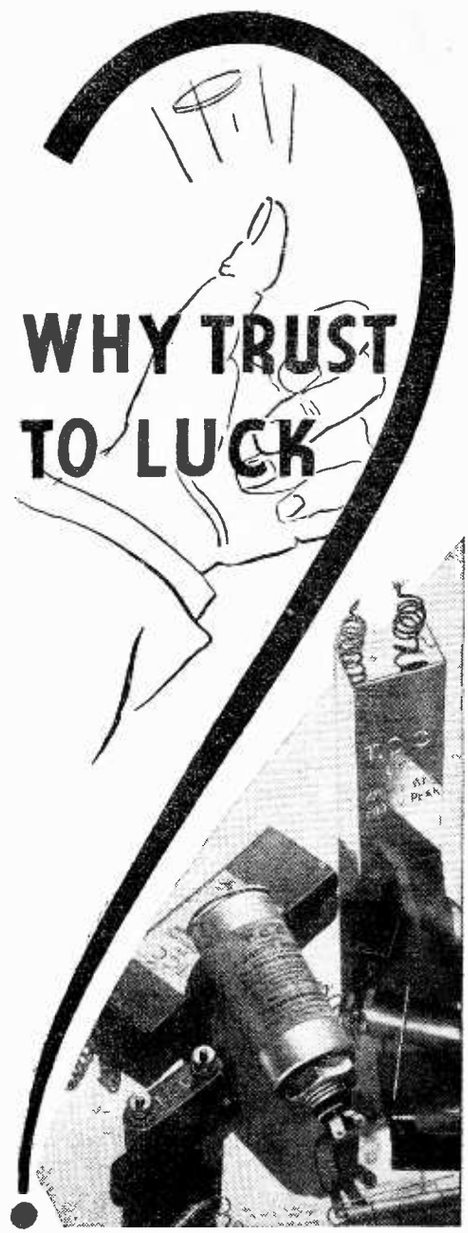
The reappearance of NSS on 9 metres on Saturday, February 20th, was a sure indication of increased solar activity, more especially as at 1 a.m. the next morning R9+ signals were still being obtained from the U.S. commercials WDU and WMA.

The Milwaukee 26 Mc/s transmitter W9XAZ also sprung into prominence again in the evenings.

At 8.30 p.m. on Sunday, February 21st, WICOO on 28 Mc/s was a good R9+ signal and sounding like a local station, outperforming all the U.S. short-wave broadcasters at this time.

The general effect of conditions on the succeeding days has been dealt with earlier in these notes and was notable for the very favourable transmission on the very high frequencies, but one must mention W2XE on 21.52 Mc/s (14 metres) at R7/9 at midnight, Wednesday, February 24th, directive to S. America.

[1] The word "transmission" here is deemed always to have included the reception as well as the sending of messages.—Sect. 1, Sub-sect. 1, W.T. Act (Expl.), 1925.



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Random Radiations

By "DIALLIST"

A Sound Scheme

THE B.B.C.'s training school for the new boys and new girls of its senior staff seems to have come in for a good deal of comment one way or another. To me it seems a first-rate scheme—one, in fact, that might well be adapted and adopted by business concerns and Government Departments—to put the newly appointed through a general course of instruction in broadcasting as a whole before they take up their regular duties. To be able to do his job well your announcer must know something of the work of the programme-builder, of the operator at any of the control panels, of the producer, of the effects man, and so on, right through all the departments of the B.B.C. Each will be all the better for gaining an understanding of the multitude of tasks that go to make a broadcast, whatever his own particular pidgin is going to be. Another good thing is that such a training helps to make the staff more or less elastic. When all have a sound outline of the general scheme it is much easier to cope with emergencies, such as a 'flu epidemic or anything of that kind.

But Why So Costly?

My only criticism is that this training school costs so much. The figure given is £11,000 a year, but that, I imagine, can't take into account the fact that those who are going through the course receive full pay whilst doing so. There are normally twenty-five students, and if their salaries are taken to average £250, there's £6,250 under that head alone. They don't, of course, spend a year at school, but since there is always a "term" attending or about to attend or just having attended, that's about what it comes to. If I may hazard a suggestion, the B.B.C. is rather prone to be too skimpy with the cash in some ways and too lavish in others. So far as their training school is concerned they appear rather to have damned the expense, for the capital costs in building alterations must have been pretty heavy—but let's hope that the £11,000 a year will prove to be money well and wisely spent.

No Heckling Here

TRULY, the uses of the radio valve and the loud speaker are legion. I see that one M.P., Major J. S. Courtauld, of Chichester, has been speaking from Westminster to meetings of his constituents by means of a telephone line reserved for the occasion and connected to some form of PA equipment. The president of the local political association got the idea from hearing at a London dinner a relayed address by the Prime Minister of Canada. The G.P.O., when approached, gave their hearty support and the thing was done. He expects other M.P.s to follow this lead, and foresees the time when a candidate will be able to do an "S.B." to meetings all over his constituency.

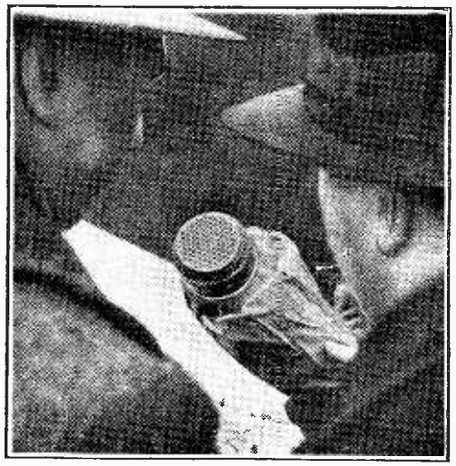
Just the thing for the nervous candidate, what? One thing about the loud speaker is that it transmits no back answers. Let the hecklers heckle never so stoutly, the candidate will know nothing of them. Interruptions will mean nought to him; the engineer in charge will merely turn up the wicks of the amplifier until they are drowned. And should the opposition start saying it with eggs and things, I have no doubt that they will batter in vain against the stout protecting grille of the election model loud speaker.

Sound Films for Radiograms

A LONGISH time ago now there was an interesting and extensive correspondence in *The Wireless World* on the subject of gramophone records designed for photo-electric reproduction. The limitations of the wax record are obvious. Its playing time is short, and even if you have an automatic changer that plays both sides of a record and then does the same with those that follow, you have to be content with more or less "potted" versions of some of the big things in music. The knockout blow to the suggestions of those who wanted photo-electric records by the reel seemed, for the moment at any rate, to have been given by the writer of a letter who pointed out the comparatively enormous cost of several hundred feet of celluloid sound film. But there were many of us who thought that the time must come when something as effective as celluloid, but far less costly, would come.

In the Right Direction

As come it has, for now we have the Duo-Trac process, utilising something that looks very like the familiar cellophane. I'm not going to express any opinion about the performances of Duo-Trac machines, for the very good reason that I haven't yet been able to hear one of them at work. But there must clearly be an absence of needle scratch, since there is no needle, and it is claimed that background noises are at a very low level. It is also stated that the frequency range is greater than that obtainable with the wax disc. Be these things as they may, the introduction of small reels that give fifteen minutes' playing followed by an automatic reversal, and then a further fifteen minutes from the second track, and of large reels which provide a full hour's music, is a step in the right direction. I haven't the least doubt that the future of recorded music is closely bound up with that of the photo-electric cell. Doubtless there'll be big developments on these lines before much water has flowed beneath the bridges.



BRAVING THE ELEMENTS. German commentators, even in bad weather, can fearlessly go about their tasks at open-air events when using this waterproof-covered microphone.

A DC/AC Converter Query

WILL any of those who run AC mains sets from small private lighting plants by means of DC/AC converters give us the benefit of their experiences? Though I have come across several people who work radio receivers in this way, all have proved not delightfully but exasperatingly vague when you try to get some facts out of them. Some say airily: "Wonderful scheme. Get top-hole reception. Doesn't cost me a bean"; others hint (but don't get much beyond the hinting stage) at the dimming of lights when the radio set is switched on and mutter darkly about the extra hours of charging that have to be done—though they won't say how many. I don't see why the DC/AC converter shouldn't be perfectly satisfactory with a lighting plant that is well up to its work; but there are plants which have already just about as much as they can do to keep the lights going, and if a converter is operated from one of them it may prove a rather expensive luxury.

Off Company's Mains

The converter run off company's DC mains is, of course, quite another story. The voltage then is usually between 100 and 250, and the extra load is neither here nor there. I'm not at all sure that the best solution of the problems facing those who are still on DC is not to work AC sets by means of a converter of some kind; it is so extraordinarily difficult to ensure on DC good short-wave results with an "all-wave" set designed on standard lines. Two firms at any rate, Philips and R.G.D., utilise built-in converters in their AC/DC sets. I shouldn't be surprised to see a good many others following suit in the near future. From some DC supplies the current is so rough that it may be described as permanently waved!

A Caution

BEFORE you invest in one of the midget AC/DC sets of foreign origin that are offered every now and then at almost incredibly low prices it is just as well to bear in mind that old slogan "Safety first." In some of them the entire chassis is "live" when the set is used on DC, and the chassis includes condenser and other spindles. Not long ago the owner of a brand-new house served by DC mains showed me with some pride his bathroom, whose fittings included a set of this kind. "Neat little thing; takes up no room at all, and you can hear almost anything you want to," he told me. He was rather taken aback when I pointed to a grub-screw whose head was only just countersunk in the tuning knob, and mentioned (a) that it was "live," and (b) that the resistance of the human body during or just after a hot bath is astonishingly low. The AC/DC set, if it is to be safe, can't just be thrown together anyhow. It must be well designed and well made—and you can't expect either of these things at a given-away-with-a-pound-of-tea price.

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"Degeneration"—

You could take an amplifier with an appalling characteristic curve, all peaks and hollows, and by degenerating as described convert it into a nearly perfect straight-line amplifier. You will no doubt be remarking, "Yes, but if it doesn't amplify . . . !" In practice, of course, one does *not* take an amplifier with an appalling characteristic curve. But when a very high standard of uniformity is wanted one ordinarily has to observe great precautions in design. The transformers, if used, are very massive and costly. The step-up ratio is small, in order to avoid loss at top frequencies due to stray capacity. The valves, too, must have a low internal resistance and hence low amplification. So more stages must be used. Resistance coupling, as an alternative, also demands many stages if extreme uniformity is to be obtained. Negative feed-back offers the option of putting together an amplifier of very high gain (which can be done quite cheaply) and then using some of the surplus amplification to straighten out the characteristic curve.

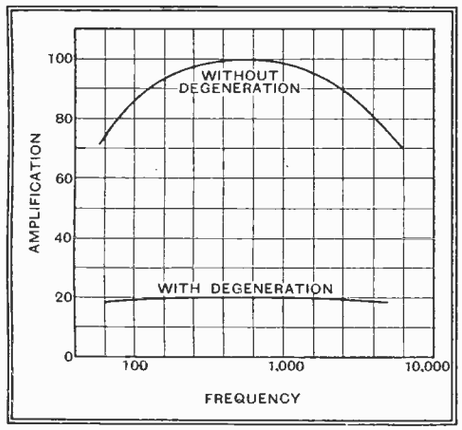


Fig. 2.—Typical example of how a rather bad amplification characteristic can be improved. The loss in amplification can easily be made good without reintroducing more than a fraction of the distortion originally present.

It does a great deal beside. We have been thinking of *frequency distortion*, which is perhaps the least objectionable form of distortion unless it is very grossly indulged in. But there is harmonic distortion, which consists in the introduction of tones that were not present in the original. A certain amount of it is inevitable with valves. Then there is noise, also (we assume) not present in the original. And there is a certain amount of variability in results if the supply voltages for the amplifier are not steady, and this may be a point to consider in some cases. *All* of these defects are reduced by negative feed-back, in the same ratio as the reduction in amplification. As we have followed the action pretty closely in the case of frequency distortion it should be quite easy to see how this comes about.

Reducing Harmonic Distortion

To choose figures that might conceivably apply in a practical case, suppose an output of 100 volts is required, and that owing to restrictions in design, or a desire to economise, the harmonic distortion reaches the rather serious figure of 10 per cent. In addition to the faithfully amplified programme, there would be 10 volts of harmonics present in the output. Now apply degeneration to bring the amplification down to one tenth. It is necessary to increase the gain of the earlier stages correspondingly to make good this drop, but as the signal level in the amplifier then remains the same as before there is no corresponding increase in harmonics generated. On the contrary, the harmonics have been reduced by the degeneration process to 1 volt, and therefore constitute only 1 per cent. of the output—an extremely satisfactory figure.

And so for the other things. And I haven't even mentioned one of the main objects of negative feed-back in *The Wireless World* amplifier referred to — the reduction in the effective resistance of the output valve; a great advantage if the pentode must be used. That effect has already been fully dealt with, and I just remind readers that negative feed-back does not necessarily *reduce* the resistance; it depends on the circuit used. Another important point: The feed-back circuit itself must not cause distortion; but it is generally much easier to ensure that than to avoid distortion in an amplifier.

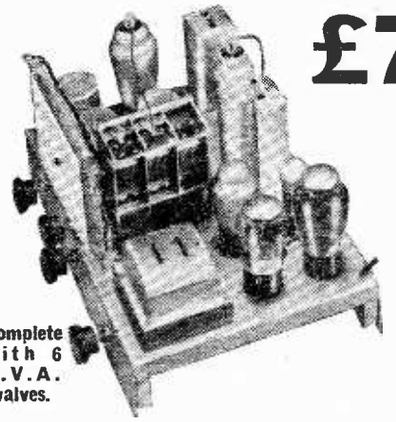
All these benefits sound very good. Now for the snags. There is, of course, the fact that increased gain is needed to make up for that thrown away. Nowadays that is not usually so very difficult, and it is a poor business if the increase in distortion due thereto is not considerably less than the increase in amplification, considering that the signal level is unchanged. The more serious snag lies in the fact that at certain frequencies the output may not synchronise with the input. You connect the feed-back line so that it opposes the input—maximum positive synchronising with maximum negative, and so on—but at a much higher or lower frequency the phase may be right out of step, so that you get *positive* feed-back at that frequency, with greatly increased amplification and perhaps even oscillation! This phase-shift is particularly likely to occur in amplifiers that one most desires to improve by negative feed-back, and if on the other hand the phase-shift is small the amplifier is probably very good in other respects! That seems to defeat the purpose of the scheme entirely.

But not quite. Provided that the phase-shift does not exceed certain fairly wide limits the effect of negative feed-back is to pull it into step, thus reducing even this, the only remaining form of distortion.

So far as broadcast reception is concerned, the application of negative feed-back to enable good reproduction to be obtained from pentodes, as in the *Wireless World* design, is perhaps the most useful.

McCARTHY

new series better than ever —no increase in prices!



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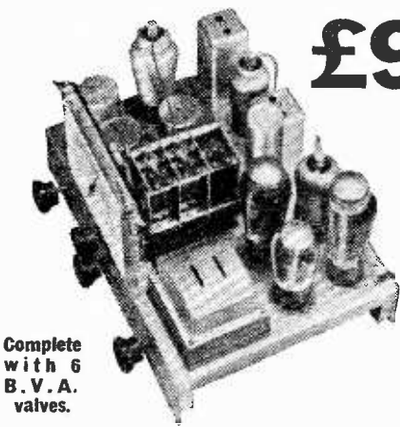

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"DEGENERATION"

By "CATHODE RAY"

Improving Quality by Reversed AF Reaction

NO, this is not going to be a lament over the present-day deterioration in tone of radio (in whatever sense you may care to take that); on the contrary, it refers to a method for reducing distortion. As a technical term *degeneration* may therefore appear to be even more inappropriate than the majority of those we have to employ; and that is saying a good deal.

The Americans—who dictate our terminology in this field—are not entirely devoid of logic in this case, however. What is called *reaction* by you and me, and *retroaction* by a select group of highbrows, is in America termed *regeneration*. All these words refer to the use of some of the output of an amplifier to boost the original weak signal at the input. This may be a very useful way of increasing the amplification, and is still employed in many of the simpler types of receiver as a substitute for extra valve amplifying stages. As everybody knows, the usefulness of this device to everybody concerned comes to an abrupt end when so much power is fed back that the system generates oscillations quite independently of assistance from the incoming signal. The utility of the opposite process—back-coupling the amplifier so that it tends to quench itself—is less obvious, but as a name for it *degeneration* seems quite natural as the opposite to *regeneration* (c.f., *deform* with *reform*).

Its application is to the part of the receiver where *regeneration* is undesirable—the low- or audio-frequency portion. The reason why it is undesirable is that it tends to strengthen amplification where it already is greatest, whereas one generally wants amplification to be as uniform as possible over all audible frequencies. Arguing backwards from this, one might expect degeneration to reduce amplification where it was greatest, so improving the uniformity or "straight line" nature of its characteristic. But as in radio things comparatively seldom turn out as one expects it is advisable to consider the thing a little more closely before running away with a conclusion.

In passing, I would mention that the term *degeneration* has obvious objections, for instance, when drawing up the list of selling points of a receiver, where it might merely convey to the public an impression that truth in advertising had at last arrived. It may even offend the susceptibilities of the technically minded, so at the expense of some terseness one may describe the device as *negative feed-back* or *reverse feed-back*.

The results of the system and how they can be realised have already been explained in *The Wireless World* (November 6th, 1936), but there may be some readers who are not quite clear *how* negative feed-back produces the results named (and others unnamed).

Suppose the box in Fig. 1 contains an amplifier. When a signal of 1 volt is applied to the input terminals, 100 volts (say) appears at the output. The voltage amplification is 100. Next, suppose that across the output terminals is a potential-divider (the potentiometer of commerce) wherewith one-hundredth of the total, *i.e.*, 1 volt, can be taken and fed to the other end in series with the signal. There are two ways in which the wires may be connected; of these we select the way that makes the two voltages oppose one another. The amplifier is assumed to be perfect, so that the feed-back volt is an exact replica of the original, and therefore cancels it out completely. For a fraction of a second you may suppose that as the voltage applied to the input terminals of the amplifier has thus been exactly neutralised there is now no signal, and amplification has been reduced to zero. But it is obvious that if it were so the neutralising volt would also be reduced to zero and things would be back where they were at the beginning! Something in between these two extremes must actually happen. Making an inspired guess, suppose that the amplification is cut down to a half so that 50 volts appears at the output, and hence half a volt is fed back. The input to produce 50 volts must also be half a volt, which by a stroke of luck it happens to be—the original signal, 1 volt, less half a volt fed back.

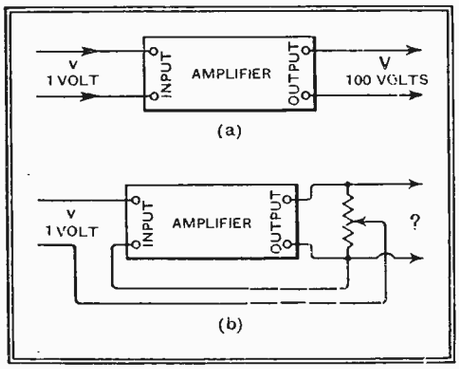

Fig. 1 (a) A straightforward amplifier. (b) The same, with the addition of degeneration. What happens is described in the text.

If the potential-divider is set so as to feed back a different proportion the calculation is not quite so easy, though it is within the reach of the most elementary algebra. While it is not essential to what I am going to say, I would mention that if v is the signal voltage, A the voltage amplification of the amplifier (without feed-back), B the "amplification" of the *negative* feed-back circuit (in the above case it would be $\frac{1}{100}$ or 0.01; if the whole of the output were fed back it would be 1), and V the output voltage, then $V=\frac{Av}{1+AB}$. $\frac{V}{v}$ is, of course, the effective amplification with feed-back (call it A1), so $A1=\frac{A}{1+AB}$. Take the example just considered, in which A is 100. Then if B is nil, A1 = A (obviously). But if B is 0.01, A1 = $\frac{1}{2}$A, as we found. Increase the feed-back nine-fold, so that B is 0.09 and A1 = $\frac{1}{10}$A.

In words, if nine volts are fed back for every volt of original signal, the amplification is cut down to one-tenth, and the fed-back voltage thereby reduced to nine-tenths of a volt, which, when deducted from the original one volt signal, leaves a small balance to be amplified. On the same principle, feeding back 99 times the input would cut the amplification down to 1/100th, so with the amplifier of our example the final output, so far as voltage is concerned, would be no greater than the input. That may seem to be going to extremes, but it should be remembered that the voltage used to work a low-impedance loud speaker may be no greater than that at the input of the amplifier. The *power* is enormously greater, however.

Now suppose that owing to poor design or the inevitable limitations of components the amplification over the whole audible scale of frequencies is not uniform at 100, but falls, say, to 50 at the extreme bass and treble. When a signal of 1 volt is applied at these frequencies, the output would ordinarily be only a half of that at the intermediate frequencies. But when extensive feed-back is employed, the voltage fed back is also only a half, and the amplification-destroying effect thereof is only about a half, so the final output is practically the same as that at the more-favoured frequencies. If you have any doubt about this, work it out:—

	Mid-scale frequencies	Extreme frequencies
Input signal (v) ...	1 volt	1 volt
Amplification without feed-back (A) ...	100	50
Output without feed-back (vA)	100 volts	50 volts (i.e., 50% loss)
Proportion fed back (B)	0.99	0.99
Amplification with feed-back $\left(\frac{A}{1+AB}\right)$ or A1 ...	1	0.99
Output $vA1$ ...	1 volt	0.99 volt (i.e., 1% loss)

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Station.	kc/s.	Tuning Positions.	Metres.	kW.
Swedish Relay Stations	1312	.....	228.7	—
Magyarovar (Hungary)	1321	.....	227.1	1.25
German Relay Stations	1330	.....	225.6	—
Montpellier, P.T.T. (France)	1339	.....	224	1.2
Lodz (Poland)	1339	.....	224	2
Dublin (Irish Free State)	1348	.....	222.6	0.5
Rjukan (Norway)	1348	.....	222.6	0.15
Salzburg (Austria)	1348	.....	222.6	2
Tampere (Finland)	1348	.....	222.6	0.7
Cairo No. 2 (Egypt)	1348	.....	222.6	0.5
Königsberg (Germany)	1348	.....	222.6	2
Nottoden (Norway)	1357	.....	221.1	0.15
Italian Relay Stations	1357	.....	221.1	—
Warsaw, No. 2 (Poland)	1366	.....	220	2
L'Ile de France (France)	1366	.....	219.6	0.7
Basle (Switzerland)	1375	.....	218.2	0.5
Berne (Switzerland)	1375	.....	218.2	0.5
Lyons (Radio Lyons) (France)	1393	.....	215.4	25
Stara-Zagora (Bulgaria)	1402	.....	214	2
Vaasa-Vasa (Finland)	1420	.....	211.3	0.5
Alexandria, No. 2 (Egypt)	1429	.....	209.9	0.5
Turku (Finland)	1429	.....	209.9	0.5
Miskolc (Hungary)	1438	.....	208.6	1.25
Paris (Eiffel Tower) (France)	1456	.....	206	5
Pecs (Hungary)	1465	.....	204.8	1.25
Belgian Relay Stations	1465	.....	204.8	0.1
Bournemouth	1474	.....	203.5	1
Plymouth	1474	.....	203.5	0.3
Binche (Belgium)	1487	.....	201.7	0.1
Belgian Relay Stations	1492	.....	201.1	0.1
Nimes (France)	1492	.....	201.1	0.7
Albacete (Spain)	1492	.....	201.1	0.2
Santiago (Spain)	1492	.....	201.1	0.5
Belgian Relay Stations	1500	.....	200	0.1
Pietarsaari (Finland)	1500	.....	200	0.25
Radio Alcalá (Spain)	1500	.....	200	0.2
Karlskrona (Sweden)	1530	.....	196	0.2
Liepàja (Latvia)	1734	.....	173	0.1

SHORT-WAVE STATIONS OF THE WORLD

Station.	Call Sign.	kc/s.	Tuning Positions.	Metres.	kW.
Batavia (Java)	YDA	3,040	.....	98.68	10
Ponta Delgada (Azores)	CT2AJ	4,000	.....	75.00	0.05
Kharbarovsk (Russia)	RV15	4,273	.....	70.20	20
Caracas (Venezuela)	YV5RC	5,800	.....	51.72	1
San Jose (Costa Rica)	TIGPH	5,820	.....	51.52	—
Maracaibo (Venezuela)	YV5RMO	5,850	.....	51.28	—
Vatican City (Vatican State)	HVJ	5,970	.....	50.26	10
Trujillo (Domenica)	HIX	5,980	.....	50.16	0.2
Mexico City (Mexico)	XEBT	6,000	.....	50.00	1
Moscow (Russia)	RW59	6,000	.....	50.00	20
Montreal (Canada)	CFCX	6,005	.....	49.96	—
Havana (Cuba)	COCO	6,010	.....	49.92	0.5
Prague (Podebrady) (Czechoslovakia)	OLR	6,010	.....	49.92	30
Singapore (Malaya)	ZHI	6,018	.....	49.85	0.09
Bogota (Colombia)	HJ3ABH	6,018	.....	49.85	1.6
Zeesen (Germany)	**DJC**	6,020	.....	49.83	50
Panama City (Panama)	HP5B	6,030	.....	49.75	0.1
Calgary (Canada)	VE9CA	6,030	.....	49.75	0.1
Boston (U.S.A.)	W1XAL	6,040	.....	49.67	10
Miami (U.S.A.)	W4XB	6,040	.....	49.67	2.5
Barranquilla (Colombia)	HJ1ABG	6,042	.....	49.65	0.15
Daventry (Gt. Britain)	GSA	6,050	.....	49.59	15
Cincinnati (U.S.A.)	W8XAL	6,060	.....	49.50	10
Philadelphia (U.S.A.)	W3XAU	6,060	.....	49.59	10
Skamleback (Denmark)	OXY	6,060	.....	49.50	0.5
Manizales (Colombia)	HJ4ABL	6,070	.....	49.45	0.15
Penang (Malaya)	ZHJ	6,080	.....	49.34	0.05
Chicago (U.S.A.)	W9XAA	6,080	.....	49.34	0.5
Nairobi (Kenya)	VQ7LO	6,083	.....	49.31	0.5
Bowmanville (Canada)	CRCX	6,090	.....	49.26	0.5
Hong Kong (China)	ZBW2	6,090	.....	49.26	2
Johannesburg (South Africa)	ZTJ	6,100	.....	49.20	5
Bound Brook (U.S.A.)	W3XAL	6,100	.....	49.18	35
Chicago (U.S.A.)	W9XF	6,100	.....	49.18	10
Belgrade (Yugoslavia)	.....	6,100	.....	49.18	1
Manizales (Colombia)	HJ4ABB	6,105	.....	49.15	0.3
Daventry (Gt. Britain)	GSL	6,110	.....	49.10	15
Calcutta (India)	VUC	6,110	.....	49.10	0.5
Wayne (U.S.A.)	W2XE	6,120	.....	49.02	1
Havana (Cuba)	COCD	6,130	.....	48.92	0.25
Halifax (Canada)	VE9HX	6,130	.....	48.92	0.2
Pittsburgh (U.S.A.)	W8XK	6,140	.....	48.86	40
Winnipeg (Canada)	CJRO	6,150	.....	48.78	2
Lisbon (Portugal)	CSL	6,150	.....	48.78	0.50
Caracas (Venezuela)	YV5RC	6,150	.....	48.78	—
Parede (Portugal)	CT1GO	6,200	.....	48.40	5
Trujillo (Domenica)	HIZ	6,320	.....	47.50	—
Caracas (Venezuela)	YV5RC	6,375	.....	47.04	0.3
San Jose (Costa Rica)	TIPG	6,410	.....	46.80	0.5
Barranquilla (Colombia)	HJ1ABB	6,450	.....	46.52	1
Valencia (Colombia)	YV6RV	6,520	.....	46.00	0.5
Riobamba (Ecuador)	PRADO	6,620	.....	45.31	—
Guayaquil (Ecuador)	HC2RL	6,670	.....	45.00	0.2
Amateurs	.....	7,000 to 7.300	.....	42.86 to 41.10	0.01
Moscow (U.S.S.R.)	RV96	7,520	.....	38.89	25
Prangins (Radio-Nations) (Switz'Id)	HBP	7,780	.....	38.48	20
Quito (Ecuador)	HCJB	8,210	.....	36.50	0.25
Budapest (Hungary)	HAT4	9,125	.....	32.88	5
Havana (Cuba)	COCH	9,430	.....	31.80	0.15
Rio de Janeiro (Brazil)	PRF5	9,500	.....	31.58	5
Daventry (Gt. Britain)	GSB	9,510	.....	31.55	15
Melbourne (Australia)	VK3ME	9,510	.....	31.55	1.5
Hongkong (China)	ZBW3	9,520	.....	31.49	2
Jelöy (Norway)	LKJ1	9,520	.....	31.49	1.5
Schenectady (U.S.A.)	W2XAF	9,530	.....	31.48	30
Tokio (Japan)	**JZI**	9,530	.....	31.48	50
Zeesen (Germany)	**DJN**	9,540	.....	31.45	50
Suva (Fiji)	VPD2	9,542	.....	31.45	—
Zeesen (Germany)	**DJA**	9,560	.....	31.38	50
Bombay (India)	VUB	9,565	.....	31.36	4.5
Millis (U.S.A.)	W1XK	9,570	.....	31.35	10
Daventry (Gt. Britain)	GSC	9,580	.....	31.32	15
Lyndhurst (Australia)	VK3LR	9,580	.....	31.32	1
Philadelphia (U.S.A.)	W3XAU	9,590	.....	31.28	10
Sydney (Australia)	VK2ME	9,590	.....	31.28	20
Eindhoven (Holland)	PCJ	9,590	.....	31.28	20
Prangins (Radio-Nations) (Switz'Id)	HBL	9,595	.....	31.27	20
Moscow (Russia)	RAN	9,600	.....	31.25	20
Rome (Italy)	2RO	9,635	.....	31.13	25
Sourabaya (Java)	YDB	9,650	.....	31.09	1
Lisbon (Portugal)	CT1AA	9,655	.....	31.09	2
Buenos Aires (Argentina)	LRX	9,660	.....	31.06	5
Lisbon (Portugal)	CT1CT	9,680	.....	31.00	0.5
Madrid (Spain)	EAQ	9,860	.....	30.43	20
Bandoeng (Java)	PMN	10,260	.....	29.24	3
Ruysselede (Belgium)	ORK	10,330	.....	29.04	9
Bandoeng (Java)	PLP	11,010	.....	27.25	3
Stockholm (Sweden)	SM5SX	11,700	.....	25.63	0.5
Winnipeg (Canada)	CJRX	11,720	.....	25.60	2
Paris (Radio-Colonial) (France)	TPA4	11,720	.....	25.60	12
Daventry (Gt. Britain)	GSD	11,750	.....	25.53	15
Prague (Podebrady) (Czechoslovakia)	OLR	11,760	.....	25.51	30
Zeesen (Germany)	DJD	11,770	.....	25.49	50
Boston (U.S.A.)	W1XAL	11,790	.....	25.45	10
Vienna (Austria)	OER2	11,800	.....	25.42	1.5
Rome (Italy)	2RO	11,810	.....	25.40	25
Daventry (Gt. Britain)	GSN	11,820	.....	25.38	15
Wayne (U.S.A.)	W2XE	11,830	.....	25.36	1
Lisbon (Portugal)	CT1AA	11,830	.....	25.36	2
Daventry (Gt. Britain)	GSE	11,860	.....	25.29	15
Pittsburgh (U.S.A.)	W8XK	11,870	.....	25.27	40
Paris (Radio-Colonial) (France)	TPA3	11,880	.....	25.23	12
Moscow (Russia)	RNE	12,000	.....	25.00	20
Lisbon (Portugal)	CT1CT	12,082	.....	24.83	0.5
Reykjavik (Iceland)	TFJ	12,235	.....	24.52	7.5
Parede (Portugal)	CT1GO	12,400	.....	24.20	0.35
Warsaw (Poland)	SPW	13,635	.....	22.00	10
Amateurs	.....	14,000 to 14,400	.....	21.42 to 20.84	0.01
Sofia (Bulgaria)	LZA	14.970	.....	20.04	1.5
Zeesen (Germany)	**DJL**	15,111	.....	19.85	50
Vatican City (Vatican State)	HVJ	15.123	.....	19.84	10
Daventry (Gt. Britain)	GSF	15,140	.....	19.82	10
Daventry (Gt. Britain)	GSO	15,180	.....	19.76	10
Hongkong (China)	ZBW4	15,190	.....	19.75	2
Zeesen (Germany)	**DJB**	15,200	.....	19.74	50
Pittsburgh (U.S.A.)	W8XK	15,210	.....	19.72	40
Eindhoven (Holland)	PCJ	15,220	.....	19.71	20
Prague (Podebrady) (Czechoslovakia)	OLR	15,230	.....	19.69	30
Paris (Radio-Colonial) (France)	TPA2	15,243	.....	19.68	12
Daventry (Gt. Britain)	GSI	15,260	.....	19.66	10
Wayne (U.S.A.)	W2XE	15,270	.....	19.65	1
Zeesen (Germany)	**DJQ**	15,280	.....	19.63	50
Buenos Aires (Argentina)	LRU	15,290	.....	19.62	5
Daventry (Gt. Britain)	GSP	15,310	.....	19.60	10
Schenectady (U.S.A.)	W2XAD	15,330	.....	19.57	18
Zeesen (Germany)	**DJR**	15,340	.....	19.53	50
Budapest (Szekesfehervar) (Hungary)	HAS3	15,370	.....	19.52	20
Zeesen (Germany)	**DJE**	17,760	.....	16.89	50
Wayne (U.S.A.)	W2XE	17,760	.....	16.89	1
Bound Brook (U.S.A.)	W3XAL	17,780	.....	16.87	35
Daventry (Gt. Britain)	GSG	17,790	.....	16.86	10
Bandoeng (Java)	**PLE**	18,830	.....	15.93	60
Daventry (Gt. Britain)	GSH	21,470	.....	13.97	10
Wayne (U.S.A.)	W2XE	21,520	.....	13.94	1
Daventry (Gt. Britain)	GSJ	21,530	.....	13.93	10
Pittsburgh (U.S.A.)	W8XK	21,540	.....	13.93	40

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PRINCIPAL BROADCASTING STATIONS OF EUROPE

Arranged in Order of Frequency and Wavelength

(This list is included in the first issue of each month. Stations with an Aerial Power of 50 kW. and above in heavy type)

Station.	kc/s.	Tuning Positions.	Metres.	kW.
Ankara (Turkey)	153	.....	1961	5
Kaunas (Lithuania)	153	.....	1961	7
Radio Romania (Brasov) Romania	160	.....	1875	150
Hilversum No. 1 (Holland) (10 *kW.* till 1440)	160	.....	1875	150
Lahti (Finland)	166	.....	1807	150
Moscow, No. 1, RW1 (Komintern) (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
Droitwich	200	.....	1500	150
Minsk, RW10 (U.S.S.R.)	208	.....	1442	35
Reykjavik (Iceland)	208	.....	1442	16
Motala (Sweden)	216	.....	1389	150
Novosibirsk. RW76 (U.S.S.R.)	217.5	.....	1379	100
Warsaw, No. 1 (Poland)	224	.....	1339	120
Luxembourg	232	.....	1293	150
Leningrad, No. 1 RW53 (Kolpino) (U.S.S.R.)	232	.....	1293	100
Kalundborg (Denmark)	240	.....	1250	60
Vienna, No. 2 (Austria)	240	.....	1250	0.5
Kiev No. 1 (U.S.S.R.)	248	.....	1209.6	100
Vigra (Aalesund) (Norway)	253	.....	1186	10
Tashkent, RW11 (U.S.S.R.)	256.4	.....	1170	25
Oslo (Norway)	260	.....	1153.8	60
Moscow, No. 2, RW49 (Stchelkovo) (U.S.S.R.)	271	.....	1107	100
Tromsö (Norway)	282	.....	1065	10
Tiflis, RW7 (U.S.S.R.)	283	.....	1060	35
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. RW12 (U.S.S.R.)	355	.....	845.1	20
Budapest, No. 2 (Hungary)	359.5	.....	834.5	18
Sverdlovsk. RW5 (U.S.S.R.)	375	.....	800	40
Voronejc, RW25 (U.S.S.R.)	390	.....	769	10
Boden (Sweden)	392	.....	765	0.6
Banska-Bystrica (Czechoslovakia) (15 *kW.* after 1700)	392	.....	765	30
Geneva (Switzerland)	401	.....	748	1.3
Moscow, No. 3 (RCZ) (U.S.S.R.)	413.5	.....	726	100
Ostersund (Sweden)	413.5	.....	726	0.6
Oulu (Finland)	431	.....	696	10
Hamar (Norway)	519	.....	578	0.7
Innsbruck (Austria)	519	.....	578	1
Tartu (Estonia)	522	.....	575	0.5
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
Athlone (Irish Free State)	565	.....	531	100
Klaipeda (Lithuania)	565	.....	531	10
Palermo (Italy)	565	.....	531	3
Stuttgart (Germany)	574	.....	522.6	100
Alpes-Grenoble, P.T.T. (France)	583	.....	514.6	15
Madona (Latvia)	583	.....	514.6	59
Vienna No. 1 (Austria)	592	.....	506.8	100
Rabat (Morocco)	601	.....	499.2	25
Sundsvall (Sweden)	601	.....	499.2	10
Florence (Italy)	610	.....	491.8	20
Cairo, No. 1 (Egypt)	620	.....	483.9	20
Brussels, No. 1 (Belgium)	620	.....	483.9	15
Lisbon (Portugal)	629	.....	476.9	15
Tröndelag (Norway)	629	.....	476.9	20
Christiansand (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
North Regional (Slaithwaite)	668	.....	449.1	70
Jerusalem (Palestine)	668	.....	449.1	20
Sottens (Switzerland)	677	.....	443.1	100
Belgrade (Yugoslavia)	686	.....	437.3	2.5
Paris. P.T.T. (France)	695	.....	431.7	120
Stockholm (Sweden)	704	.....	426.1	55
Rome, No. 1 (Italy)	713	.....	420.8	50
Kharkov. No. 1, RW20 (U.S.S.R.)	722	.....	415.4	10
Fredrikstad (Norway)	722	.....	415.4	1
Tallinn (Estonia)	731	.....	410.4	20
Madrid, EAJ2 (Spain)	731	.....	410.4	3
Seville (Spain)	731	.....	410.4	5.5
Munich (Germany)	740	.....	405.4	100
Marseilles, P.T.T. (France)	749	.....	400.5	90
Pori (Finland)	749	.....	400.5	1
Katowice (Poland)	758	.....	395.8	12
Scottish Regional (Falkirk)	767	.....	391.1	70
North Scottish Regional (Burghead)	767	.....	391.1	60
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
Lwow (Poland)	795	.....	377.4	50
North Welsh Regional (Penmon)	804	.....	373.1	5
West Regional (Washford Cross)	804	.....	373.1	70
Milan, No. 1 (Italy)	814	.....	368.6	50
Bucharest (Romania)	823	.....	364.5	12
Kiev No. 2, RW9 (U.S.S.R.)	832	.....	360.6	35
Agen (France)	832	.....	360.6	0.5
Berlin (Germany)	841	.....	356.7	100
Norwegian Relay Stations	850	.....	352.9	—
Sofia (Bulgaria)	850	.....	352.9	1
Valencia (Spain)	850	.....	352.9	3
Simferopol, RW52 (U.S.S.R.)	859	.....	349.2	10
Strasbourg (France)	859	.....	349.2	100
Poznan (Poland)	868	.....	345.6	16
London Regional (Brookmans Park)	877	.....	342.1	70
Linz (Austria)	886	.....	338.6	15
Graz (Austria)	886	.....	338.6	15
Helsinki (Finland)	895	.....	335.2	10
Limoges, P.T.T. (France)	895	.....	335.2	1.5
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
Bordeaux-Sud-Ouest (France)	968	.....	309.9	30
Odessa (U.S.S.R.)	968	.....	309.9	10
Northern Ireland Regional (Lisburn)	977	.....	307.1	100
Genoa (Italy)	986	.....	304.3	10
Torun (Poland)	986	.....	304.3	24
Hilversum No. 2 (Holland). (15 *kW.* till 1540)	995	.....	301.5	60
Bratislava (Czechoslovakia)	1004	.....	298.8	13.5
Midland Regional (Droitwich)	1013	.....	296.2	70
Chernigov (U.S.S.R.)	1013	.....	296.2	4
Barcelona, EAJ15 (Spain)	1022	.....	293.5	3
Cracow (Poland)	1022	.....	293.5	2
Oviedo (Spain)	1022	.....	293.5	0.7
Königsberg No. 1 (Heilsberg) (Germany)	1031	.....	291	100
Parede (Portugal)	1031	.....	291	5
Leningrad. No. 2, RW70 (U.S.S.R.)	1040	.....	288.5	10
Rennes-Bretagne (France)	1040	.....	288.5	120
Scottish National (Falkirk)	1050	.....	285.7	50
Bari No. 1 (Italy)	1059	.....	283.3	20
Paris (Radio Cité) (France)	1068	.....	280.9	0.8
Tiraspol, RW57 (U.S.S.R.)	1068	.....	280.9	10
Bordeaux-Lafayette (France)	1077	.....	278.6	12
Zagreb (Yugoslavia)	1086	.....	276.2	0.7
Falun (Sweden)	1086	.....	276.2	2
Madrid, EAJ7 (Spain)	1095	.....	274	5
Vinnitsa (U.S.S.R.)	1095	.....	274	10
Kuldiga (Latvia)	1104	.....	271.7	50
Naples (Italy)	1104	.....	271.7	1.5
Moravska-Ostrava (Czechoslovakia)	1113	.....	269.5	11.2
Radio Normandie (Fécamp) (France)	1113	.....	269.5	10
Alexandria, No. 1 (Egypt)	1122	.....	267.4	0.25
Newcastle	1122	.....	267.4	1
Nyiregyhaza (Hungary)	1122	.....	267.4	6.25
Hörby (Sweden)	1131	.....	265.3	10
Turin. No. 1 (Italy)	1140	.....	263.2	7
Trieste (Italy)	1140	.....	263.2	10
London National (Brookmans Park)	1149	.....	261.1	20
North National (Slaithwaite)	1149	.....	261.1	20
West National (Washford Cross)	1149	.....	261.1	20
Kosice (Czechoslovakia)	1158	.....	259.1	10
Monte Ceneri (Switzerland)	1167	.....	257.1	15
Copenhagen (Denmark)	1176	.....	255.1	10
Nice-Corse (France)	1185	.....	253.2	60
Frankfurt (*and Relays*) (Germany)	1195	.....	251	25
Prague. No. 2 (Czechoslovakia)	1204	.....	249.2	5
Lille, P.T.T. (France)	1213	.....	247.3	60
Bologna (Radio Marconi) (Italy)	1222	.....	245.5	50
Gleiwitz (Germany)	1231	.....	243.7	5
Cork (Irish Free State)	1235	.....	242.9	1
Saarbrücken (Germany)	1249	.....	240.2	17
Riga (Latvia)	1258	.....	238.5	10
Rome, No. 3 (Italy)	1258	.....	238.5	1
San Sebastian, EAJ8 (Spain)	1258	.....	238.5	1
Nürnberg (Germany)	1267	.....	236.8	2
Juan-les-Pins (Radio Côte d'Azur) (France)	1276	.....	235.1	27
Dresden (Germany)	1285	.....	233.5	0.25
Aberdeen	1285	.....	233.5	1
Klagenfurt (Austria)	1294	.....	231.8	5
Vorarlberg (Austria)	1294	.....	231.8	5
Danzig	1303	.....	230.2	0.5

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The Television Receiver—

give a 2.0 Mc/s interference pattern on the screen. This is not likely to be of importance in comparison with the fundamental beat.

There are further possibilities of interference, however. As both sound and vision signals will reach the frequency-changer it will give two outputs, one for each. The sound intermediate frequency will be *higher* than the vision intermediate frequency when the oscillator is higher in frequency than the vision signal. In addition to these there will inevitably be their harmonics. If this were all no difficulty would arise, but as there is always some non-linearity in valves, new frequencies may be formed from the beats between the harmonics. In addition there is always the possibility of trouble due to harmonics of the intermediate frequency in the receiver output being fed back to the input.

The types of interference which may occur are no different from those which are sometimes found in ordinary broadcast superheterodynes, where they cause the familiar superhet whistles. The usual remedies are consequently applicable, but the most effective—a high degree of preselection—is not nearly so easily obtained as in a broadcast set. We have to rely to a greater degree upon the correct choice of intermediate frequency, therefore, and in the writer's opinion it is asking for trouble to chose a frequency equal to the difference between the two stations.

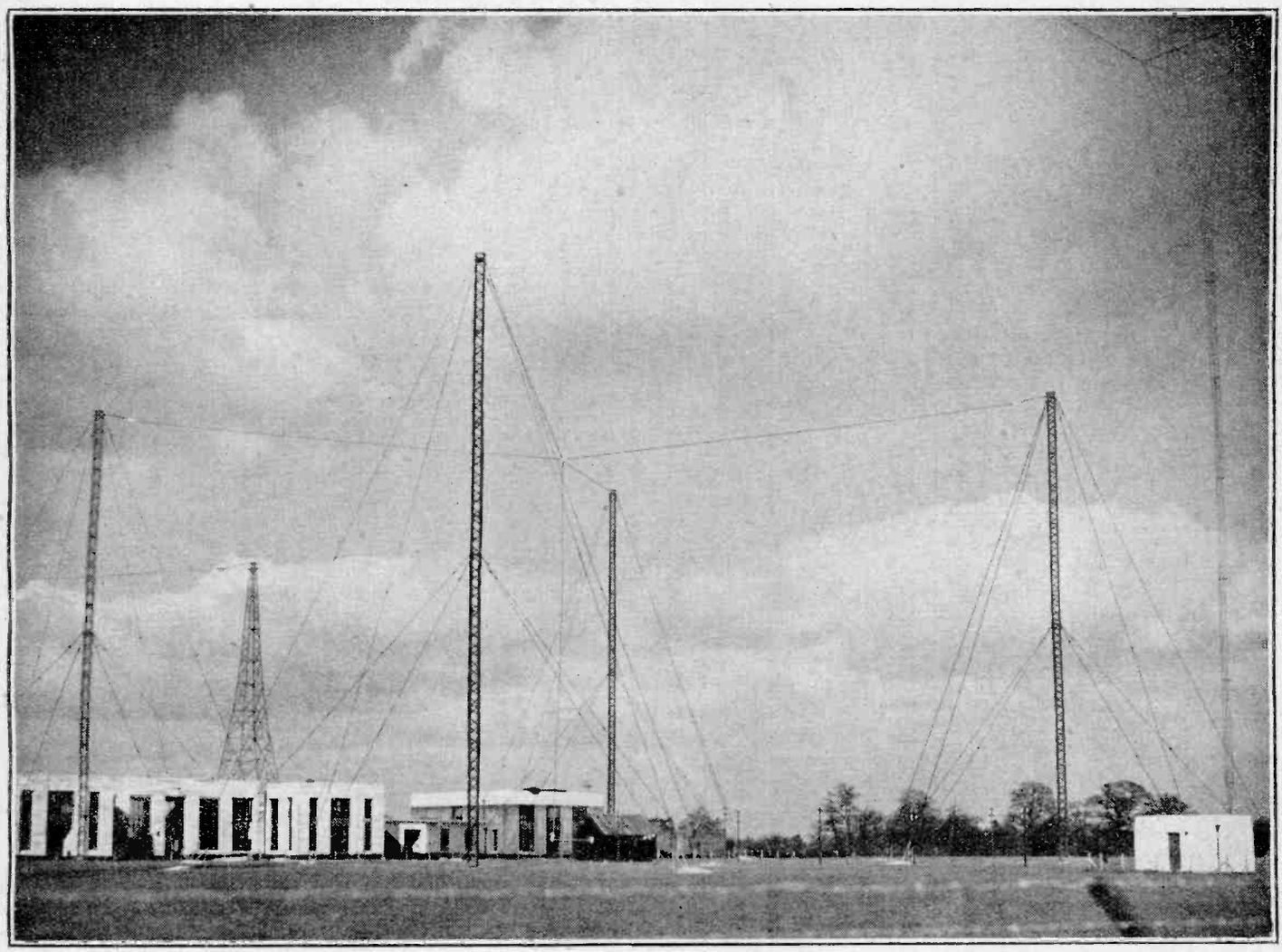
We thus find that we shall be unwise to choose a lower frequency than 5.0 Mc/s. If we work single sideband and use the type of coupling described in this article the stage gain will be about 10.8 times. On the other hand, still adopting single-sideband working, we need a band-width of 2.0 Mc/s only for the coupling of the tuned anode type dealt with in Part III, and for the same drop at the limits of the band we can obtain a stage gain of 16.35 times. Even with double-sideband working, for which a band-width of 4.0 Mc/s is needed, the gain will be just over 8 times per stage.

It is thus clear that the particular type of coupling described here is not as good as the tuned anode unless a low intermediate frequency is adopted; it is then much better, and is really the only type of coupling of much use. In a vision-frequency amplifier, too, it is very important. Unfortunately, as we have seen, it is unwise to adopt a low intermediate frequency.

The Earth's Magnetism. By S. Chapman, M.A., D.Sc., F.R.S. Pp. 116+xii. 35 diagrams. Methuen and Co., Ltd., 36, Essex Street, London, W.C. Price 3s. 6d.

THIS little book contains a summary of the present state of knowledge of the magnetic phenomena which exist on the surface of the earth and of the deductions which can be made as to the nature of the magnetic fields within the earth and in the surrounding atmosphere. Owing to limitations of space the author has been unable to include any mathematical account of the subject or to discuss in detail such kindred subjects as the aurora, earth currents or solar phenomena. The book consists essentially of an analysis of the periodic variations in the earth's magnetic field produced by the sun and the moon. The ionised layers of the upper atmosphere are discussed, not from the point of view of radio research, but with respect to the probability that convection currents in these layers give rise to a gigantic system of electric currents and thereby are responsible for the greater part of the earth's magnetic field. The author hopes to publish in the near future, in collaboration with Professor J. Bartels, a much more extensive and detailed account of the subject.

R. T. B.



AERIAL ACTIVITY. During the one bright day of last week our staff photographer visited the London Transmitter at Brookmans Park where four new masts have changed the scene since his last visit. The masts support an "array" that suggests experiments to improve the directional properties of the Regional aerial in southern areas. Have blind spots improved during this last week?

www.americanradiohistory.com

The Television Receiver—

Quite a good amplifier can be built using a mixture of couplings. An amplifier using five IF valves has six couplings, and by using two having parallel resistance and four having series resistance a nearly symmetrical resonance curve is obtained. The gain per stage is quite reasonable, for a television amplifier, and the couplings are by no means critical.

It is not, however, necessary to retain

An untouched photograph of a picture received on an experimental superheterodyne in "The Wireless World" Laboratory

both sidebands in television reception. It is possible to work with only one sideband by so tuning the receiver that the IF carrier lies at one edge instead of in the middle of the pass-band. One sideband then falls within the pass-band, whereas the other falls on the steeply sloping side of the resonance curve and is greatly attenuated. In this way the necessary width of the pass-band can be halved and the gain per stage doubled.

The main disadvantage of single sideband working is that tuning is somewhat more difficult. Instead of tuning for maximum response in the usual way the receiver must be mistuned by a definite amount. If the mistuning is too great the sensitivity will be inadequate, and the picture may be distorted by "plastic"—that is, it will appear in relief. If the mistuning is not sufficient there will be a loss of definition due to the lack of the higher modulation frequencies. When a low intermediate frequency is used, however, this effect is usually masked by the intermediate frequency itself appearing on the screen in the form of spots. The difficulties of tuning are not, however, really great, and in some cases are well worth the simplification obtainable in the IF amplifier.

The appearance of IF potentials on the screen sets a limit to the lowest intermediate frequency which it is possible to employ satisfactorily. It is difficult to design a satisfactory filter to follow the detector, but when the intermediate frequency is appreciably higher than the highest modulation frequency it is possible to employ a tuned trap circuit. By using a full-wave detector, however, the fundamental IF output of the detector disappears, and only the second harmonic remains. With such a detector it is possible to use an intermediate frequency of one-half the minimum tolerable value with a single detector. Owing to the increased stage gain being accumulative throughout the amplifier, the use of an extra valve for full-wave detection is readily justifiable.

Some experiments carried out by the writer, using an unmodulated carrier and a plain raster, indicate that the IF is barely visible on the screen when the frequency is about 3.5 Mc/s. This is for close inspection of the screen, and at normal viewing distance it would hardly be noticeable. What traces there are can be completely suppressed by a trap circuit in the detector output.

Now, for series resistance type couplings $CR = 226{,}000/f_r$, so that $CR = 75{,}500$ at 3.0 Mc/s. With $C = 25\ \mu\mu F$. and $g = 6.0$ mA./v, $R = 3{,}000$ ohms and A reaches the very respectable figure of 18 per stage. Four such stages will give a gain of 10,400 times, and the frequency-changer is likely to increase this to 18,700 times. Owing to the fact that we have to mistune to the extent of losing 6 db. response, the effective gain will be halved, however, so that it will be equivalent to 9,350 times only with double sideband working. A single RF stage will give a gain of about 6 times, so that we can obtain an effective gain of about 55,000 times from 1 RF, 1 FC, and 4 IF stages. By using a particular circuit, to be described later, it is possible to double this figure without increasing the cost of the receiver. With a total of eight valves in the receiver it is possible to secure a gain of over 100,000 times without difficulty, no part of the equipment being at all critical.

With 4 IF stages there are 5 couplings, and as the response of each at 3.0 Mc/s is -1.2 db. the overall response is -6.0 db., which is what we require. For the moment we can ignore the sideband cutting of the RF circuits.

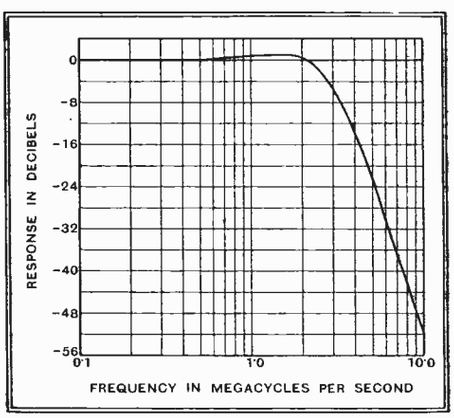


Fig. 11.—In this illustration the response curve for four couplings is shown for a resonance frequency of 3.0 Mc/s.

The values of the inductances necessary for the series resistance coupling are easily calculated from the formula $L = 1/\omega^2 C$. In our case $L = 112\mu H$.

So far we have not considered the values of C1 and R1. Since the input capacity of V2 is about 10 $\mu\mu$F., C1 must not be less than 0.001 μF. if we are not to lose more than 1 per cent. efficiency in this part of the coupling. The value of R1 can be computed according to the ordinary laws governing resistance coupling, and we find that for 2 per cent. loss at 1 Mc/s R1 can be as low as 780 ohms, with $C1 = 0.001\ \mu F$. We cannot, of course, employ such a low value, for its shunting effect upon the preceding part of the circuit will be serious, but any higher value will be satisfactory from the point of view of transferring energy from the anode of one valve to the grid of the next. If the coupling is to remain unaffected by the presence of R1 it must be of the order of 100 times the value of R, or in this case 300,000 ohms. Actually it would be sufficient to employ a standard value component of 0.25 megohm.

Susceptibility to Interference

With four IF stages five couplings are necessary, but, for reasons to be explained later, the detector coupling may have to be different. The calculated response curve for four couplings of the type which we have been considering is shown in Fig. 11, the values of components being $R = 3{,}000$ ohms, $L = 112\ \mu H.$, $C = 25\ \mu\mu F$. As we require the response to be -6.0 db., and with four circuits it is -4.96 db., we shall have to provide additional attenuation of about 1 db. in the remaining coupling. At 3.5 Mc/s off this point, or 6.5 Mc/s, the response is -38.4 db., so that these four circuits discriminate by $38.4 - 4.96 = 33.44$ db. against the sound channel. This arrangement seems so attractive that one at first wonders why any other is considered. There are, however, certain disadvantages which are quite serious in practice. In the first place, an amplifier of this type is very efficient over a wide band of frequencies within a part of which lies the medium-wave broadcast band. The natural result is that serious interference from the local station will occur unless the proper precautions are taken. These precautions include the use of thorough screening and a dipole aerial with a proper feeder; the latter is essential.

Of greater importance is interference, which may occur between the sound and television transmitters. These are spaced by 3.5 Mc/s, and it is hardly feasible to employ sufficient preselection to exclude the sound signals from the frequency-changer. Non-linearity in the IF amplifier may consequently produce a beat frequency of 3.5 Mc/s, which will interfere with a vision IF of this order. We have seen that we cannot readily use a much lower frequency than this, and to avoid trouble we ought to choose a vision intermediate frequency of at least 1 Mc/s, and preferably 2 Mc/s, greater than this figure. Consequently, we ought not to choose a lower frequency than 4.5 Mc/s.

Suppose we use 5.0 Mc/s. Any interference due to the formation of the 3.5 Mc/s beat between the stations will appear at 1.5 Mc/s on the picture and is not likely to be very noticeable. If we work double sideband we may also find interference from the second harmonic of this beat. The frequency will be 7.0 Mc/s and will

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The Television Receiver

IV.—INTERMEDIATE FREQUENCY COUPLINGS

By W. T. COCKING

THE type of coupling normally adopted in a VF amplifier can also be used in the IF circuits in some cases and it is especially suited to single sideband reception. The design of such couplings is considered in this article.

ONE of the simplest types of inter-valve coupling, which in certain circumstances gives extremely good results, is the tuned anode circuit with series instead of parallel resistance. The latter circuit was discussed in Part III, but when series resistance is used the characteristics are entirely different. Instead of a response curve symmetrical about the resonance frequency, one which is sensibly flat from the resonance frequency to as low a frequency as we like is obtained.

The coupling is really resistance-capacity coupling such as is used in AF amplifiers, with the modification that a coil is included to prevent the response falling off as rapidly as usual at high frequencies. The properties of such couplings have already been dealt with in *The Wireless World*,[1] but the circuit is of so great importance in television that it will be fully treated here, especially as the article referred to considered mainly its aspects as a VF amplifier.

The circuit diagram is shown in Fig. 9, and it will be seen that the coupling is like resistance - capacity coupling save for the inclusion of the coil L in series with the coupling resistance R. This series combination of inductance and capacity is actually shunted by the capacity C, which is made up of the sum of the input and output capacities of V2 and V1 and stray wiring capacities, assuming that C1 is very large compared with the input capacity of V2. In practice, of course, the coil L has some self-capacity. One cannot rigorously include this with C, for it is not directly in parallel with it; one cannot ignore it, however. An exact analysis taking it into account becomes surprisingly complicated, particularly from the point of view of manipulating the equations to enable a ready choice of circuit values to be made. In practice, provided that the self-capacity of L is a good deal smaller than the total of all the other strays, it is sufficiently accurate for most purposes to add it to the other capacities and so treat it as though it were in parallel with the whole coupling. This capacity will rarely be greater than 10 $\mu\mu$F., and with a well-designed coil should be nearer 5 $\mu\mu$F., while the other capacities will total about 20 $\mu\mu$F. Experience shows that if we take C = 25-30 $\mu\mu$F. the measured response curve is not very different from the calculated; this value, of course, is for particular valves, the TSP4.

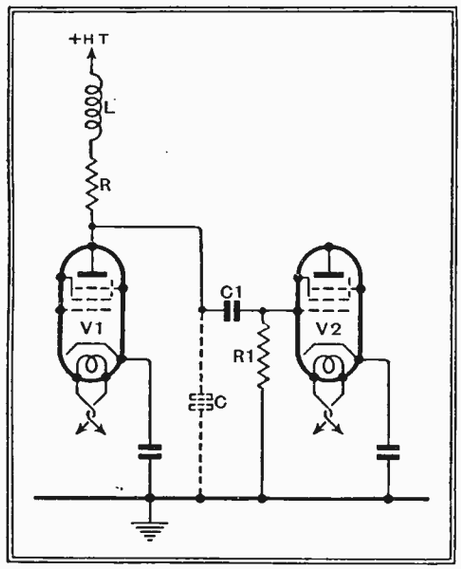

Fig. 9.—The frequency response of a resistance-coupled amplifier can be extended by the insertion of a coil L and it can then be used for IF amplification.

In addition to the foregoing we shall assume that the reactance of C1 is very small compared with the resistance of R1 at the lowest frequency required, that the value of R1 is very high compared with that of R, and that the valve resistance of V1 is also very high compared with R. These assumptions are justified because they are all easily met in a practical amplifier.

If C1 and R1 are made large enough the response will be maintained at very low frequencies down to about 20 c/s. Neither L nor C plays any part here, and the coupling is, in effect, purely resistance-capacity. The stage gain A = gR, where g is the mutual conductance of V1 in A/v. When the components have their optimum relationship for the most even response curve the response gradually rises with frequency until it reaches a maximum of about +0.25 db. at a frequency which is 0.55 of the resonance frequency at which $\omega^2LC = 1$. Thereafter, it commences to fall, passing the 0 db. point at $\omega^2LC = 0.68$, and being − 1.2 db. at resonance.

[1] *The Wireless World*, April 26th and May 3rd, 1935.

The response curve of Fig. 10 brings this out clearly. It is actually plotted in frequency ratios, for this renders it universal. The scale of x corresponds to frequency, since $x = f/f_r$ where f_r is the resonance frequency $= 1/6.28\sqrt{LC}$. In order to employ the curve to show the

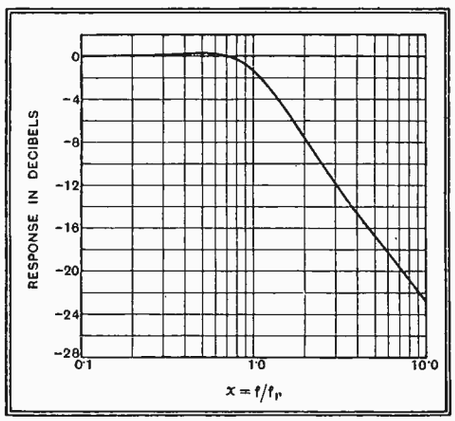

Fig. 10.—The response curve of the amplifier of Fig. 9 is shown here, the bottom scale being in frequency ratios.

response at any desired frequency it is only necessary to multiply the x – scale by the resonance frequency. Thus, if we make L and C resonate at 4 Mc/s the response will be − 1.2 db. at this frequency; when $x = 2$ the response is − 7.5 db. and the frequency is 8 Mc/s. The frequency of maximum response (+0.24 db.) is $4 \times 0.55 = 2.2$ Mc/s.

The relationship upon which this curve is based and which must be kept if the curve is to hold is $L/CR^2 = 0.5$; this is rather more conveniently expressed as $CR = 1.414/\omega_r = 0.226/f_r$, C being in farads, R in ohms, and f in c/s. It is sometimes more convenient to use $\mu\mu$F., ohms and Mc/s, and the question becomes $CR = 226{,}000/f_r$ with these units.

Single Sideband Reception

If we take the particular case when C = 25 $\mu\mu$F., $R = 9{,}050/f_r$, and since A = gR, the stage gain is inversely proportional to the resonance frequency. Now this circuit can be used for IF amplification. If we wish to work double-sideband retaining modulation frequencies up to 1.5 Mc/s we can make $x = 1$ at 1.5 Mc/s higher than our intermediate frequency and have a drop of 1.2 db. per stage. With an intermediate frequency of 3.0 Mc/s the resonance frequency must be 4.5 Mc/s and consequently R = 2,000 ohms. With a valve having g = 6.0 mA/v., A = 12, and this is about twice as good as we could obtain with the circuit having parallel resistance.

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UNBIASED

By FREE GRID

A Low-Down Scheme

I AM not the sort of person to stick at trifles, as my readers will bear witness, but I must confess to feeling a sense of great indignation at a plan for forcibly raising the moral tone of listeners which I am told is being discussed behind closed doors in Portland Place. In my opinion the B.B.C. have done far too much already in the moral uplift line and it is high time a halt was called before we all find ourselves completely bereft of all our vices with no opportunity of returning to them or of indulging in new ones.

It appears that the idea was suggested as a result of a regrettable incident which I mentioned a week or two ago. You will remember that an unfortunate Polish television enthusiast of artistic tendencies became so absorbed in an experimental television programme of a cinema film showing the Figurantes of the Folies Bergère that he edged himself nearer and nearer to the screen of the cathode-ray tube in an endeavour to get greater detail until eventually he pushed his face right through it and so electrocuted himself by making contact with the high voltage anode.

This unfortunate incident has apparently given the B.B.C. an idea how to eliminate quietly, quickly and without trace certain undesirables—meaning you and me—from the ranks of its patrons. The idea is to put on the ether a selection of vision programmes of a sufficiently low grade type to excite our interest, the argument being that we shall become so entranced that we shall unwittingly follow the example of the unfortunate Pole.

"Behind closed doors at Portland Place"

I, for one, have already taken the necessary precautions against the putting into operation of this unworthy plan and I advise you to go and do likewise. I have protected myself by the simple expedient of arranging for an invisible ray to cross the screen about a quarter of an inch in front of my television receiver so that my face would cut it—the ray I mean—before touching the screen. Arrangements have been made, of course, that the cutting of the ray switches off the set and lights up a warning red lamp. There will be no moral uplift in my case.

Are Vacuum Cleaners Vulgar ?

I SUPPOSE that at some time or another most of us have come across the superior type of person who always likes to go one better than anybody else, whether it be in the matter of personal possessions, social acquaintances or anything else. The thing which I detest most, however, is that form of perverted civic pride which leads the inhabitants of Garden Cities to imagine that their wretched localities and all that appertains to them are superior to more plebeian districts such as Southend or Salford. To people of such mentality even the very dogs and cats in their district, to say nothing of the rats and domestic insects, are of superior breed. Women are undoubtedly the chief offenders in the matter of this sort of locality-snobbery, and no doubt, even in the days of our cavemen ancestors, the ladies of Stonehenge regarded themselves as superior to their fellow cave-cleaners at Wigan.

Quite recently I have had to put up with quite a lot of this sort of thing, as I have been in the throes of bringing my electric light installation up to date by rewiring the whole house and there are tangled masses of trailing wires in every room, with the result that it is utterly impossible to keep the noises of the various vacuum cleaners and female face-lifters in the locality out of the loud speaker.

A good lady of the type I have referred to happened to drop in on Mrs. Free Grid and myself the other afternoon, and I was dragged away from my studies to entertain her with polite conversation until Mrs. Free Grid had had time to make up her face in a manner suitable for this particular visitor. The precise reason for her visit was not defined, and in reply to my guarded enquiries she left me in a rather uncertain state of mind by remarking that she had been devoting the day to "slumming," and, finding herself in the vicinity of my abode, she felt she really had to call.

Mrs. Free Grid seemed to be engaged for a long time in the face-repairing business, and conversation flagged somewhat. In my desperate efforts to entertain the visitor I switched on the wireless set, and as one of the B.B.C. bands was at the time putting out one of the morbidly tuneless high-brow compositions for which it is so justly renowned, my high-brow visitor was not unduly displeased, although she certainly did gaze rather contemptuously through her lorgnette at me as though I were something the cat had brought in. For a while, all went as merrily as a mothers' meeting, and everybody might have lived happily ever after had not some wretched woman in the neighbourhood started up her vacuum cleaner

"Something the cat had brought"

My fair visitor's classic eyebrows were elevated slightly as she turned a look of pained enquiry on me. I hastened to explain the cause of the noise and added that no doubt it was a sound which she never heard in her set at home. I was fully prepared to hear the usual unjust censure on my receiver, but certainly did not expect the sweeping denunciation of the social status of the whole of my locality which, by a suitable inflexion of her voice, she managed, as only women can, to express in a single sentence. "Naturally," she said condescendingly, "I am unfamiliar with the sound as the cheap and noisy type of vacuum cleaner is never used in W . . . ."

A Death-ray Enquiry

I WONDER if any of you short-wave experimenters can give me any technical data concerning the stopping of motor car engines by means of the so-called death-ray. I know it can be done, for a very well-known authority has said that it is very effective in this respect; and, furthermore, I happen to know privately that the police are experimenting with it in their gongster cars. The reason I want technical data about it is that I am kept awake late at night by the cars of people leaving a low-down night club which has recently opened up in my vicinity and I desire to put a stop to it.

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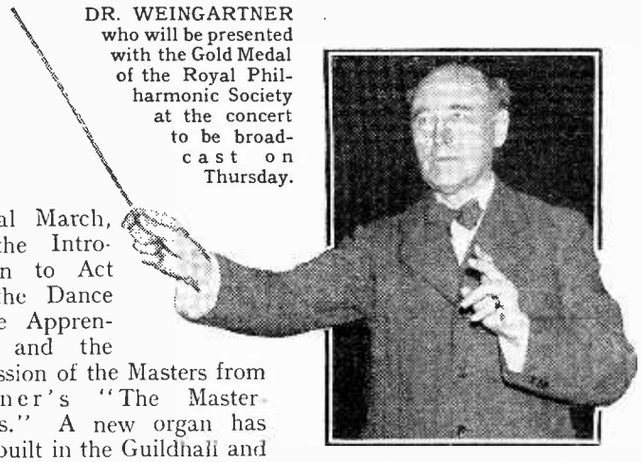
The Week

Outstanding Broadcasts at Home and Abroad



DR. WEINGARTNER who will be presented with the Gold Medal of the Royal Philharmonic Society at the concert to be broadcast on Thursday.

Funeral March, and the Introduction to Act III, the Dance of the Apprentices, and the Procession of the Masters from Wagner's "The Mastersingers." A new organ has been built in the Guildhall and will be used on this occasion.

At the Sunday Orchestral Concert this week (6.30, Reg.) the Kolisch Quartet will play an arrangement by Arnold Schönberg of a Handel concerto grosso. The Kolisch Quartet, who come from Vienna, are a very fine ensemble, and make a point of playing nearly all their repertoire from memory. One of their peculiarities is that the first violin is left-handed, which necessitates reversing the usual order of the strings on his violin.

The Philharmonic Concert to be held in the Queen's Hall on Thursday will be broadcast in the Regional programme at 8.15. Dr. Weingartner will conduct the all-Beethoven programme, and Cyril Smith will be the soloist in the Concerto No. 1. In 1928 he won the first prize (a grand piano) in the National Piano Playing Contest organised by a London daily newspaper.

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"INSPIRATION TO A POET"

THIS is an adaptation by Marianne Helweg of a play by a well-known Danish actor and dramatist, Tavs Neiiendan. The theme is unusual, and gives considerable opportunities to both comedy and pathos. The story revolves round an elderly clergyman whose only claim to fame is that he is author of a series of passionate love poems written in his youth. An astute journalist, hard up for news, decides to secure an interview with the lady who inspired these. She turns out to be the portly owner of a delicatessen shop famous now for her chitterlings rather than her charm. Continuous entertainment will be provided by the involved situations consequent on the blaze of publicity accorded two such incongruous figures of romance. National listeners will hear this programme at 7.35 on Thursday, and Regional listeners the next day.

Details of the week's Television programmes will be found on p. 242.

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"I WAS THERE"

THE third talk in the new edition of this popular series will be given by R. J. Dalby in the National programme at 9.20 to-night (Friday). He was on a small clipper barque in the Straits of Sunda between Java and Sumatra in August, 1883, when there occurred in this region one of the most violent cataclysms of Nature on record, the eruption of the volcano of Krakatoa. A vivid eye-witness account of this terrible disaster, in which it is estimated 36,000 human beings lost their lives, will be given by Mr. Dalby.

THREE BROTHERS

AN unusual feature of the twenty-second Thursday concert from the State Broadcasting building to be radiated by Copenhagen at 7 is that the three brothers Busch will be taking part. Adolf and Hermann will be playing solo parts for violin and 'cello, whilst Fritz will be conducting. Surely this is a rare event!

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CONEY ISLAND

THE Finnish stations will broadcast an interesting programme on Wednesday at 6.55 entitled "Fifty Minutes Through Coney Island." Listeners will be entertained by sound impressions from the huge playground of New York.

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FOLK LORE

AN interesting O.B. in Finland will be radiated by all Scandinavian stations on Tuesday at 8. It comes from the Eastern coast of the Gulf of Bothnia, that most northerly part of the Baltic Sea, which is usually frozen up during the winter months. The programme will be a description, backed by music and revelry, of the ancient marriage customs which still obtain in some of the Finnish villages.

Songs and folk humour from the picturesque wooded country in the vicinity of the Ruhr will be included in the programme, "An Evening in Hohenlimburg," from Cologne at 7.45 to-night (Friday).

FODEN'S MOTOR WORKS BAND, who last year won the Crystal Palace band competition for the sixth time, will be heard to-night (Friday). Mr. F. Mortimer, the conductor, can be seen in the centre.

OPERA

Home: From Sadler's Wells on Saturday at 9.5, in the Regional programme, listeners will hear the second act of "Madam Butterfly." The scene for this act is laid in the house at Nagasaki of Butterfly (Cho Cho San).

Abroad: An abundance of opera transmissions are included in Saturday's programmes. A recorded performance by the Stuttgart Station Orchestra of Puccini's "La Bohême" comes from Munich at 7.10. Bizet's "Carmen" comes from Radio Normandie at 8.40. The inestimable privilege of a Royal Flemish Opera performance of Verdi's "Aïda" occurs via Brussels II at 8. Rome relays at the same time, from the Teatro San Carlo, Naples, Giordano's "Fedora." Paris PTT gives the chance of hearing a much less familiar opera in its 8.30 transmission, which consists of Meyerbeer's three-act opéra-comique, "The Pole Star."

Berlioz's three-act "Benvenuto Cellini" comes from Rennes-Bretagne at 8.30 on Tuesday. The National Orchestra and Raugel Choir, conducted by M. Inghelbrecht, will support a distinguished cast.

On Wednesday the Deutschlandsender relays "Manon" from La Scala, Milan.

◇ ◇ ◇

MISCELLANY

COLOGNE at 6 on Sunday celebrates the first anniversary of the return of German troops into the Rhine zone.

Joseph Hislop, the famous Scottish tenor, will be heard, accompanied by the Swedish Wireless Orchestra, from the Swedish stations at 7 on Tuesday.

Electronic organ music will be heard in the Swedish programmes at 7.40 on Monday. The Hammond organ played by Erik Erling will be making its broadcasting debut in Sweden on this occasion.

THE AUDITOR.

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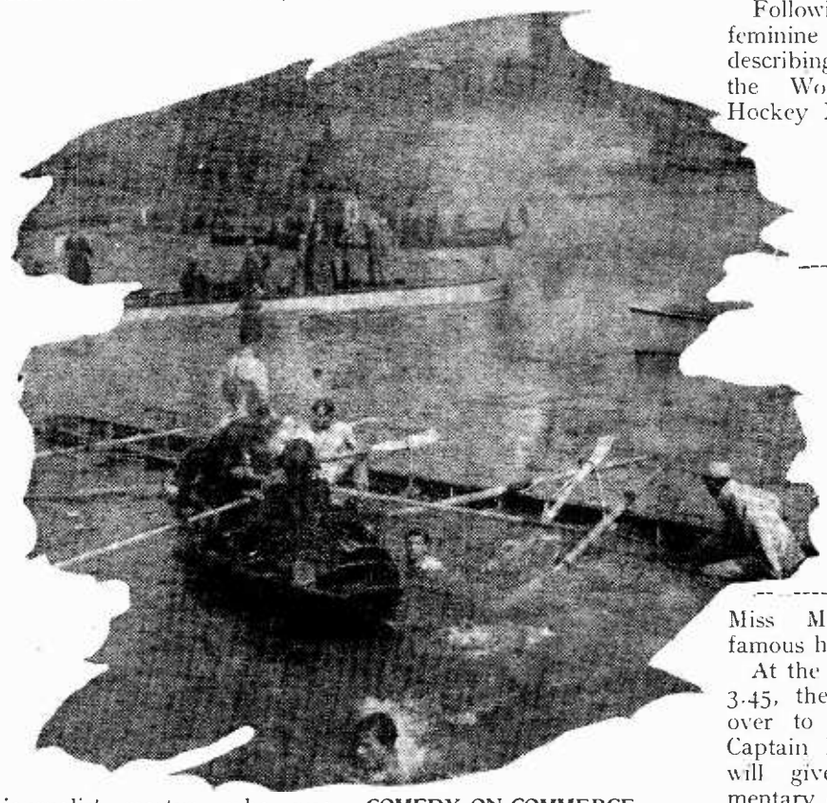
Listeners' Guide fc

SOMETHING of what lies behind the phrase, "Here is the first news, copyright reserved," which is heard daily from all B.B.C. stations, will be brought to light in a programme this week. It will deal with outstanding episodes in the history of news gathering and its distribution. A line will be drawn connecting Cæsar's despatches from Gaul, through the centuries to the earliest newspapers, on to the modern Press with its gigantic circulation and enormous influence, and finally to the broadcast news bulletins.

Included in this feature will be the story of the fight for freedom of speech in England, and the trial of Coleman, the journalist martyr, who was indicted before Judge Jefferies for treason. The last part of the programme in particular maps the growth of the modern newspaper. This will be produced for Regional listeners on Monday at 9.



BOAT RACE enthusiasts will remember that it was in 1912, the year to be dealt with in this week's Scrapbook, that both the boats sunk. Here some of the Cambridge crew are making for the shore. Capt. R. C. Bourne, M.P., who stroked Oxford, will speak during the programme.

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ANOTHER SCRAPBOOK

CHARLES BREWER and Leslie Baily present on Tuesday and Thursday at 8 (Nat.) and 6 (Reg.), respectively, another of their now popular Scrapbooks, which, this time, will recall some of the interesting events of 1912.

There was a boom in the theatre in 1912, some of the most successful runs being "The Girl in the Taxi," "The Dancing Mistress," and "Milestones." This year saw the first Royal Command Variety performance at the Palace Theatre, and the invasion of these shores by American ragtime.

Among the more serious events which the collaborators are working out for portrayal is the tragic disaster of the sinking of the *Titanic*, the death of Lord Lister, the pioneer of aseptic surgery, and the loss of Captain Scott and his comrades.

COMEDY ON COMMERCE

ONE of Galsworthy's slighter, but also one of his most charming and characteristic, plays, "Old English," will be heard via the microphone for the first time on Sunday at 9.5 (Nat.). Essentially a study in character rather than a play of action, it should be ideally suitable for a radio drama.

The scene is set principally in the board-room and offices of the Island Navigation Company, shipbuilders of Liverpool, in 1905. The central figure of the drama, Sylvanus Heythorp, the chairman of the company, is drawn on a truly heroic scale. Listeners should enjoy this intensely human comedy of commercial life.

SPORTS COMMENTARIES

THREE venues of sport will be visited for National listeners on Saturday afternoon, thereby giving them commentaries on a variety of sporting events.

At 3 they will be taken to the Royal Horticultural Hall, Westminster, where Bernard Taylor will describe the final stages in the Men's Doubles All-England Badminton Championship. Listeners will hear the ping of the "bird" as it is driven to and fro in the long rallies which are a feature of this fast game.

Following this at 3.15 a feminine voice will be heard describing the second half of the Women's International Hockey Match between England and Germany at Kennington Oval. The voice will be that of a new commentator, Miss Margery Pollard, a famous hockey international.

At the conclusion of this, at 3.45, the switch will be put over to Twickenham, where Captain H. B. T. Wakelam will give a running commentary on the second half of the Inter-Services Rugby match between the Royal Navy and the Army.

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MUSIC

ON Wednesday the B.B.C. Symphony Orchestra will visit Southampton, where, under the direction of Sir Adrian Boult, they will give a concert at the new Guildhall. This will be broadcast on the National wavelengths from 7.45 to 10, the News being given during the interval at 8.45.

The programme is an attractive one, consisting of Elgar's "Cockaigne" overture, three numbers from Holst's "The Planets," the César Franck Symphony, Mozart's Masonic

HIGHLIGHTS OF THE WEEK

FRIDAY, MARCH 5th.

Nat., 5.15, Frank Biffo's Brass Quintet. 7.20, "Cornish Tin": feature programme from the West. 8, The Fol-de-Rols.

Reg., 6, Foden's Motor Works Band. 7.30, Van Phillips and his two orchestras. 9.10, "Money with Menaces": play by Patrick Hamilton.

Abroad.

Radio Normandie, 8, Lehár's operetta, "The Merry Widow."

SATURDAY, MARCH 6th.

Nat., 3, Sports Commentaries. 7.30, "In Town To-night." 9.20, Music Hall.

Reg., 4, The Fol-de-Rols. 7.30, The Leicester Brass Band Festival. 9.5, Act II of "Madam Butterfly" from Sadler's Wells.

Abroad.

Leipzig, 7.10, "Flowers That Herald Spring": Winter Relief Concert from Dresden.

SUNDAY, MARCH 7th.

Nat., 6.30, "Father and Son": John and Eric Ansell conduct the Theatre Orchestra. 7.55, Moody Centenary Service from the Lyceum. 9.5, "Old English."

Reg., 5, The Eastbourne Municipal Orchestra. 6.30, Sunday Orchestral Concert.

Abroad.

Frankfurt, 7, Museum Society's Sixth Concert from the Saalbau.

MONDAY, MARCH 8th.

Nat., 7.45, Jessie Matthews. 8, It's Happening Now. ¶Pianoforte Recital: Edwin Fischer.

Reg., 8.30, Music from the Movies. 9, "News," feature programme.

Abroad.

Deutschlandsender, 7.50, Berlin Philharmonic Orchestra.

TUESDAY, MARCH 9th.

Nat., 6.30, Orchestre Raymonde. ¶A Nation of Shoppers. 8, Scrapbook for 1912. 9.20, World Population.

Reg., 6, Raunds' Temperance Band. ¶B.B.C. Variety Orchestra. 9, Van Phillips and his two orchestras.

Abroad.

All Scandinavian stations, 7.55, An East Bothnian Peasant Wedding: relayed from Finland.

WEDNESDAY, MARCH 10th.

Nat., 7, Songs You Might Never Have Heard—V. 7.45, B.B.C. Symphony Orchestra, from Southampton.

Reg., 7.30, The World Goes By. ¶Variety Concert from the Drill Hall, Hounslow.

Abroad.

Frankfurt, 7.45, Winter Relief Military Band Concert from Cassel.

THURSDAY, MARCH 11th.

Nat., 6.20, This Way Out: John Hilton. 7.35, "Inspiration to a Poet." ¶Reginald Foort at the Theatre Organ with two trumpeters and two trombonists.

Reg., 6, Scrapbook for 1912. 8.15, Royal Philharmonic Concert.

Abroad.

Kalundborg, 7.10, Concert from the State Broadcasting Building.

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There is provision for gramophone reproduction, and the external loud speaker sockets incorporate a special jack switch enabling the external loud speaker to be used with or without the internal loud speaker. The HT supply is derived from a full-wave rectifier through a two-stage smoothing circuit.

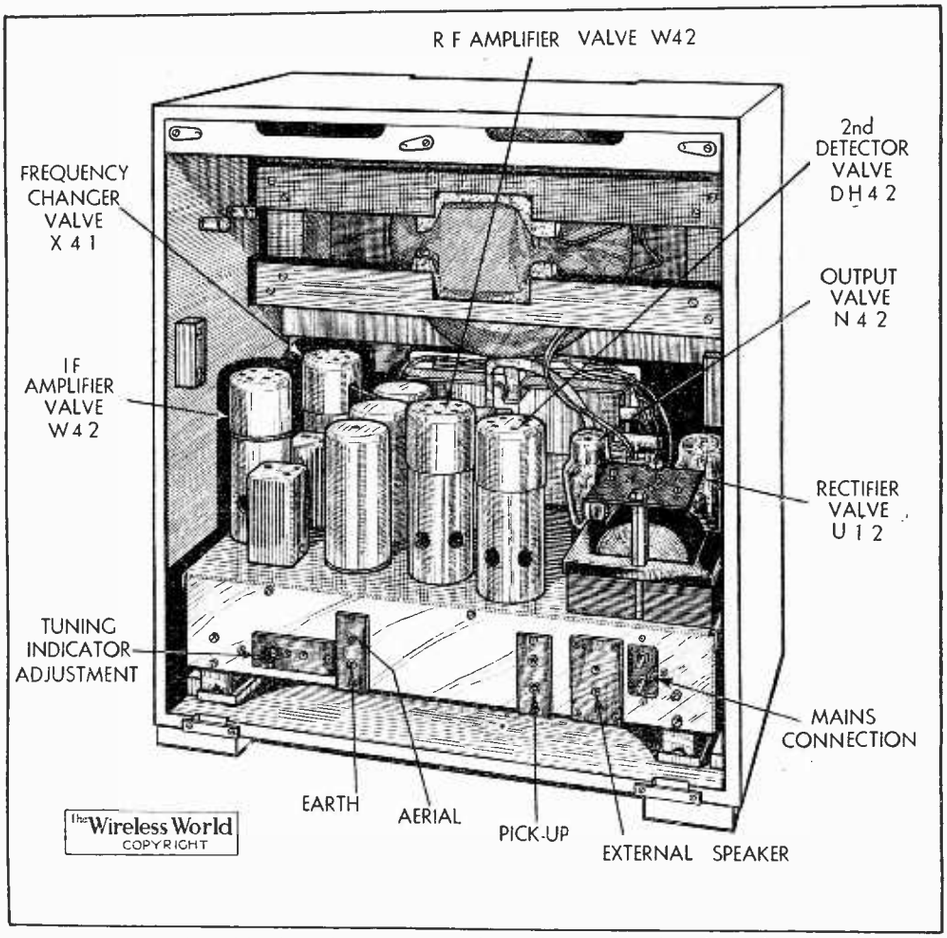
The controls are arranged in three groups, the first being the tuning control with a large-diameter knob which can be pulled out or pushed in to give ratios of 75 : 1 and 15 : 1. A subsidiary vernier pointer enables more accurate notes to be made of station settings on the two short wavebands. These, incidentally, are calibrated only in megacycles, with the usual bands to indicate where the broadcast transmissions are grouped. On the medium- and long-wave ranges the scales are divided on a wavelength basis, and a representative, but not overcrowded, list of station names is included. Near the bottom of the dial there are auxiliary pointers showing at a glance the settings of the muting control and waverange switch.

Grouped Controls

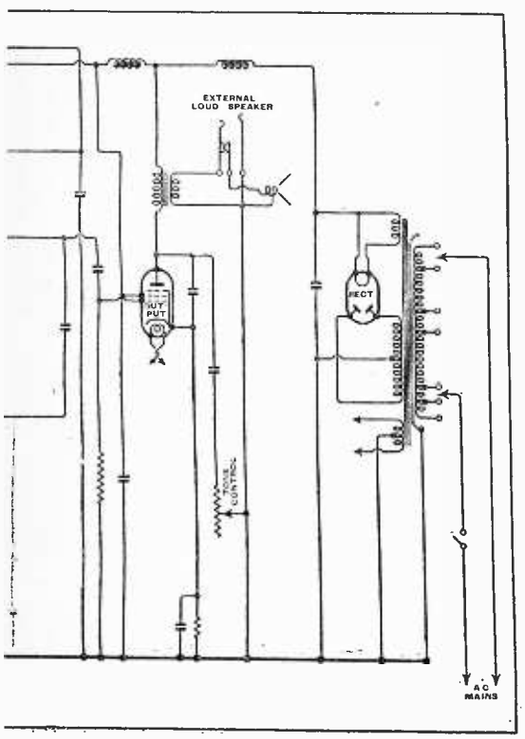
The remaining controls consist in each case of a key switch concentric with a rotating knob. In the one on the left-hand side of the cabinet the knob controls volume, and the switch gives three degrees of muting and sensitivity, as well as switching the set on and off. The switch in the right-hand group is for waverange control, and the knob is a combined tone and selectivity (fidelity) control. The normal intermediate setting of this knob, which is located by a notch, provides maximum selectivity but no reduction of high frequencies in the AF amplifying circuit. Movement of the control in an anti-clockwise direction leaves the selectivity at maximum, but reduces high-note response by the AF tone control. Starting from the normal position and turning the control in a clockwise direction, on the other hand, leaves the AF response at maximum, but increases the band width of the IF amplifier to give the highest degree of fidelity of which the set is capable.

The permanent-magnet moving-coil loud speaker is of special design and makes the best use of the audio-frequency range supplied to it from the receiver. The improvement in quality when the high-fidelity setting of the tone control is used on the local station is quite definite. The receiver has not the aggressive efficiency of sets in which everything has been sacrificed to range, but anything which it may lack in this direction is amply compensated for by the absence of irritating noise between stations which are invariably worth listening to.

The same may be said of the two short waveranges, and if more sets were available with this quiet background there is little doubt that listeners who are accustomed to the standards of the medium and long wave bands will come to regard short-wave listening more as a service and less as an ordeal. Excellent reception was



Both chassis and loud speaker are mounted on rubber to guard against microphony.



reproduction combines brilliance in the upper middle register with a smooth and full bass response which is unaffected by cabinet resonances.

We were particularly impressed with the high standard of quality obtained with the normal setting of the "Fidelity-Tone" control, particularly as the selectivity was appreciably better than the average. On the medium waveband it was possible to approach within less than one channel on either side of the London Regional and National transmitters before their modulation could be heard, and on the long waveband there was actually a silent space between the Deutschlandsender and its powerful neighbours in wavelength on either side.

Judging from the strength of the long-wave German station and the number of Continental transmissions available in daylight on the medium waveband, the obtained from W3XAL, 17.78 Mc/s (16.87 metres), W2XAD, 15.33 Mc/s (19.57 metres), and W8XK, 15.21 Mc/s (19.72 metres) during the afternoon. Incidentally, the best setting of the "Fidelity-Tone" control for American reception proved to be about one-third of the range of the control from the normal position towards maximum fidelity.

Two models are made, one for the home market, where long-wave reception is important, and the other for overseas, in which the four wavebands give a complete coverage from 13.6 to 550 metres. Both models are suitable for use either in temperate or tropical climates, and the chassis is built on a zinc-plated steel frame. The base is rubber-mounted, and, as an additional precaution, the loud speaker itself is insulated from the cabinet batteries by sponge rubber strips to remove all possibility of microphonic feed-back.

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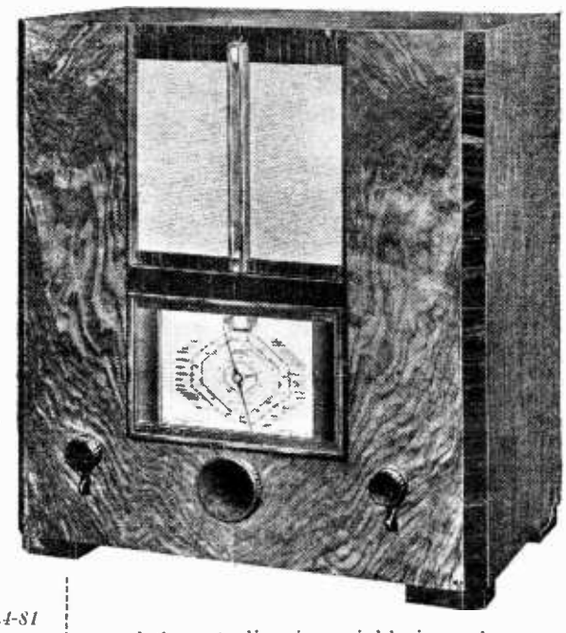
G.E.C. All-Wave 6

A WELL-BUILT RECEIVER WITH A GOOD ALL-ROUND PERFORMANCE



CONSIDERABLE thought has obviously been given to ensure that this receiver will meet the requirements of every class of listener, whether at home or abroad. Both cabinet and chassis are built to stand up to severe climatic conditions, yet from the point of view of appearance the set can take its place with the best of the table models designed primarily for use in this country alone.

The valve types used have been decided upon mainly from the point of view of securing the highest possible reliability, and it is gratifying to find that efficiency on the short wavebands has not been developed to the exclusion of the normal broadcast bands. On the latter ranges selectivity of a high order has been provided, and, by the inclusion of variable selectivity, wide-range audio-frequency response is available for quality reception when conditions permit. Background noise, even at the highest sensitivity, is remarkably low, and a muting control gives a completely silent background for lower degrees of sensitivity.

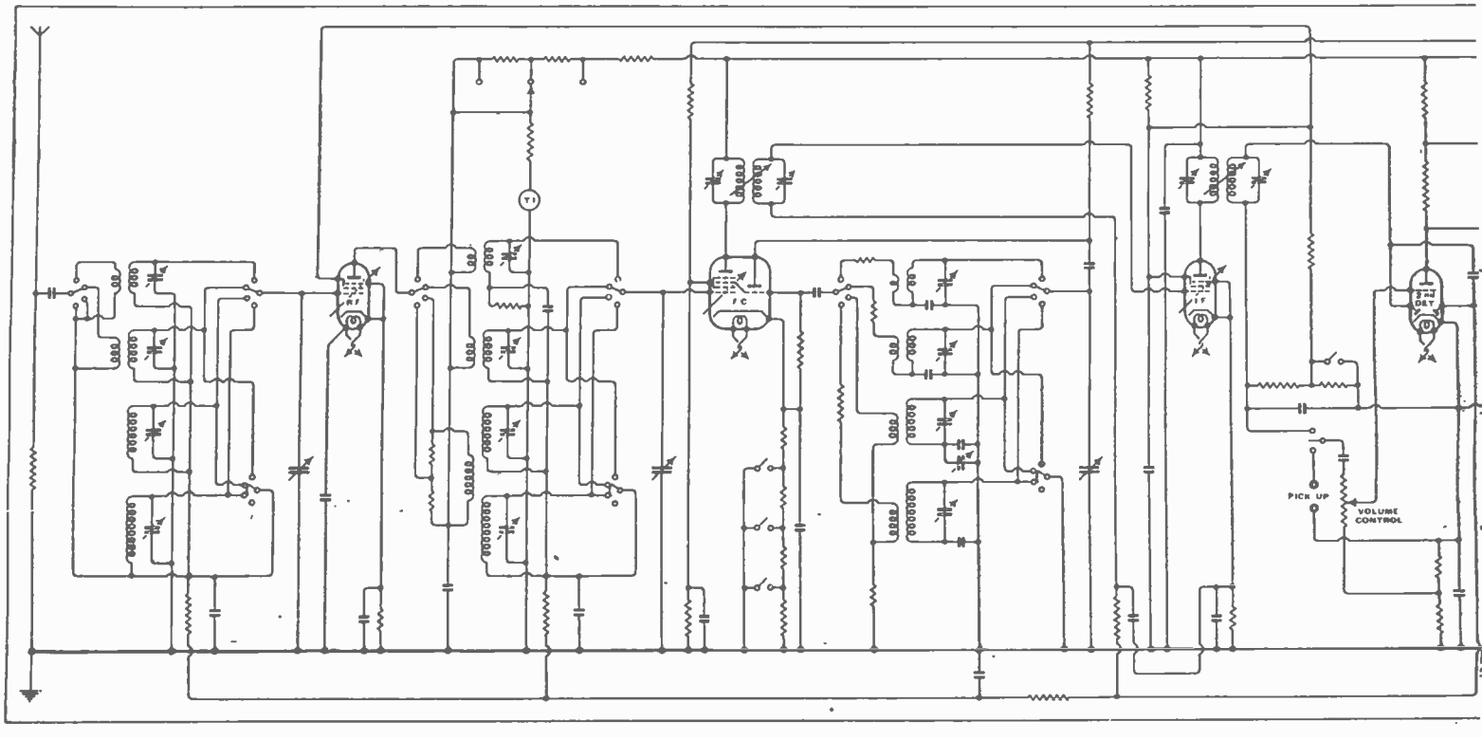
The set is designed to work on a normal aerial and earth system, and the incoming signal is amplified at radio frequency by a variable-mu pentode before passing through transformer coupling to a triode hexode frequency-changer. The neon-type tuning indicator is operated from the anode circuit of the RF amplifier.

A single IF stage operating at 445 kc/s follows the frequency changer. The IF transformers are of the iron-cored type, and the coupling is variable in each case, giving a band width from 3 to 8 kc/s. The second detector is a double-diode-triode, the amplifying portion of which is resistance-capacity coupled to a pentode output valve. The combined muting and sensitivity control, which has three positions, operates a series of switches to give a progressively increasing negative bias to the frequency-changer valve and, in the case of the two lowest degrees of sensitivity, a small positive bias to the signal diode rectifier.

AVC is derived from a second diode fed through a small condenser from the output IF transformer secondary, the rectified control voltage being applied through suitable filters to the first three stages.

FEATURES. ***Type.—****Table model superheterodyne for AC mains. Waveranges: — (Model BC3760). (1) 13.6-30 metres. (2) 29.4-81 metres. (3) 200-550 metres. (4) 950 - 2,200 metres. (Model BC3762). (1) 13.6-30 metres. (2) 29.4-81 metres. (3) 73-200 metres. (4) 200-550 metres.* ***Circuit.—****Var.-mu pentode RF amplifier—triode hexode frequency-changer—var.-mu pentode IF amplifier—double-diode-triode second detector—pentode output valve.—Full-wave valve rectifier.* ***Controls.—****(1) Tuning. (2) Combined volume control, muting, sensitivity, gramo. and on-off switch. (3) Combined tone, variable selectivity (fidelity) and waverange.* ***Price. — 19 guineas. Makers.—****General Electric Co., Ltd., Magnet House, Kingsway, W.C.2.*

Variable selectivity and a three-stage muting and sensitivity control are notable features of the circuit specification.



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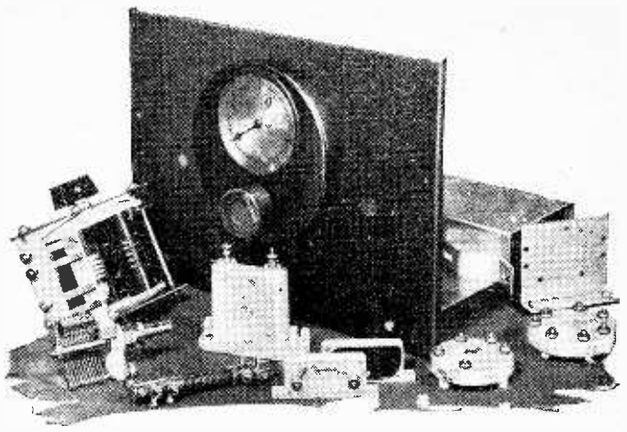
New Apparatus Reviewed

RECENT PRODUCTS OF THE MANUFACTURERS



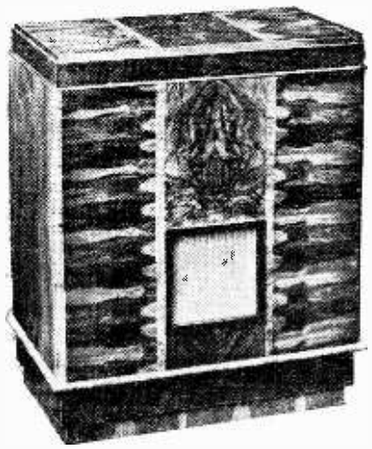
Selection of Lissen Hi-Q short-wave components and metal chassis used in the construction of the test receiver.

RADIOGRAMOPHONE CABINET

WE have received from H. L. Smith and Co., Ltd., 287-289, Edgware Road, London, W.2, a specimen radiogramophone cabinet for examination. The model in question is made of ¾ in. thick laminated wood finished with walnut veneer on both sides.

The cabinet is of modern design and measures 36½in. high, is 30in. wide and 18½in. deep. A recessed motorboard is fitted, and headroom up to 8in. can be allowed for the gramophone fittings if required.

Though a loud speaker fret is shown in the illustration at the bottom of the



Radiogramophone cabinet made by H. L. Smith and Co.

cabinet, this opening can be cut in any position and in any size to suit individual requirements.

The cabinet shown is in figured walnut and highly polished, and the price is £5 10s.

LISSEN HI-Q COMPONENTS

LISSEN Hi-Q components have been designed especially for short- and ultra-short wave use, and the particular description adopted signifies that both in design and in choice of the materials every care has been taken to ensure the highest possible efficiency compatible with reasonable cost.

A comprehensive range of these components was recently sent to us for test, and as there were sufficient parts to build a receiver, and furthermore a chassis and panel with holes for fixing the major components, it was decided to adopt this course, since it would enable a good idea to be had of the general efficiency of the parts.

A simple two-valve set was assembled consisting of an RF pentode detector with regeneration obtained by wiring the circuit as an electron-coupled oscillator with control of oscillation effected by varying the screen potential. The other valve was a high-efficiency AF pentode.

The reason why the electron-coupled arrangement was adopted was that the Lissen four-range coil unit is designed for use in this manner.

This coil unit is particularly interesting, as the various coils are assembled on a rotating member and only the one actually in use is connected in the circuit, the others being entirely removed, though they are not short-circuited. However, this does not introduce any "blind" spots.

The results obtained with this set were rather surprising, for in general liveliness it compared favourably with many short-wave sets having one RF stage.

On the lowest range of the coil unit, which tunes down to about five metres, the vision signals from Alexandra Palace were received well, but for the sound range two had to be used. Very strong signals were received in London. Range two tuned up to 17.5 metres, and was very satisfactory on both the 13- and 16-metre bands. Range three covered 16.7 to 43 metres, and was the most productive of signals, since it took in a part of the 16-metre as well as the 25- and 31-metre broadcast bands and 20- and 40-metre amateur bands. The 31-metre stations were exceptionally good, five in all being received in daylight at good strength.

During the late afternoon W2XAD and one other unidentified U.S. station were also received at good strength.

Reaction was satisfactory throughout the entire waveband covered, which, incidentally, with range four in use went up to approximately 83 metres.

Since this set had Lissen components throughout with the exception of two small fixed condensers, the results obtained exemplify the efficiency of the new Hi-Q components.

The condenser drive is of interest in that it has a clock-type face, the minute hand making one complete revolution for $\frac{1}{10}$th of a revolution of the hour hand.

Since the 360-degree scale has 100 divisions, it is equivalent to one some ten times in length and having 1,000 divisions. Accurate logging of stations is thus possible. It is smooth running and gives a reduction of 25:1.

The prices of the principal components are: 4-range coil unit, 15s. 6d.; 160 m-mfd. tuning condenser, 7s. 6d.; Decimal slow-motion dial, 12s. 6d.; complete chassis and panel, 7s. 6d.

There are many other components in the range, but space precludes reference to them. The makers are Lissen, Ltd., Angel Road, Edmonton, London, N.18.

FERRANTI SERVICE KITS

FERRANTI, LTD., Moston, Manchester, have compiled two kits of fixed resistance and fixed condensers for the use of service engineers. These include a good selection of half-, one- and two-watt resistances and large and small capacity fixed condensers, the values chosen being those most commonly found in commercial receivers. They are intended to provide a ready stock of replacement parts.

The kit A contains 47 resistances made up of 23 half-watt, 21 one-watt and 3 two-watt sizes and 21 fixed condensers, in which is included a useful selection of high- and low-voltage dry electrolytic models.

In kit B there are 100 resistances with about the same proportion of half-, one- and two-watt types as in kit A and 39 fixed condensers, but in addition four volume controls, one each of 15,500 ohms and half-megohm and two of 1 megohm, are included.

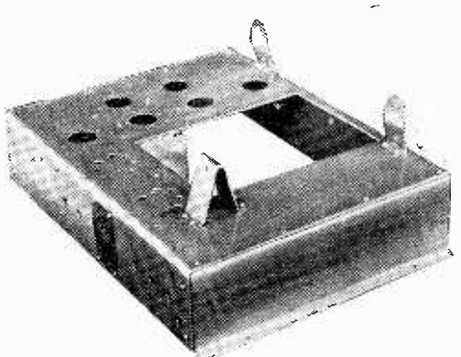
These kits are available at trade prices to service engineers.

SCOTT-SESSIONS CHASSIS

CONSTRUCTORS who take a pride in the appearance of their receivers may be interested to learn that G. Scott-Sessions and Co., Exchange Works, Muswell Hill, London, N.10, can supply chassis with a non-chippable gold finish for any *Wireless World* receiver or amplifier. They are described as Scott-Sessions de Luxe Radio Chassis.

A specimen chassis made for the All-Wave Super Seven and finished in this manner has been sent in for examination. It is made of aluminum, and has all the necessary holes drilled in their correct positions. Brackets are also fitted where required.

The enamel, or whatever the material used may be, is certainly very hard and durable, and it is also a rather good insulator, so that when mounting components that require earthing to the chassis care



Scott-Sessions chassis with gold finish for "Wireless World" All-wave Super Seven Receiver.

should be taken to ensure that the metal round the fixing holes on the underside of the chassis is perfectly clean.

The chassis illustrated costs £1.

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The Wireless World

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

EDITORIAL COMMENT

Receiver Controls

Need for Identification

ALTHOUGH the actual business of tuning-in stations on receivers has been greatly simplified in recent years with the introduction of visual tuning aids, dials calibrated with station names, and other refinements, this simplification has been accompanied at the same time by an increase in the number of controls for such purposes as wave-band switching, tone adjustment and band width, so that whilst simplification has occurred in some directions additional knobs have appeared, the purpose of which must be properly understood by the set user if a satisfactory performance is to be expected.

One constantly finds that sets are left with all sorts of odd adjustments of these controls, the tuning dial and, perhaps, the volume control alone being used, and the rest forgotten or adjusted in such a haphazard way as to mar reception of the programmes.

It can be argued, of course, by the set manufacturer that with every new set he issues a booklet of instructions which should remove all possibility of ignorance on the part of the user as to the correct adjustment of the controls. But booklets of instruction, even if they may be conscientiously read when the set is new, are soon laid aside and the advice they contain forgotten.

What seems necessary is that suitable information regarding the nature and operation of the controls should be in some permanent position on the set. Many sets are marketed to-day with no label of any sort on the controls even to serve the purpose of identifying them. To name the controls would be some contribution, but it is not enough, and whilst we might concede that a permanent instruction plate or plates affixed to the front of a receiver, where the controls are external, might look unsightly, this objection could be overcome if some form of cover plate were fitted to it. In the case of receivers of the radio-gramophone type with a lid closing down on the controls, there seems to be no excuse at all for not including proper instructions.

If manufacturers would only take steps to insure that their receivers are properly used, it would do much to enhance the reputation of the receivers and increase the appreciation of the public for broadcasting. A mistuned receiver with tone and band width controls set indiscriminately can sound far worse in performance than a receiver of antiquated type which, because it has none of these refinements, cannot be similarly abused.

Electricity Supply

Government Approve Standardisation

THE announcement was made by the Minister of Transport last week that the Government had decided to adopt, in principle, the recommendations of the Committee appointed to consider the question of electricity distribution. This news is important to the radio industry because it paves the way for standardisation in sets on the supply side and heralds the disappearance of direct-current supply.

These changes will take place gradually, of course, and it will be some time before DC or Universal models of sets cease to be manufactured. We have always discouraged the idea of standardisation in radio sets where this might mean stagnation in improvement or development, but the standardisation of supply offers every gain to the designer with no disadvantages.

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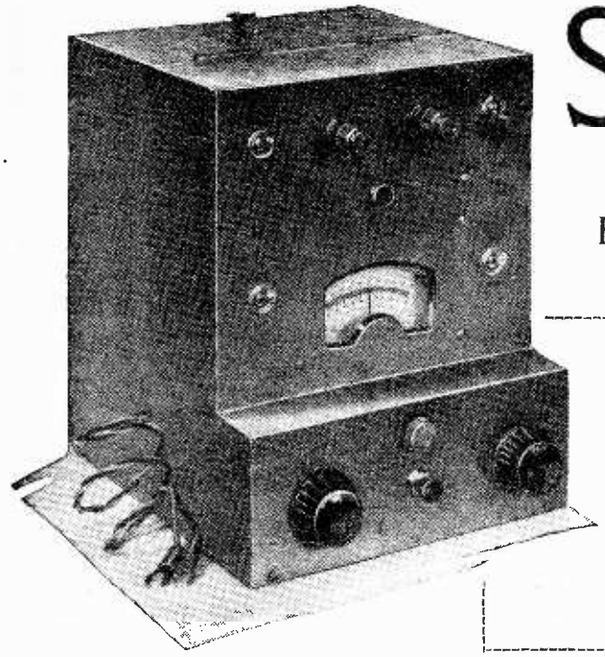

Sensitive Valve

FROM 0.01 TO 1 VOLT IN TWO STEPS

DESCRIBING the design and construction of a simple and inexpensive valve voltmeter for measuring low voltages. Alternative methods of calibration are described.

FOR ordinary work a valve voltmeter giving a full-scale deflection for voltages between five and ten is satisfactory, and a simple reflex anode bend arrangement can be made to give a stable performance without difficulty. Occasions arise, however, where a greater sensitivity than this is desirable, for with a 5-volt instrument the lowest accurate reading is in the neighbourhood of 0.25 volt. The voltmeter to be described was devised to operate on the range immediately below this. It will give readings of as low as 0.01 volt and a full-scale deflection with 0.125 volt.

To obtain a high sensitivity such as this one obvious solution is to utilise an amplifying valve either before or after the voltmeter valve itself. This, however, is not altogether satisfactory, for difficulties are experienced with instability of calibration. It was decided, therefore, to use a single valve for the purpose and to operate it under conditions which automatically gave the improved sensitivity required. Obviously, the first modification is a change from anode bend to grid rectification, using the circuit shown in simplified form in Fig. 1. The grid and cathode may be regarded as a diode rectifier, and on the application of a signal the grid will acquire a negative potential which, in turn, will reduce the anode current. Provided the signal applied is never large enough to cause more than a fractional reduction in the anode current, there is no question of overloading, and the arrangement works perfectly satisfactorily.

The conditions for high efficiency are:

1. A high-slope valve.
2. Operation around zero grid volts.
3. No anode load, so that one uses the full static slope of the valve.
4. A high grid leak.

The first two requirements are self-evident. It will be obvious, however, that condition 2 means a considerable standing anode current, so that, in the interests of economical running, one is limited to a valve of the HL or L class. Regarding condition 3, it is clear that we are measuring the actual current change, so that we need the highest milliamps per volt, which is obtained with no load in the anode circuit. The grid leak resistance must be high in order that the grid condenser may charge as nearly as possible to the peak value of the applied signal. Theoretically, a very high leak would be most suitable, but this is impracticable. In the first place, the condenser takes a long time to reset itself after the withdrawal of a signal, while secondly a small change in the actual value of the leak will affect the calibration to an appreciable extent. Since no valve is perfectly hard, this means that any small alteration in the ionisation conditions in the valve will cause wandering of the calibration, so that temperature and similar external conditions will cause inaccuracy.

The trouble may be minimised by the use of a special voltmeter triode such as is made by the G.E.C., but in the present instance it was not considered necessary to go to such lengths, and as a compromise a value of three megohms, with a 0.01-mfd. coupling condenser was found satisfactory. Fig. 2 shows the difference in sensitivity with a three-megohm leak and a very high leak. The variation is quite appreciable, but the three-megohm leak gave stable results, whereas the very high leak did not. Incidentally, the values quoted are satisfactory for frequencies down to 50 cycles, the loss at even such low frequencies as this being quite negligible.

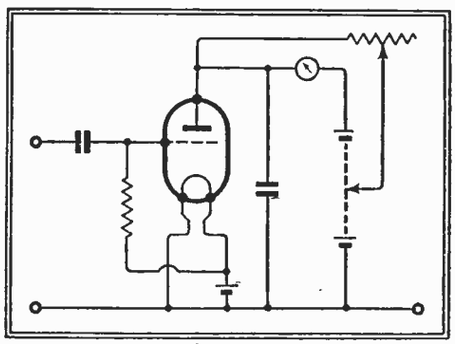

Fig. 1.—Simplified diagram of the grid-rectifying valve voltmeter, with "backing-off" circuit for balancing out the standing anode current.

The grid leak is returned to the positive side of the filament. Returning it to the negative side puts a slight delay on the operation of the grid as a diode, and the voltmeter is then insensitive to signals less than this effective delay. With a small positive bias the grid automatically runs itself back to the optimum condition, and the meter starts to read straight away. The characteristic of the instrument is, unfortunately, of a square-law character in the early stages, so that there is an unavoidable knee in the calibration, but thereafter the relationship between voltage input and deflection is tolerably linear.

The next point to be considered is the current-measuring device. Obviously, the change in anode current will only be quite small, whereas the steady anode current will be several milliamps. To overcome these two conflicting requirements, a sensitive meter is used with an arrangement for passing a reverse current through the meter in opposition to the valve current. The steady anode current is therefore balanced out, enabling a low-reading meter to be used to indicate the change. In the original tests a Cambridge Unipivot meter was employed, but this is expensive, and an attempt was made to find a less costly instrument.

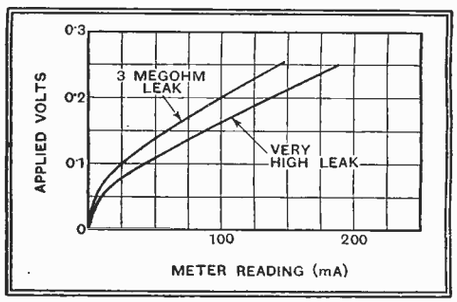

Fig. 2.—Sensitivity may be increased—but at the sacrifice of stability—by using a high-resistance grid leak.

Messrs. Griffin and Tatlock make a small but sensitive meter, known as the Microid Adaptable Galvanometer. The Universal model, wound to 375 ohms resistance, has a sensitivity of 1 microamp per division (100 microamps full-scale), which is admirable for the present purpose. Since this meter in its simplest

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√oltmeter

By J. H. REYNER, B.Sc., A.M.I.E.E.

form (without mirror) sells at 55s. only, it enables the complete instrument to be made for a reasonable price. Actually, it is a galvanometer rather than a micro-ammeter, which means that the deflection per microamp may vary slightly in different parts of the scale, but for the present purpose the inaccuracy involved is negligible.

Using this meter and a PM1HL valve (which proved on trial to be the most suitable), the range of usefulness was from 0.01 to 0.125 volt, while by shunting the meter to one-tenth sensitivity a second range of 0.1 to 1 volt was obtained.

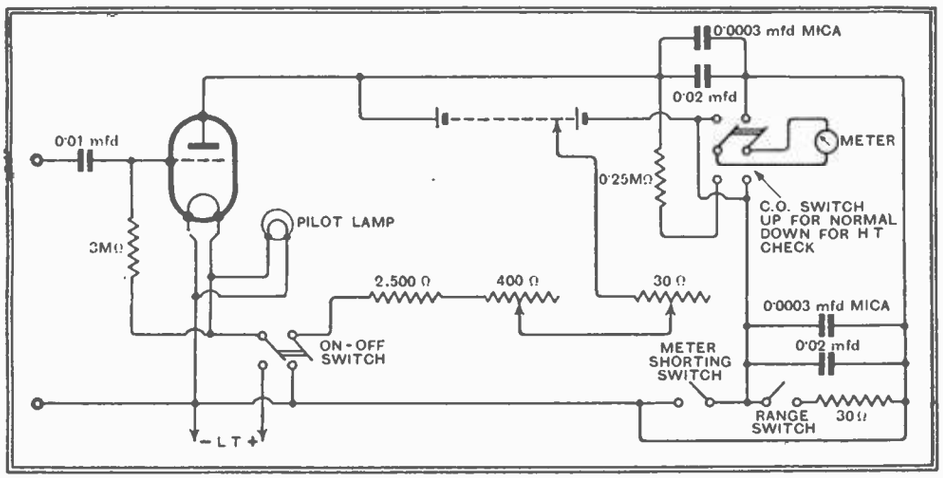


Fig. 3.—Complete circuit diagram of the two-range valve voltmeter.

Balancing Adjustments

The backing-off arrangements are described in more detail later. The resistance through which the balancing current is fed must be large compared with that of the meter itself in order to avoid shunting the meter unduly and thereby reducing the sensitivity, while a really fine adjustment is necessary. To accomplish this, two variable resistors, one of 400 ohms and the other of 30 ohms, are used in series with a fixed resistor of about 2,500 ohms. The actual value of the fixed resistor must be chosen to suit the valve used, since there is rather a wide variation of anode current between different specimens. The adjustment has only to be made once, however, and it was considered preferable to use a fixed resistor rather than incorporate still another variable.

One final point requires to be considered before dealing with the construction—namely, the question of constancy of calibration. With the simple anode bend type of meter the variation of calibration as the HT battery runs down is only small, but experiments showed that with a grid rectifier the variation was serious, a change of 10 volts causing the calibration to alter by some 2½ per cent. It thus becomes necessary to adopt some method of holding the HT voltage reasonably constant. Any form of series resistance or potentiometer is unsuitable, as it introduces a load in the anode circuit which alters the calibration by a greater amount than the variation of HT voltage which it is intended to correct, and the best arrangement is to use a battery having 1½-volt taps at one end or to use a grid battery in series.

A switch on the panel enables the meter to be connected in series with a high resistance across the HT battery so that it becomes a simple HT voltmeter. By adjusting the reading to a suitable figure, the voltage may be checked from time to time and the accuracy of the calibration ensured.

The construction of the meter is self-explanatory. The various operating parts are mounted on a metal panel, folded with a double bend to accommodate the meter. A window is cut in the panel to allow the scale to be seen. There are two adjustments on the meter itself. One is a zero adjustment, which twists the suspension slightly to enable the pointer to be set to zero. In the present instance the actual zero setting is electrical, so that this control is only used to obtain an approximate setting.

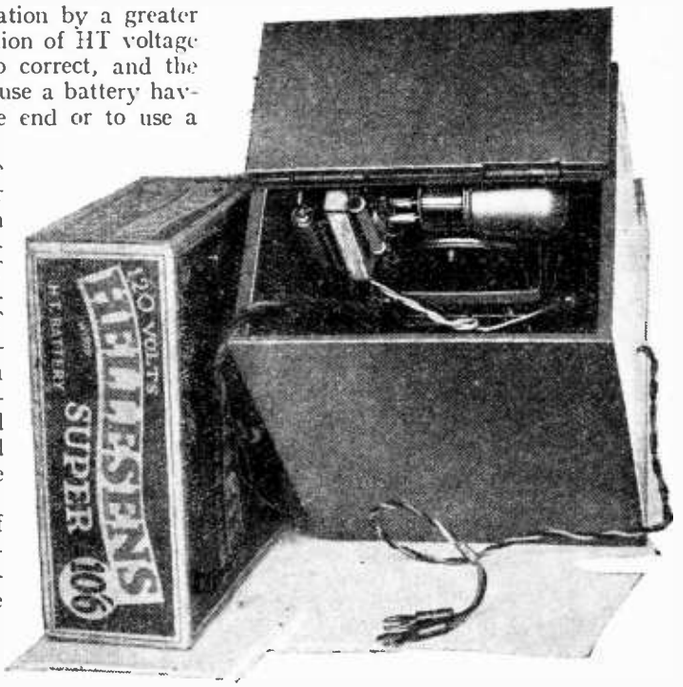
The second adjustment is a locking device, which operates a clamp inside the meter and locks the movement when not in use. This is to prevent the delicate suspension from becoming damaged in transit, and is operated by a small bakelite button on the back of the meter. It is necessary to arrange that this device can be operated from the top of the panel, and has been done by fitting a push-pull switch.

When the meter is first received the locking button is held in the clamped position with a piece of wire passing through a small hole. Cut this wire and remove it. Then take a small length of 16 s.w.g. copper wire and push this through the hole in the button. It will be a nice tight fit, and the end may be bent round and secured with a blob of solder. Be careful not to break the bakelite button in doing this, and see that the button is still in the clamped position while any adjustment is being made, so that the meter is not damaged.

The other end of the wire is then bent over and soldered to the end of a suitable push-pull switch mounted on the panel, this being done with the switch pulled out. A switch with a parallel-sided contact and preferably having a groove or other locating device should be used. When this has been done, pushing the switch in gently should release the pointer of the meter and allow it to swing freely.

The other controls on the panel are as follows:—

(1) An on-off switch.



With the exception of the LT battery, the meter is self-contained. The components are secured to the top panel, and space is provided for the HT battery in the base of the container.

(2) A meter short-circuiting switch. This should always be on when the meter is first used, to avoid damage to the meter if the voltage on the input is too great or if by any chance the balancing adjustment is seriously incorrect.

(3) A range switch which shunts the meter for the insensitive range as already described.

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Sensitive Valve Voltmeter—

(4) An HT check switch which changes the connection of the meter and converts it to an HT voltmeter.

(5) An indicator lamp to denote when the meter is in use. This is desirable because the drain on the HT battery is quite appreciable, and without some warning device there is a risk of inadvertently leaving the instrument "on."

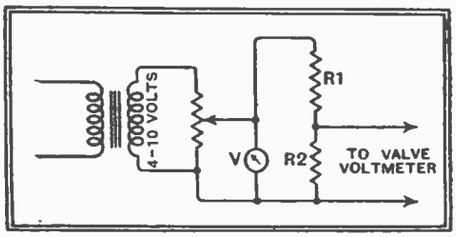

Fig. 4.—Calibrating the meter from the mains with the help of an AC voltmeter.

These controls are on the main panel. In addition there are on the raised front portion the two balancing controls, giving coarse and fine adjustment, as previously described. The connection of the various controls is made clear in Fig. 3.

We can now discuss the setting up and operation of the meter. The first move is the adjustment of the balancing, and for this purpose the galvanometer in the instrument itself should be temporarily disconnected and replaced by a milliammeter reading anything up to 10 mA full scale. On switching on and opening the meter shorting switch, the meter will read. Adjust the backing-off tap on the HT battery to about 10 or 12 volts positive. Variation of the coarse balance control on the panel should now enable the current to be reduced to zero, but if it does not do so the fixed resistor should be decreased slightly. Choose a value which enables the meter reading to be reduced to zero and a little beyond. Preferably, the zero point should occur about the middle of the coarse control.

Adjustment and Calibration

This trial-and-error adjustment has only to be done when the instrument is first set up, or if the valve is changed at any time. Once it has been done, the sensitive meter may be reconnected and the panel screwed in position. On switching on again the meter will probably move gently off the scale to one side or the other. Bring it back with the balancing adjustments, using first the coarse and then the fine, until it is set at zero.

The meter, of course, must be calibrated, and this may conveniently be done by using AC mains. The HT battery should be set to the lowest tap on the extra 9-volt battery, so that, as it runs down, the voltage may be suitably increased from time to time. Set the meter to zero with the LT battery switched off by using the mechanical adjustment already mentioned. Now throw the meter switch to the check position, when a reading will be obtained about three-quarters of the way over the scale. This reading corresponds to the voltage of the HT battery under the calibrating condition, and the value should be noted. Then on any future occasion a simple check can be made to ensure that the battery voltage is approximately correct (within about one division either way of this reference reading). As the battery runs down, the reading in the check position will fall, and thus the HT tapping must be moved up in 1½-volt steps at a time to bring the overall voltage to the correct value.

The actual reading on a meter is, of course, unimportant since no attempt has been made to provide an accurate HT voltmeter, but providing the reading is always kept at the same point the HT battery will be delivering the right voltage and the calibration will be substantially accurate.

The method of calibrating depends upon the apparatus available. If an AC voltmeter is to hand, the circuit of Fig. 4 can be used. A voltmeter is employed to read the voltage across the whole circuit, while a small portion of this is tapped off for application to the meter. By using relatively low resistances, as shown, the

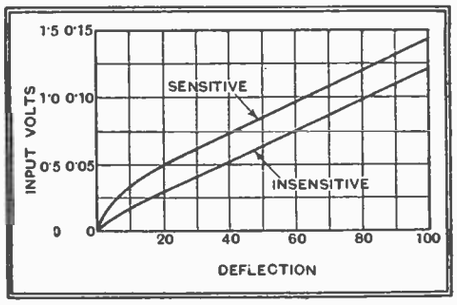

Fig. 5.—Calibration curves of the original meter (PM1HL valve).

input impedance of the meter will have a negligible effect on the calibration, so that if R2 is one-tenth of the total resistance, then the effective input voltage is one-tenth of that given by the meter. By making the ratio 100 to 1 still smaller voltages can be applied.

The actual ratio of resistance depends upon the meter. If the meter reads 10 volts full scale then a 100/1 step-down would be required for the sensitive range. By adjusting the voltage across the whole circuit between 1 and 10 volts in suitable steps the voltage applied to the valve voltmeter will be from 0.01 to 0.1, and the meter reading at each point can be noted and plotted on a graph. For the less sensitive range a 10-1 potentiometer would suffice. The various points should be plotted on a graph and should then all lie on an approximately straight line, except at the very bottom of the scale where the curve bends round somewhat sharply. (See Fig. 5.)

An alternative method of calibration is to pass a known current through a variable resistance. This requires an AC milliammeter, and once again the value of resistance chosen will depend upon the reading of the milliammeter available. The actual voltage, of course, is simply the product of the current in milliamps multiplied by the resistance R in thousands of ohms.

One final point may be mentioned—that of the input impedance of the meter. Since a grid rectification scheme is employed there will be some grid current damping, although this will not be as heavy as with the normal grid rectifier, owing to the almost complete absence of Miller effect. The anode of the valve is by-passed to earth with a large condenser, so that the effective amplification, even at 50 cycles, is practically zero. Under these conditions the input impedance is made up simply of the static input capacity, which is of the order of 15 micro-microfarads, allowing for the valve holder, with an effective resistance in shunt due to the grid current taken on the peaks of the signal. Measurements show that this resistance is of the order of 2 megohms.

Damping Effects

The instrument, therefore, will inevitably introduce some small damping into the circuit at the point where it is used, the relative severity of this depending upon the effective impedance of the circuit under test. At audio-frequencies a shunt of the order mentioned is usually of small importance, while it will only appreciably affect the readings of radio frequencies on quite "good" circuits. The input capacity of the meter will, of course, have an appreciable effect, but, since most of the circuits to be measured will, in any case, feed into a valve having at least as much capacity, if not more, the difficulty introduced from this cause is only small.

The calibration of the original meter appended will serve as a guide. It does not vary much with different valves, though, of course, some alteration is inevitable, but the curves show the order of deflection to be expected with different inputs on the two ranges. It should be

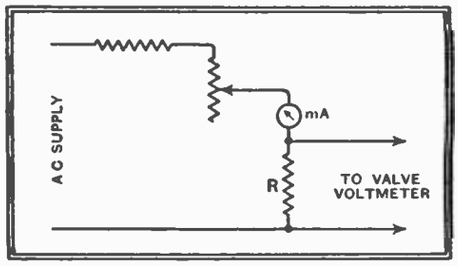

Fig. 6.—Another method of calibration : in this case the current flowing through R is measured, and the voltage developed across it is calculated.

noted, of course, that the balancing adjustment is slightly different on the two ranges, though still within the range of the controls provided the fixed resistance has been correctly made.

In practice this meter has proved both sensitive and accurate. It is not subject to drift to any serious extent, which is an important point, and it enables many measurements to be made which would otherwise be impossible. It is suitable for any frequency from 50 cycles to 20 megacycles, and was, in fact, developed for short-wave work.

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Extension Speaker Control

Easily Made Attenuator for Regulating Volume

By R. H. WALLACE

NOW that extension speakers are being more widely used the problem of volume control of such a speaker at the remote point is a very real one, as it is often required to lower the volume without going to the set.

The two usual methods are by resistance in series or by potentiometer; of these the former is the worse in its effects, as in order to effect a reduction of 10 db. it is necessary to use a resistance up to 3 times the speaker impedance, and the consequent mis-matching and loss of quality are serious, whilst the effect upon an output pentode and its associated components if the set speaker is silenced and the load is increased thus to 4 times the normal is likely to lead to a much shorter life. The potentiometer, especially if connected on the low-impedance side of the speaker transformer, is less disturbing, though here the impedance varies greatly. Both methods affect at the same time the volume of any other speaker connected to the set.

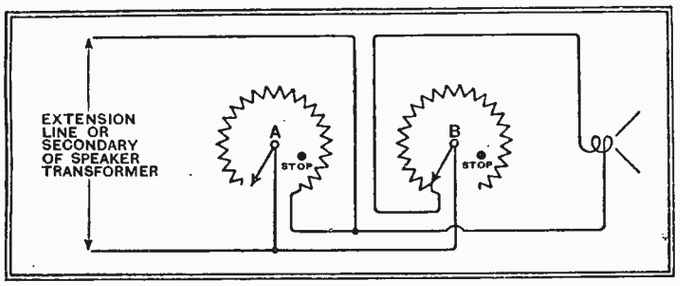

Fig. 1.—How the ganged rheostats are wired to the speech coil: the control is shown in the position corresponding to maximum volume.

The only real solution is an attenuator such as is used by broadcasting stations, talkie equipments and PA apparatus which presents to the extension line a constant impedance no matter what the setting of the control. These have to be calculated for each speaker impedance and are very expensive, besides being bulky.

It is the purpose of this article to describe the construction of a simplified version of an attenuator which, while not accurate enough for measuring purposes, is quite good enough for a loud-speaker volume control. It is robust, simple to make and, above all, extremely cheap. The control described gives an attenuation of about 10 db. at minimum, and while this might seem hardly enough for an ordinary volume control, is quite sufficient for an extension speaker where the volume has only to be reduced from the normal highest volume level of the set, and where in any case it is not desirable to reduce it to inaudibility in case users forget to switch the set off. The control has no appreciable effect on the volume of other speakers connected.

The construction will first be described with reference to a 2-ohm impedance speech coil, which is the commonest value for extension speakers and the method of calculation and alteration necessary for other speech coils will be dealt with later. The apparatus required is easily obtained, being two 6-ohm filament rheostats, which many enthusiasts will already have as relics of "bright emitter" days, or which can be purchased for a few pence from "surplus" dealers. These have to be ganged together "back to back" with spindles connected, so that while one is at the minimum resistance position the other is at the "off" position beyond the maximum resistance. The spindles are connected both mechanically and electrically, or are replaced by a common long spindle which may be a piece of 2 BA rod and on which both moving arms are locked. The bodies of the rheostats may be rigidly connected by two pieces of screwed rod as long as these are in such a position as to give a free movement of about 0.7 of the normal travel of the arms.

There is a G.E.C. type rheostat now on sale in many shops which is particularly easy to gang; this is the type with the element strip-wound and placed inside an insulating cylinder. With these it is easy to gang by two 6 BA screws and nuts, holding the two together, one screw being prolonged to stop the travel of the arms at about 0.7 of the maximum. The spindles are removed and replaced by a piece of 2 BA rod with suitable flats to engage with the moving arms; a bracket of sheet metal may be interposed between the two bodies to fix the assembly to the cabinet.

The mechanical side of the business being done, it only remains to connect up as shown in the diagram, taking care, if the speaker is of the high-resistance type, to break the secondary leads of the transformer and interpose the control there. Of course, two high-resistance rheostats could be used on the high-impedance side of such a speaker, but would be more expensive and would sacrifice the robustness of the control described, which is one of its most attractive features.

A study of the diagram will show the manner of operation, while the graph in Fig. 2 is plotted from the calculated values at 13 equi-distant positions of the arms arbitrarily chosen. It will be clear that when the control is at maximum, no resistance is in series with the speech coil and the shunt resistance is open-circuited; the impedance to line is 2 ohms and the attenuation zero. Consider position 2, the line is shunted by 7 ohms, and the speaker coil of 2 ohms is in series with a further 0.5 ohms; combining these impedances by the usual law, we get the resultant impedance to line as 1.71 ohms. Similarly in position 3 the shunt resistance is 5.5 ohms and there is 1 ohm in series with the speech coil, giving a resultant of 1.94 ohms. The proportion of the line voltage across the speech coil is, of course, equal to the coil impedance over the impedances of coil plus series resistance, and the ratio is translated into decibels and then doubled to give attenuation of speaker output.

Constant Loading

It will be observed that this is remarkably uniform for such a makeshift arrangement. The curves show that the impedance to line begins to fall very rapidly after about the 9th position, and it is for this reason a stop is put to limit the travel of the arms since otherwise the purpose of the control would be defeated. Between the limits adopted the impedance is at its highest 2.12 ohms, and at its lowest 1.71 ohms, both quite near enough in practice.

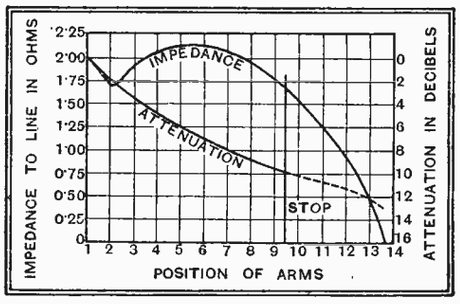

Fig. 2.—Impedance of the line is sensibly unaffected over a 10-decibel range.

For speakers of 7½ ohms impedance, a rheostat of 22.5 ohms should be used; the standard value of 30 ohms will work quite well though, and for 15-ohm speakers, 45 ohms is the correct value, but the standard value of 50 ohms will be found sufficiently near. The double action of the control helps to reduce the discrepancy.

Users of this form of control who have had previous experience of the more usual methods will be pleasantly surprised at the quality of reproduction at low volume levels, and the absence of the usual modification of the built-in speaker's quality and volume when the extension volume is turned down.

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The Television Receiver

V.—THE DETECTOR AND ITS ASSOCIATED CIRCUITS

By W. T. COCKING

ALTHOUGH any type of detector can theoretically be used in a television receiver, the diode is almost invariably adopted. The requirements for a satisfactory performance are discussed in this article and both single-diode and push-pull detectors are treated. In addition, a voltage-doubler detector which is especially advantageous in television is described.

IN television reception the detector need differ little in essentials from the arrangements normally adopted in sound reception. A diode detector is naturally best when the cathode-ray tube is to be fed directly from it, for there is no steady voltage with it which must be balanced out. Nevertheless, there are certain differences which occur in practice owing to the necessity for retaining very high modulation frequencies in the output.

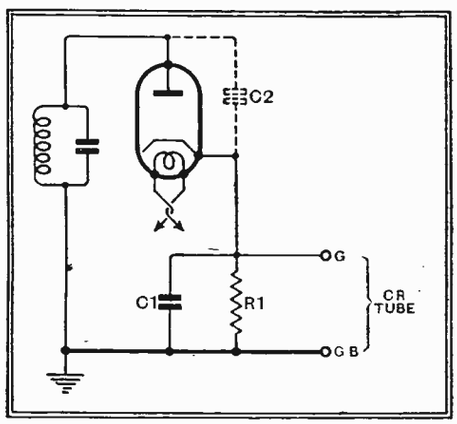

Fig. 12.—The connections of a single diode detector are shown here. The condenser C2 represents the anode-cathode inter-electrode capacity.

The basic connections are shown in Fig. 12 and ideally the reactance at the highest modulation frequency of the various capacities which are effective in shunting R1 should be very high compared with R1 in parallel with any other resistance which may be in shunt with it, while at the input frequencies the reactance of C1 should be very low compared with the detector impedance. These requirements are often mutually incompatible and we must usually sacrifice efficiency to quality.

A filter in the detector output circuit is often impracticable, and then the input capacity of the CR tube—some 15 $\mu\mu$F—appears in parallel with C1, and from the point of view of the vision frequencies C2 is also in shunt with it. This capacity is the anode-cathode capacity of the diode and is about 4 $\mu\mu$F; the total capacity is thus 19 $\mu\mu$F plus C1 plus the stray wiring capacities, or say 25 $\mu\mu$F plus C1. From the point of view of the IF input the capacity shunting the diode load is the same but minus C2, or 21 $\mu\mu$F plus C1.

It is thus obvious that the circuit resistances must be kept small. Actually the time constant CR for a 3 db. loss at 2.0 Mc/s must be 51,500 (C in $\mu\mu$F., R in ohms). If we assume that C1 = 10 $\mu\mu$F, the total capacity is 35 $\mu\mu$F, so that the resistance must not exceed 1,470 ohms, which is an exceedingly low value. The resistance to be used is R1 in parallel with the AC resistance of the diode to modulation frequencies and we must consequently choose a low-resistance diode such as the Osram D42.

The AC resistance is by no means a constant figure, for it depends on the load resistance and upon the input. It is, however, of the order of 1,500 ohms with R1 = 7,000 ohms and a normal television input, so that the above conditions can be fulfilled.

The Load Circuit

Now it is to be noted that to avoid attenuation of the higher modulation frequencies the diode load impedance must be kept of a moderately high order up to perhaps 2.0 Mc/s. On the other hand, the input must be applied to the detector through this circuit, so that if it offers appreciable impedance to the input frequencies only a proportion of the input will ever reach the detector. Furthermore, it is possible for the circuit impedance to vary within the sideband range, when it will attenuate the lower sideband frequencies more than the high. This occurs in the case of single sideband working; with an intermediate frequency of 3.0 Mc/s the sidebands may extend from 3.0 Mc/s to 1.0 Mc/s, whereas the rectified output is from zero to 2.0 Mc/s. From the point of view of the input R1C1 must be of low impedance, whereas to deal with the output they must be of high impedance. As the two frequency ranges overlap, a solution is impossible.

When a high intermediate frequency is used, however, no such difficulty arises and the circuit is quite a feasible one. In order to secure an output of 30 volts p-p, the input must be about 30 volts RMS or 42.5 volts peak. The output required from the preceding stage must be greater than this, however, because the full output can rarely be applied to the detector valve itself. An output of at least 50 volts peak should be legislated for.

If we adopt a parallel-resistance type tuned circuit of the type described earlier in these articles, the shunting resistance must be of the order of 1,000 ohms in order to prevent sideband cutting. The output voltage must be developed across a resistance of this order so that the power will be something like $50^2/2 \times 1{,}000 = 1.25$ watts. In practice it is very difficult to find a valve which will give this output into a load resistance which is as low as 1,000 ohms. In the writer's experience the best course is to use a low-capacity output pentode, such as the N43, for the last IF valve, and to tolerate an increased amount of sideband cutting in the coupling to the detector, reducing the gain of the earlier stages in order to permit compensation for the increased attenuation of the higher modulation frequencies.

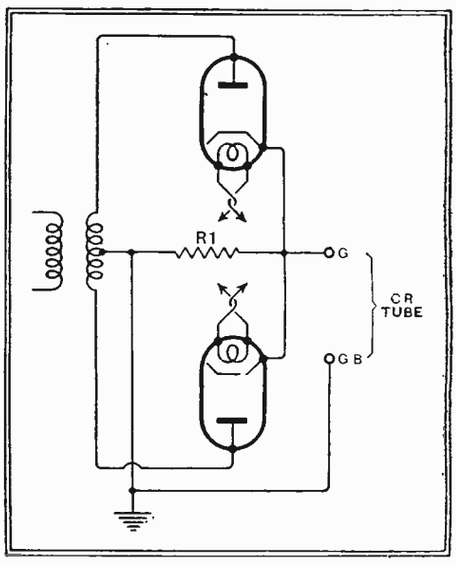

Fig. 13.—Two diodes are needed for a push-pull detector and the input transformer must be very carefully designed.

When we wish to adopt a low intermediate frequency a different form of detector must be used. The usual course is to employ two diodes connected as a full-wave rectifier of the push-pull type as shown in Fig. 13. No by-pass capacity is required across the load resistance R1, but as for vision frequencies there is the capacity of an additional valve across it, the total effective capacity is little different. Accordingly R1 must still be of the order of 7,000 ohms.

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The Television Receiver—

Because of the push-pull connections the input frequencies do not flow through the VF load circuit so that no difficulty exists even when the sidebands overlap the vision frequencies. Moreover, with good balance no appreciable IF potentials of fundamental frequency are developed across R1 but only the second harmonic of the intermediate frequency. It is consequently theoretically possible to use an intermediate frequency of one-half the value of that needed with the single diode to prevent the IF from appearing on the screen.

All is not gain, however, for the detector requires a larger input than the single diode to provide the same output. With one diode we rate the detector efficiency as 100 per cent. when the DC output voltage equals the peak IF input. On this basis the efficiency of a single D42 with a 7,000 ohms load is 70 per cent.

The Push-Pull Detector

With the push-pull circuit, the true detector efficiency will be higher and probably about 85 per cent., and there is no loss in the load circuit. Consequently, to obtain 30 volts output we shall need some 35.4 volts peak input, or 25 volts RMS per valve. The total will thus be 70.8 volts peak, or 50 volts RMS, across the transformer secondary, so that the true efficiency of the stage as a whole is about 42.5 per cent. In the ideal case, the efficiency of a push-pull detector expressed on a voltage basis, and taking no account of power, is 50 per cent. as compared with 100 per cent. for a single diode. The question of the input power of the detector does not interest us because the circuit capacities prevent us from matching impedances properly. For the same circuit impedance the push-pull detector demands in the ideal case four times the power output from the last IF stage that the single diode needs. In practice, it will need only 2.5-3 times the power.

The necessary input transformer is another drawback. If proper push-pull operation is to be secured the windings must be well-balanced, and the secondary really ought to be screened from the primary. In order to obtain the necessary band-width of perhaps 1-3 Mc/s, the windings must be of low capacity and the primary and secondary very tightly coupled. These requirements are opposing and it is very difficult to secure tight coupling with low capacity as well as properly balanced operation. As a result, both primary and secondary must be heavily damped with parallel resistances.

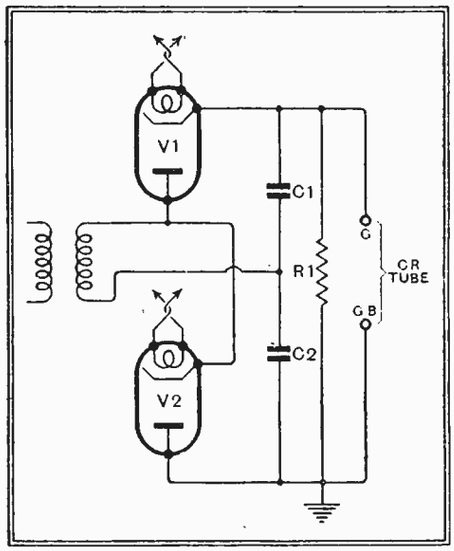


Fig. 14.—An input transformer is needed with the voltage-doubler detector, but its design is not difficult.

Assuming correct proportioning of the various elements, the last IF valve works into a load equal to one-half the primary shunting resistance. If a triode is used, however, its own AC resistance can provide the necessary primary damping and it works into a load equal to its own resistance. The net result is that when a triode is employed it need deliver only one-half the power that a pentode would have to give in order to provide the detector with the same input voltage. For this reason, and because it is almost impossible to secure a pentode which will give sufficient output into the low load impedance with which it can only be provided, a triode is usually adopted for the last IF valve.

It is, however, by no means ideal, for it gives very low gain, usually about three times only, so that it requires quite a large input itself. Moreover, it has a very high input capacity so that the preceding stage can give only low gain and can only operate into a low load impedance. Sometimes it is necessary to use an output-type pentode in the penultimate stage in order to feed the last triode. It is apparent that single sideband working at low carrier frequencies loses much of its attractiveness when such measures are necessary, for the low gain of the last IF stage and the poor detector efficiency largely offset the greater gain obtainable in the early stages.

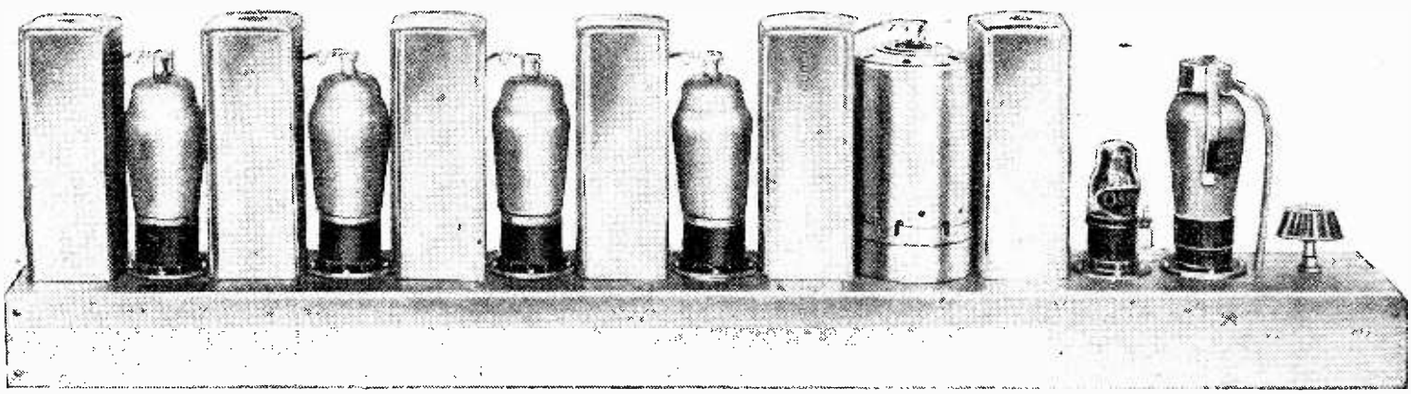
The Voltage-Doubler

There is, however, another way of obtaining full-wave detection, and that is by means of the voltage-doubler. If the ideal efficiency of the single diode is 100 per cent. and that of the push-pull detector 50 per cent., the ideal efficiency of the voltage-doubler is 200 per cent.! Assuming the same impedance for the input circuits in each case, the power requirements would be related in the ratios 16, 4, 1 for the push-pull, single diode, and voltage-doubler. It is apparent that this form of detection ought greatly to relieve the difficulties in the last IF stage, and the circuit is obviously one which merits careful consideration.

The connections are shown in Fig. 14, and it will be seen that a transformer input is needed. As a tapping is not required, however, no special balancing is necessary and it becomes comparatively easy to build it. The writer has constructed transformers having a good response over the enormous range of 0.3-4.5 Mc/s, far wider than is necessary for present-day television.

The condensers C1 and C2 are made of equal capacity, but as far as their effect upon vision frequencies is concerned they are in series, as are also the valve capacities. It is, however, probably more convenient to consider the circuit from the standpoint of two single-diode detectors operating alternately on opposite half-cycles of the input in the manner shown in Fig. 15. Here the load resistance is split into two equal sections, R1 and R2, each of one-half the value of R1 of Fig. 14, and the input capacity of the CR tube is split into two equal sections, C3 and C4, each of *double* the normal capacity.

Arguing on similar lines to those



The single-diode detector can be seen in this experimental receiver adjacent to the last screening can.

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The Television Receiver—

adopted in the case of a single diode we find that the total capacity effective on each diode at vision frequency is likely to be about 54 $\mu\mu$F, so that the effective resistance ought to be about 960 ohms only. This is a lower figure than we found for

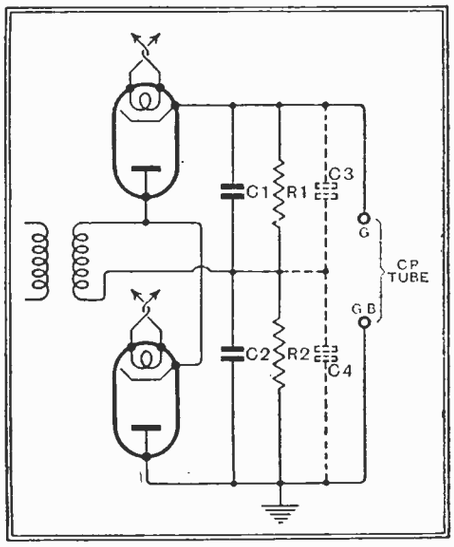


Fig. 15.—The voltage-doubler detector can be regarded as two diode detectors with their output in series.

a single diode, but can nearly be met by making R1 (and R2) 5,000 ohms. This makes the single resistance of Fig. 14 10,000 ohms.

Since the rectifier is of the full-wave type the fundamental input frequency does not appear across the output terminals, but a component of twice the input frequency. As regards the appearance of IF on the screen, therefore, it is as good as the push-pull connection.

As regards the difficulty of making R1 C1 of low impedance to all input, but of high impedance to all output, frequencies, however, we are as badly off as with the single diode. The difficulty can be got over in the same way—by the use of a higher intermediate frequency. A satisfactory compromise would seem to be to leave a gap of about 0.5 Mc/s between the highest vision frequency and the lowest sideband frequency. For modulation frequencies up to 1.5 Mc/s, this would give 3.5 Mc/s as the lowest permissible intermediate frequency, and at this frequency the IF stage gain will be only slightly lower than at 3.0 Mc/s.

To obtain an output of 30 volts p-p the input is likely to be about 25 volts peak, so that the power output of the last IF valve need be no more than 0.3 watt or so. Actually it will be less, because with transformer coupling at 3.0 Mc/s the load on the valve will be higher than 1,000 ohms. In actual practice it is easy to secure an output of 60 volts p-p from two D42 valves in the voltage-doubler circuit fed from an N43 pentode. This is about double what we need and opens up the possibility of using an RF pentode as the last IF valve.

Practical experience shows that when the intermediate frequency is above some 3-4 Mc/s the ordinary half-wave detector is as good as the full-wave from the point of view of IF potentials appearing on the screen. At frequencies above 6-7 Mc/s, the loss of IF input in the output load circuit and of VF output in the input IF coupling is small and it is just possible to obtain an output of 30 volts p-p from a single D42 detector fed from an N43 pentode, and 60 volts p-p from two D42 valves in the voltage-doubler circuit. At lower intermediate frequencies, of the order of 3-4 Mc/s, it is difficult to obtain more than 20 volts p-p from a single detector, but 40 volts p-p or even more can be obtained with the voltage-doubler.

When the interference problems dealt with in Part IV are taken into consideration it is clear that the use of a low intermediate frequency has many disadvantages—so many, in fact, that in the writer's opinion they more than outweigh the higher stage gain which it is possible to secure.

The writer has constructed a number of IF amplifiers having intermediate frequencies ranging from 2.5 to 10.0 Mc/s, and has experienced the various difficulties referred to in these articles. The general performance of the amplifiers operating at the higher frequencies has been much better than that of those working at the lower and in the light of his experience he has no hesitation in saying that a frequency of some 5.0 Mc/s should be the lowest adopted. This does not, of course, mean that good results cannot be secured at a lower frequency. Undoubtedly they can, but not so easily, and the apparatus is likely to be harder to adjust.

The use of a still higher intermediate frequency would offer some advantage from the interference point of view, but one cannot go far in this direction without prejudicing the position of the superheterodyne. As the frequency is raised so stability problems increase, and if one chooses too high a frequency one might just as well use a straight set. Incidentally, it may be remarked that the discussion of intervalve couplings and detector circuits applies as much to the straight set as to the superheterodyne.

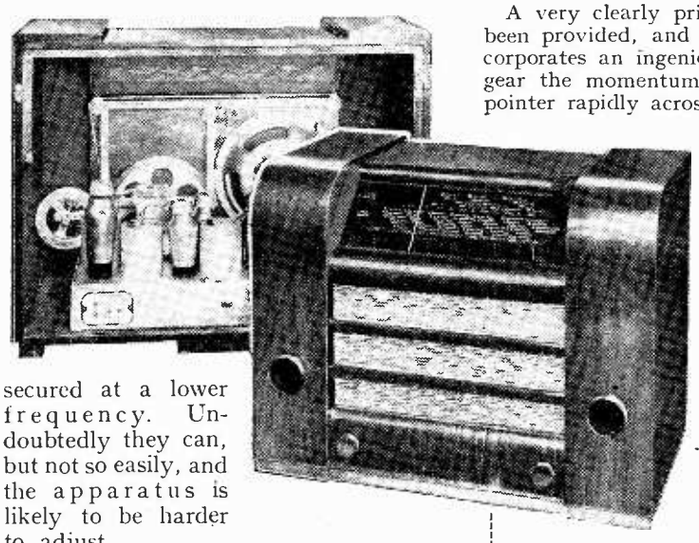
Before concluding some remarks on the question of single and double sideband working should be made. Because we have concluded that low intermediate frequencies, at which single sideband working is usually adopted, are undesirable, we have not discriminated in any way between the two systems. If we require modulation frequencies up to 2.0 Mc/s, we can work at a high intermediate frequency and provide a band-width of 4.0 Mc/s for the retention of both sidebands, or we can build our circuits for a band-width of 2.0 Mc/s only, tune the receiver so that the carrier lies at one edge of the pass-band and so work single sideband. Ideally we should obtain double the gain per stage in the second case, but in practice the benefit is not likely to be as great as this.

New Halcyon Sets

TWO new Halcyon receivers have been introduced by Ismay Distributors, Ltd., Sterling Works, Dagenham, Essex. They are an AC superheterodyne (Model A581) and its AC/DC equivalent (Model U6801). Both models have a short-wave range (16.5 to 51 metres) in addition to the usual medium- and long-wave bands, and as far as the second detector the circuits are the same, viz., triode-hexode frequency-changer, pentode IF amplifier and double-diode-triode. In the output stage there is a single high-slope pentode in the case of the AC model, and two pentodes in parallel in the universal model.

A very clearly printed tuning scale has been provided, and the tuning control incorporates an ingenious flywheel reduction gear the momentum of which carries the pointer rapidly across the scale if desired, but at the same time permits a high degree of accuracy in final adjustment.

The power consumption of the AC model is 76 watts and of the AC/DC 82 watts. The prices are 15 guineas and 16 guineas respectively.



The new Halcyon sets incorporate an ingenious flywheel tuning gear which may be seen on the extreme left of the interior view of this AC model.

India to China, by "The Buzzards." Pp. 16, 10 illustrations. Published by Eyre and Spottiswoode, Ltd., 6, Great New Street, London, E.C.4. Price 2d.

MANY methods of learning Morse have been put forward from time to time, but one of the most ingenious of these has just been brought to our notice. It consists of a book dealing with the adventures of two children in the Indian Ocean—written entirely in the Morse Code. The story, although primarily intended to appeal to Boy Scouts, is sufficiently interesting to hold the attention of other readers. N. P. V.-M.

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CURRENT TOPICS

News of the Week in Brief Review

Berlin's Signature Tune

THE programmes of the Berlin station are now closed by a melody played on a night-watchman's horn of a type used in medieval times. The melody is reproduced from a gramophone record, and is followed by the German National Anthem.

A Blind Transmitter

AN instance of the strong feeling of *esprit de corps*, usually translated as "ham spirit," existing among amateur transmitters, is the fact that Brighton amateurs are building a transmitter for a blind colleague who has recently obtained a transmitting licence.

The P.M.G.'s Speech

ACCORDING to a statement made in the House of Commons by the P.M.G., the number of relay exchanges now licensed is 334. These licences will expire at the end of 1939. The P.M.G. also referred to a proposal that it should be made possible for poor and needy listeners to pay their licence fees in half-yearly instalments. To adopt this proposal, said the P.M.G., would involve a very great deal of expense out of all proportion to the advantages derived therefrom.

Russian Television Plans

IT has been announced by M. Schostakovitsch, the Soviet television director, that the order for the new Moscow television transmitter has been placed with an American firm. It is hoped that the transmitter will be delivered in April. A Russian firm has been given the contract for supplying the Leningrad transmitter. It is hoped that by the end of the year a third station will be opened at Kiev.

Loud Speaker Demonstrations

A LECTURE and demonstration of the Voigt loud speaker will be given by Mr. P. G. A. H. Voigt, B.Sc., at Kettering on Monday, March 15th. Applications for admission should be made to the Secretary, the Kettering Radio and Physical Society, 9, Shaftesbury Road, Kettering.

On the following day, March 16th, Mr. Voigt will be lecturing at Bradford, and full particulars may be obtained from the Secretary, the Bradford Radio and Physical Society, 23, Baslow Grove, Bradford.

January Licence Figures

THE number of licences in existence in Great Britain at the end of January was 8,071,464. In France it was 3,329,628, and in Belgium 888,168.

Air Ministry Annexes 2LO's Original Home

AS old listeners will remember, the famous 2LO station was originally situated in Marconi House. In this building, which housed the transmitter, studios and administrative offices of the B.B.C., the first experimental concerts were given in 1922, a regular service being inaugurated on November 14th. The offices and studios were moved to Savoy Hill on May 1st, 1923, although the transmitter remained at Marconi House until February, 1925. This famous building has now been taken over by the Air Ministry as an annexe to Adastral House, its headquarters, which are a few yards away.

A Temporary Reprieve

THE German Supreme Court has been reviewing the cases of several prominent figures of the pre-Hitler broadcasting world, who were sentenced to various terms of imprisonment in 1933 for being too free in their financial arrangements. As a result of this enquiry the Court has ordered a new trial in several cases.

Brighter Programmes Contest

THE authorities responsible for the programmes broadcast from the Cologne station have set aside a sum roughly equal to £1,000, out of which to award prizes for new broadcast material in the nature of light music, dance music, comedies and operettas. The competition is only open to Germans.

Spate of Midget Sets

OF late there seems to be a regular "smallest-set-in-the-world" epidemic, possibly in view of the needs of the waiting crowds in the forthcoming Coronation celebrations. Even in foreign countries they are being produced, however, and the latest to come to our notice is the invention of M. Arthur Kielsen, a Danish engineer, whose instrument is said to be capable of being carried in the waistcoat pocket. Possibly they wear very large waistcoats in Denmark, or it may be that the receiver is related to the ingenious crystal set produced by a British amateur a few years ago which was so compact that, according to its inventor, it could be placed in a hollow tooth.

Police loud-speaking equipment of the type now in general use by Scotland Yard. The amplifiers are made in their own engineering department, whilst the loud speakers and microphones are productions of Film Industries Ltd.

Radio Taxes Remitted

THE German Army has been freed from all taxation in connection with radio apparatus. Permits are no longer required from the Reichspost for the use of wireless gear.

Radio at Leipzig Fair

OWING to the fact that restrictions prevent the unlimited introduction of new models of German radio receivers at this period, the famous Leipzig Fair was far less interesting than it used to be from the radio point of view. For the most part the exhibits consisted of improved models of existing types. There were several so-called novelties, including a clock which switches the set on and off at certain times for which it has been preset by the user. It will be remembered that these programme clocks were introduced at Olympia several years ago, but never enjoyed any very great popularity.

British-built Station for Czechoslovakia

IT is announced that a contract has been signed between Marconi's Wireless Telegraph Co. and the Czechoslovak administration for the supply of a high-power broadcasting station to be installed near Brno. This proposed station will take the place of the existing 32-kW transmitter which has been in operation for a number of years.

The new station will operate with an unmodulated carrier power of 100 kW, but the design of the station is such that it can be increased to 200 kW without undue complication. The frequency response will be of a high order, namely, plus or minus two decibels over a band of 35 to 10,000 cycles per second. The distortion factor will be low and will not exceed 4 per cent. at 90 per cent. modulation. A crystal drive with a stability of five in one million will ensure that the most stringent stabilisation requirements are fully met.

SPECIAL RECORDING NUMBER

Next week's issue will be mainly devoted to the subject of sound recording. The equipment now available will be reviewed and illustrated, and special attention will be paid to apparatus suitable for home recording.

Special articles will deal with the various aspects of this subject. In addition full constructional details for an amplifier designed especially for home recording will be given.

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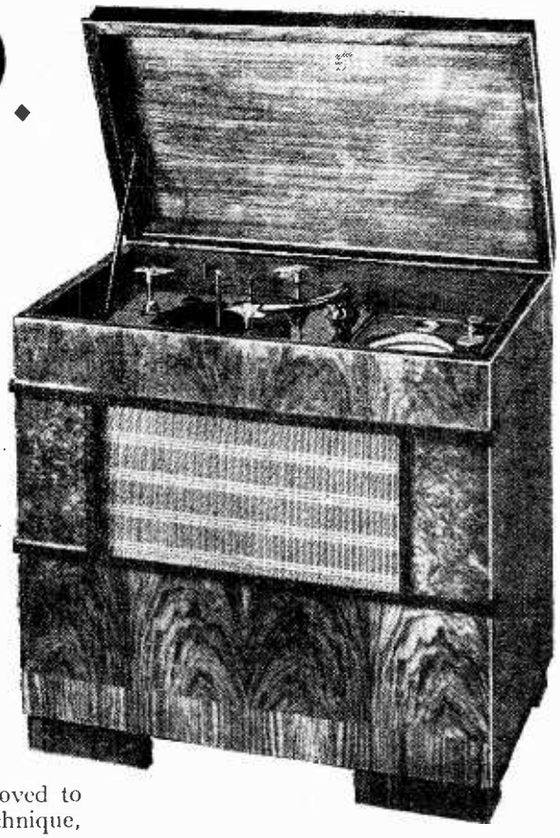
R.G.D.

MODEL 880

Radiogramophone of Outstanding Qualities



FEATURES. — ***Type.*** — *All-wave radiogramophone with record-changer for AC Mains.* ***Waveranges.***—*(1) 16-50 metres. (2) 45-150 metres. (3) 200-550 metres. (4) 850-2,000 metres.* ***Circuit.***—*Pentode RF amplifier—triode-hexode frequency-changer—pentode IF amplifier—double-diode-triode second detector—triode phasing valve—push-pull triode output valves. Full-wave valve rectifier.* ***Controls.***—*(1) Tuning. (2) Volume. (3) Variable selectivity. (4) Tone, and silent tuning switch. (5) Waverange. (6) Internal loud speaker switch. (7) Mains on-off switch.* ***Price.***—*80 guineas.* ***Makers.***—*Radio Gramophone Development Co., Ltd., Globe Works, Newtown Row, Birmingham, 6.*

THERE are certain characteristics which, to the initiated, mark this instrument unmistakably as an RGD product. Its powerful and full-bodied tone, the solidity and perfect finish of the cabinet, and the little attentions to hidden details of workmanship all form part of a policy which in the course of years has acquired the status of a tradition.

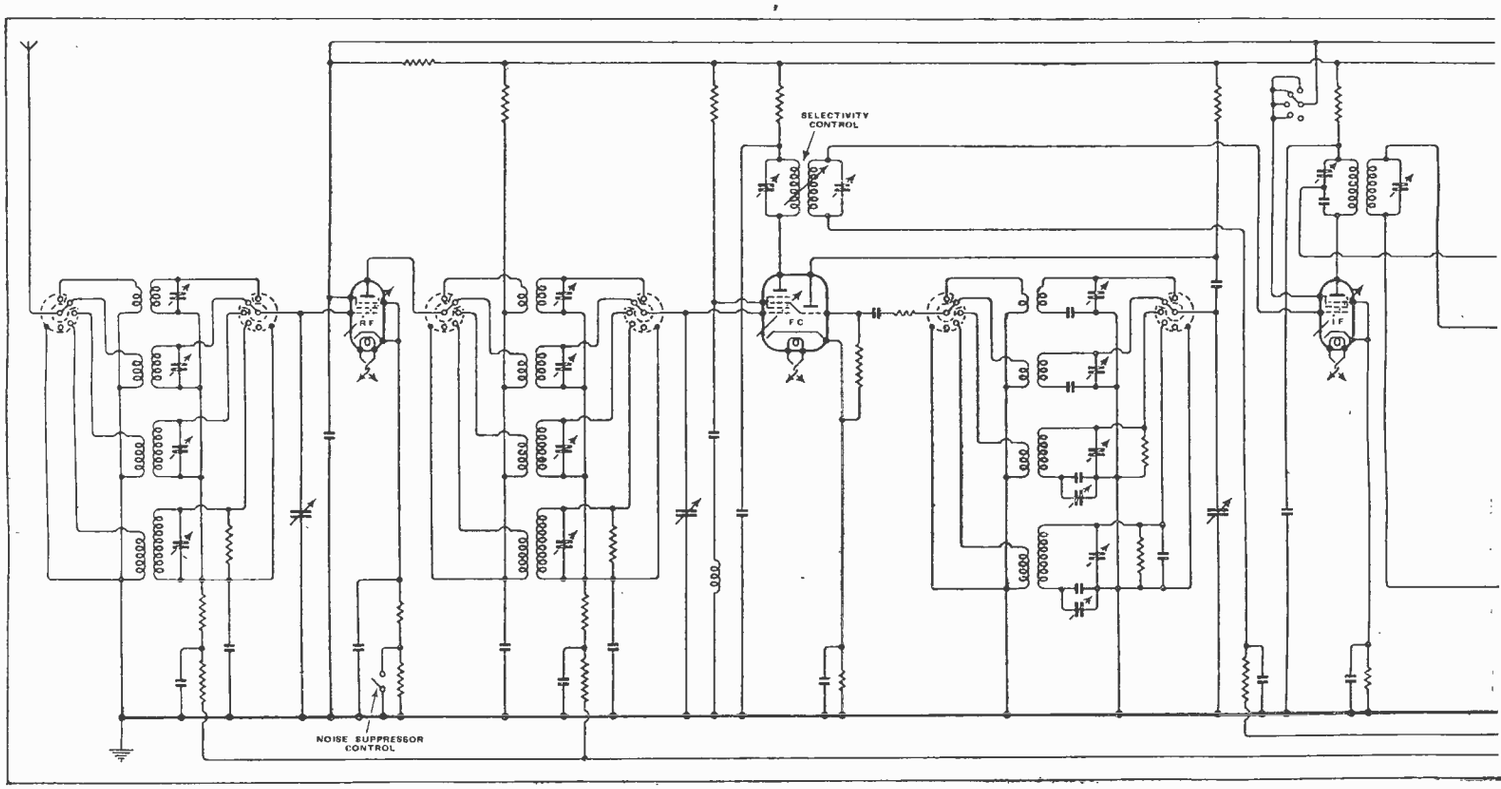
At the same time the designers have never been slow to adopt new developments in valves and circuits when these have been proved to be a permanent step forward in technique, and not merely a passing vogue or a means of cheapening production costs. The season's new models all make provision for short-wave reception, and in the Model 880 we find such refinements as variable selectivity, silent tuning between stations, and a 6-watt push-pull output stage.

As far as the general layout is concerned, the circuit is perfectly straightforward. There is an RF amplifier preceding a triode-hexode frequency-changer with transformer coupling between the two valves. The circuits associated with the four wavebands are switched in such a way that all coils not in use are shorted to earth. The standing bias on the RF amplifier is increased by a switch operated by the "muting" control to reduce sensitivity.

A frequency of 465 kc/s has been chosen for the single IF amplifying stage, in which the first of the two tuned transformers has variable coupling. During the reproduction of gramophone records the radio side is silenced by a switch arranged to remove the screen potential on this valve. A double-diode-triode is used in the second detector stage, which provides delayed AVC and first-stage LF amplification. The AVC control is graded, and a lower potential is supplied to the IF stage than to the two preceding valves. A cathode-ray tuning indicator is controlled from the signal rectifier circuit.

The Output Stage

The circuit up to this point is contained in the radio chassis, and the push-pull out-



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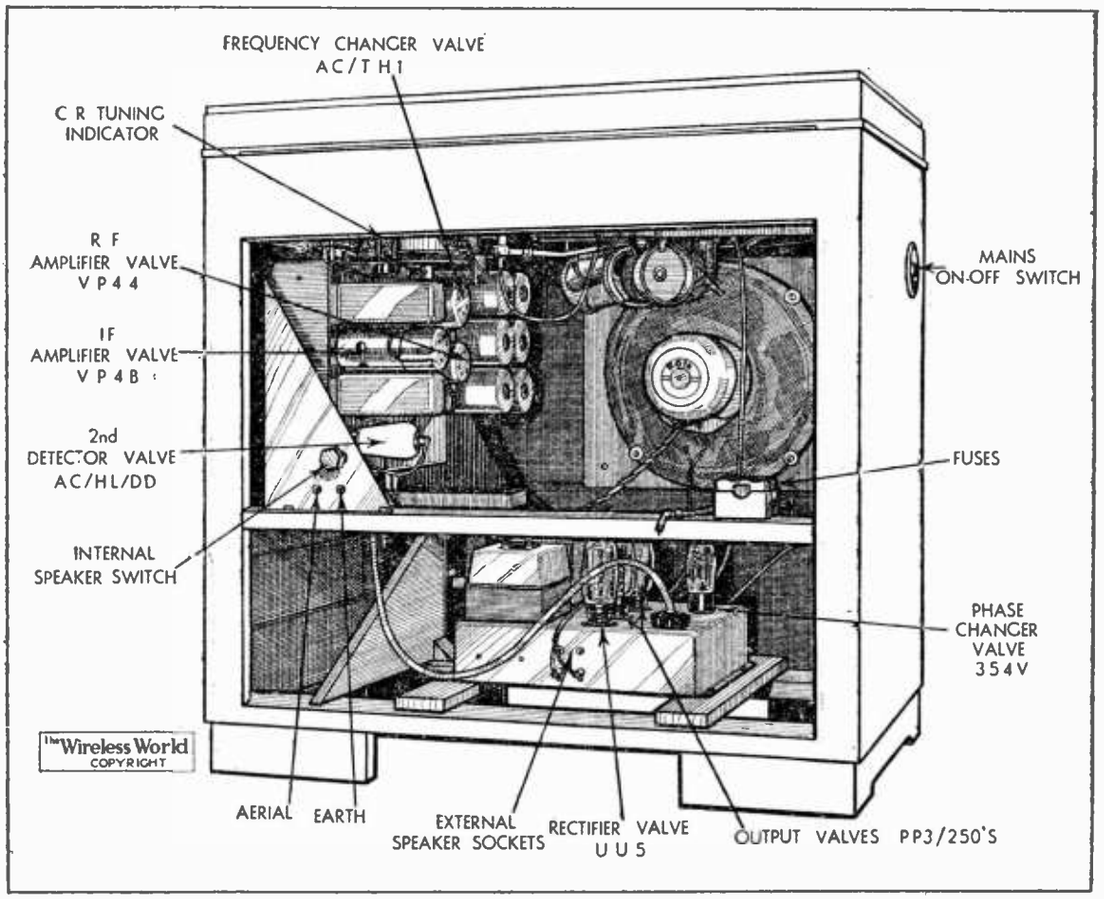
put valves, together with their phasing valve and the power rectifier, are situated in a separate power amplifier at the bottom of the cabinet. Resistance coupling is used throughout the audio-frequency stages, and in the coupling between the second detector and the phasing valve there is a switched tone control, which varies both the size of the coupling condenser and the shunt across the grid leak. The output stage feeds a 12-inch energised speaker with a frequency range of 40-8,000 cycles. A switch is provided at the back to silence the internal speaker, if desired.

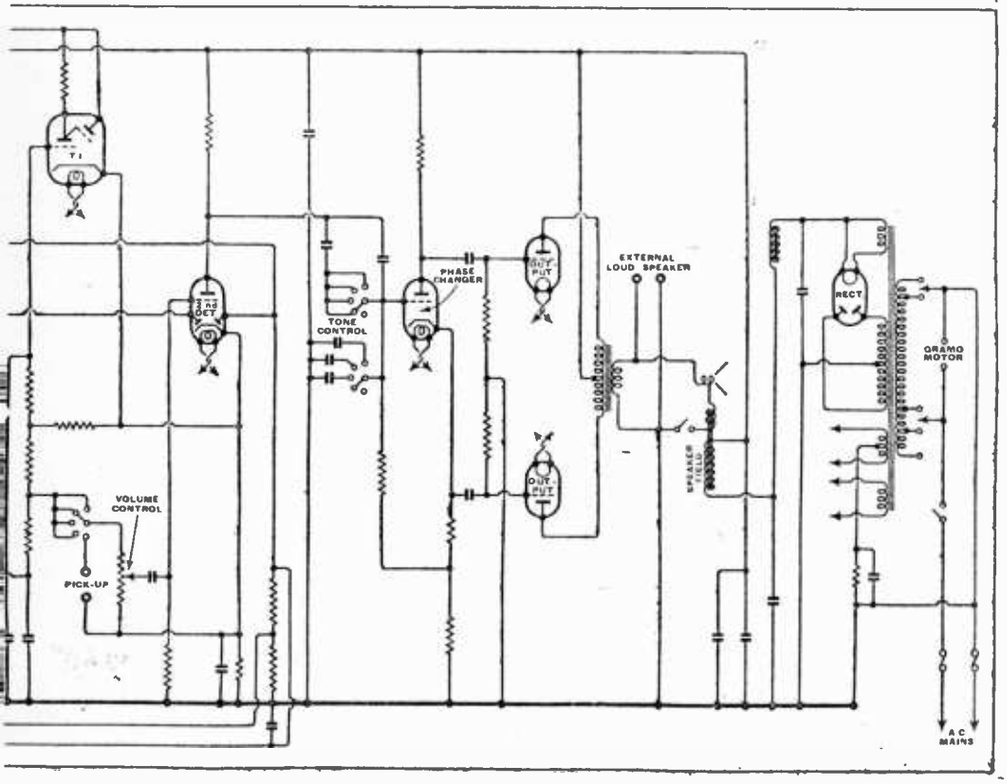
There are five positions of the tone control. The first is marked H and gives a slight reduction in bass response to improve the quality of speech for those who habitually listen at a fairly high volume level. In the second position N the full audio-frequency range of the receiver is available, while in the three remaining positions, L1, L2, and L3, there is a progressive reduction of top. Tested under conditions as regards background noise which are decidedly worse than the average, we did not find it necessary to make a more drastic reduction of high-note response than is represented by the position L1.

At the normal setting of the tone control a very fine performance is given. No resonances cause harshness in the upper middle register, so that the full top response can be used at any volume level, and the ample body of tone in the lower register gives a most realistic effect in the reproduction of organ music. On records the full value is extracted, and here in particular the fine bass response is of special value.

The piezo-electric pick-up has no obvious needle resonance, and the inevitable trace of surface noise does not warrant any reduction of high-note response by means of the tone control. The automatic record-changer plays up to eight 10-inch or 12-inch records.



Access to the underside of the receiver chassis is gained through a removable side panel in the cabinet. Variable selectivity is provided by varying the coupling of the input IF transformer.



Radio Performance

The radio performance achieves the high standard to which the instrument as a whole has been built. In particular, it possesses the quality of making the most from the point of view of entertainment value of the more distant stations. This is especially noticeable on the medium waveband in daylight. The well-designed AVC system is partly responsible, and its efficiency is easily judged by comparing the steadiness of volume with the fluctuations of the cathode-ray tuning indicator on stations where fading is present.

The circular tuning dial carries four scales, which are selectively illuminated by pilot lamps controlled from the wave-range switch. The scales of largest diameter are allocated to the medium-wave and lowest short-wave ranges. Calibration is accurate, and the tuning knob, which

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R.G.D. Model 880—
is fitted with a small subsidiary handle for rapid rotation, is most convenient to use.

There are four degrees of selectivity covering all requirements, from quality reception of the local or powerful distant stations, to long-range listening in the presence of local interference. With the highest selectivity setting comfortable separation of Droitwich, Deutschlandsender and Radio-Paris was possible on the long waves, and on the medium-wave range stations could be received which were spaced by more than one channel on either side of the Brookmans Park transmitters when using the set in Central London. Elsewhere adjacent channel separation was well within the capabilities of the set.

Short-wave reception is no less efficient than that on the medium-wave range, and three American stations were found and tuned-in during the afternoon with no call for skilled manipulation of the controls. The stage of RF amplification with its efficient pre-selection ensures that short-wave stations occur only at one point on the dial, and throughout the entire tuning range of the set no trace could be found of any form of second-channel interference. Another point which was noted with satisfaction was the stability of the oscillator on short waves. It was possible to switch off the set during the reception of an American station and to switch it on again an hour later, and, without touching the tuning, find the station still working.

The cabinet is of simple but well-proportioned design, and is exceptionally solidly built. The weight of the lid is balanced by internal springs which prevent it from slamming. The receiver chassis is mounted vertically, so that inspection of components under the base is possible through a removable side panel. The loud speaker is offset behind a woven metal grille which passes the full acoustic output without showing the slightest tendency to vibration.

Undoubtedly this is a set which one would not hesitate to put forward as representative of the best that the radio industry in this country has to offer.

In Next Week's Issue

The Wireless World

RECORDING AMPLIFIER

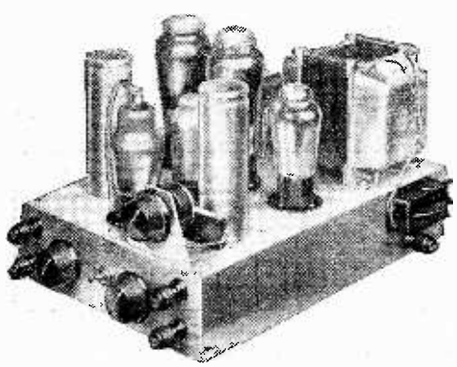
WHILE an amplifier which is used in conjunction with home-recording apparatus does not differ fundamentally from any other amplifier, there are certain features which are especially desirable in such apparatus. In particular it is advantageous to be able to increase the high frequency response above normal while recording and to reduce it by the same amount while playing the record, for an appreciable reduction in needle scratch can be obtained in this way.

The Recording Amplifier enables this to be readily done owing to the special tone control circuit included. A push-pull output stage is fitted giving an output of 4-6 watts, and the two preceding stages give sufficient gain to permit the use of a microphone. Alternative input volume controls are another feature of value in recording. Although designed especially with a view to use with recording equipment, the amplifier is also suitable for a wide variety of other purposes.

THE LIST OF PARTS REQUIRED

Certain components of other makes but of similar characteristics may be used as alternatives to those given in the following list

1 Mains transformer, primary; 200/250 volts, 50 c/s; secondaries: 350-0-350 volts, 75 mA., 4 volts, 2 amps., C.T., 4 volts, 2 amps., C.T., 4 volts, 2.5 amps., C.T.
Vortexion WW 350



1 Smoothing choke, 20 henries, 75 mA., 250 ohms. **B.T.S. CI 22**
1 Push-pull filter feed transformer, 4:1
Sound Sales "CT"

Fixed condensers:
1 0.01 mfd. **Dubilier 691**
1 0.005 mfd. **Dubilier 691**
1 0.0003 mfd. **Dubilier 690W**
1 1 mfd. 500 volts DC test
Dubilier "BB"
1 8+4 mfd., electrolytic, 500 volts peak
Bulgin EC7
1 8+8 mfd., electrolytic, 500 volts peak
Bulgin EC8
2 50 mfds., 12 volts, electrolytic
Dubilier 3016

2 Potentiometers, 0.25 megohm, tapered, less switch **Centralab 72-121**
1 Potentiometer, 1 megohm, tapered, less switch **Centralab 72-116**

Resistances, ½ watt
2 100 ohms **Bulgin HW37**
1 1,500 ohms **Bulgin HW4**
1 2,000 ohms **Bulgin HW5**
1 30,000 ohms **Bulgin HW21**
1 50,000 ohms **Bulgin HW23**
1 200,000 ohms **Bulgin HW27**
2 500,000 ohms **Bulgin HW31**
1 1 megohm **Bulgin HW33**
1 500 ohms, 10 watts **Bulgin AR500**

4 Valve holders, 5-pin (without terminals)
Clix Chassis Mounting Standard Type V1
1 Valve holder, 7-pin (without terminals)
Clix Chassis Mounting Standard Type V2
1 Switch, S.P.D.T. **Bulgin S81**
1 Plug and socket, 3-pin **Belling-Lee 1119**
1 Mains input connector, fused, with 1 amp. fuses **Belling-Lee 1114**
5 Terminals, ebonite shrouded, E, PU (4)
Belling-Lee "B"
1 Group board, 5-way **Bulgin C31**
1 Length screened sleeving **Goltone**
1 Plug-top valve connector **Belling-Lee 1175**
Chassis, 12×8×2½in.
Miscellaneous:
Peto-Scott or Scientific Supply Stores
2 lengths systoflex, 2oz. No. 18 tinned copper wire, aluminium for bracket, etc. Screws: 14 6BA ¼in. R/hd., 32 6BA ⅜in. R/hd., 4 4BA ½in. R/hd., all with nuts and washers, 2 6BA soldering tags, 2 lengths 6BA studding 1¾in. with 8 nuts.
Valves:
1 HL4+, 2 P15/250, 1 APV4 **Tungsram**
1 H42 **Osram**

Television Programmes

Transmission times are from 3-4 and 9-10 daily.

Vision	Sound
45 Mc/s.	41.5 Mc/s.

FRIDAY, MARCH 12th.

3, Beatrix Lehmann in a scene from "Twelfth Night." **3.15,** Friends from the Zoo, introduced by David Seth-Smith. **3.30,** British Movietonews. **3.40,** Twenty Minutes of Syncopation.

9, Alleyne and Leonhardt at two pianos. **9.10,** Repetition of 3.15 programme. **9.25,** Gaumont-British News. **9.35,** Robert Atkins' Bankside Players present the letter scene from "The Merry Wives of Windsor."

SATURDAY, MARCH 13th.

3, For the Children: George Queen's pantomime goose. **3.10,** In Your Garden: C. H. Middleton. **3.25,** Gaumont-British News. **3.35,** Scenes from the Grosvenor House Restaurant Revue, "Paris-Londres."

9, Music-Makers: Eileen Joyce at the piano. **9.10,** Repetition of 3.10 programme. **9.25,** British Movietonews. **9.35,** Repetition of 3.35 programme.

MONDAY, MARCH 15th.

3, Parade of Fashions in Leather: Part I. **3.20,** British Movietonews. **3.30,** Theatre Parade: The Irish Players in "The Rising Moon," by Lady Gregory.

9, Parade of Fashions in Leather: Part II. **9.20,** Gaumont-British News. **9.30,** Repetition of 3.30 programme.

TUESDAY, MARCH 16th.

3, The Orchestra and Its Instruments—VI; résumé of preceding talks. **3.20,** Gaumont-British News. **3.30,** International Cabaret.

9, Repetition of 3 programme. **9.20,** British Movietonews. **9.30,** International Cabaret.

WEDNESDAY, MARCH 17th.

3, St. Patrick's Day: Irish Dances. **3.10,** The Radio Three in close harmony songs. **3.20,** British Movietonews. **3.30,** Thirty-seventh Picture Page.

9, Maria Luth, songs. **9.5,** The Selma Four. **9.20,** Gaumont-British News. **9.30,** Thirty-eighth Picture Page.

THURSDAY, MARCH 18th.

3, Archery: a demonstration of the royal and ancient sport Toxophily in the grounds of Alexandra Park. **3.15,** Cook's Night Out—V: Marcel Boulestin's cooking demonstration. **3.30,** Gaumont-British News. **3.40,** The Policeman's Serenade; a grand little opera.

9, The composer at the piano: Jack Strachey. **9.10,** Repetition of 3.15 programme. **9.25,** British Movietonews. **9.35,** Repetition of 3.40 programme.

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Broadcast Brevities

NEWS FROM PORTLAND PLACE

"Physical Jerks" from Portland Place

EVERY four months, on an average, the question is asked: Why does not the B.B.C. give us physical jerks? And on every occasion the powers-that-be at Broadcasting House have been faced with the spectres of elderly Anglo-Indian colonels having apoplectic fits while attempting to do the exercises.

If *you* were the Corporation would you run such a risk?

A Way Out

In the past few weeks, however, the B.B.C. has been treating these spectres a little less seriously, and there is now a distinct possibility that physical training may find a place in the transmissions. The only question that arises is whether actual exercises should be broadcast or whether the new feature should take the form of talks on the benefits of physical fitness and how it can be acquired.

Precept Minus Practice

It is understood that officials at Portland Place are still chary about the "jerks" aspect of the business, so the latter course is the one more likely to be adopted. In other words, precept without practice.

Opening the Ball

Precept will, in short, go the whole hog in a series of talks entitled "Towards National Health," which will start early in April and carry through until the end of June. Eminent authorities will discuss problems of food and fitness from two standpoints, nutrition and physical culture. The first speaker on "All this talk about Health" will be Lord Horder, Physician-in-Ordinary to the King.

Second Wind

Following other nutrition talks by a Medical Officer of Health from the industrial North, the medical officer in a large modern factory, and a typical mother, housewife and worker, there will come the second part of the series, in which the Senior Medical Officer of the Ministry of Health will kick off with "Health from Within and Without." The whole question of physical culture will subsequently be brought under review. Subjects and speakers will include: "Physical Culture: Why and How," by A. H. Gem, Chief Organiser of Physical Training to the London County Council; "Physical Culture: Take Your Choice," by Miss P. C. Colson, Secretary of the Central Council of Recreational Physical Training; and "The Results of Physical Culture: What Really Happens," by Major W. K. Garnier, of the Lucas Tooth Institute.

"Fugue for Four Cameras"

HOW many viewers recognised Tuesday of last week as a "date" in television history? In "Fugue for Four Cameras," which was transmitted in the afternoon and evening programmes from Alexandra Palace, four images were simultaneously shown of one dancer—Maude Lloyd—to the accompaniment of a Bach fugue. One figure was seen as the "subject" of the fugue was announced; then, as the figure developed and "subject" and "counter-subject" were introduced, the figure was seen in duplicate, triplicate and then quadruplicate.

Just as impressive were the ghostly dissolutions of first one figure and then another until, with the final major chord, the single figure stood out again in sharp relief against a white background.

How It Was Done

This clever trick naturally called for some very complicated camera work. When all four figures were seen, each figure occupied one corner of the picture, there being two in the upper half and two in the lower. Each camera-man, on a given cue, brought the image to the pre-arranged space in his viewfinder; but the main task rested with the producer and deviser of the programme, Stephen Thomas, who had to follow the musical score and give the signal for each camera to be faded "in" or "out" in accordance with the development of the fugue.

Possibilities

Carried out on a lighter plane, the experiment might have surprising and perhaps alarming possibilities. One foresees a time when one of Mr. Cochran's Young Ladies could fill the role of a complete beauty chorus.

WHAT'S NEW IN RADIO? O. B. Hanson, Chief Engineer of the N.B.C., who talks periodically to American listeners about the latest developments in radio. He is here seen with the uni-directional velocity microphone which is being used for the weekly Saturday afternoon broadcasts from the Metropolitan Opera. The microphone is similar to the ordinary ribbon type seen on the left, but has an acoustic labyrinth on one side which renders it uni-directional.

A Tribute from America

THE B.B.C. staff at Alexandra Palace were elated when a copy of the *Boston Microphone* blew in last week. Said that journal: "The B.B.C. television policy is to broadcast 1940 programmes and let the listener end catch up, while over here we are trying to build 1940 receivers and haven't let the broadcasting end catch up."

Staggering News from Stagshaw

A SPOT of bother has developed at Stagshaw, where North-East Regional is, or rather *was*, in course of erection. It seems that there is a serious shortage of skilled labour, with the probable result that instead of opening in the autumn the station may not radiate a regular service until next Christmas.

Since Novocastrians have struggled along with a kilowatt-and-a-half for the last fourteen years, this makes no matter.

Single-mast Aerial

When it does get going, the transmitter will have a power of approximately 60 kilowatts, the wavelength being the same as that of the existing Newcastle station, viz., 267.4 metres.

The aerial system will be similar to those at Lisburn and Burghead, i.e., the single vertical mast will itself constitute the aerial.

Only

THE following cutting from the *Natal Mercury* may be of interest to listeners in this country:—

"Those who listen regularly to the Daventry news broadcasts will know the copyright formula, which ends with the intimation that the news is for the use of owners of receiving sets only. One night, towards the end of last week, an Empire news announcer said that the B.B.C had had a letter of complaint. A listener in Malaya had written to say that the restriction operated rather harshly on him, as, besides owning a receiving set, he was the owner of a horse, a dog, a piano, and a fair-sized piece of land. You see the point, of course—the placing of that tricky little word, 'only.' The B.B.C. promptly made the necessary correction, and the formula now runs: 'Only for the use of owners of receiving sets.'"

Broadcasting House and the Coronation

BROADCASTING HOUSE, along with most other places of public interest, is already threatened with numerous requests from visitors to London at Coronation time, who want to have a peep behind the scenes while they are viewing the Coronation sights. So great is the demand likely to be that the B.B.C. is already putting a stopper on, and only the early applicants—and then only to a limited extent—are going to be successful in getting a look round. In the meantime, the staff are asking to be saved from their friends.

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Listeners' Guide fo

Outstanding Broadcasts at Home and Abroad

FIVE years have passed since Henry Hall and the B.B.C. Dance Band were introduced to listeners. It was on March 12th, 1932, and actually the first broadcast to come from Broadcasting House. Many changes have taken place during the five years, but of the original twelve members six still remain. The band, which now numbers twenty-two, has contributed nearly two thousand hours of entertainment to the broadcast programmes.

To mark the band's entry into its sixth year of broadcasting, Henry Hall has, as is his custom, arranged a special anniversary programme, "Hall Marks." This will be heard Regionally on Tuesday at 8. It is described as a salute to the British song writers who have contributed so much toward the two thousand hours. A reminiscent note will be struck in the programme, during which various artistes who have performed with the band will be introduced.

HENRY HALL conducting the B.B.C. Dance Band in the television studio at Alexandra Palace. They will be heard in "Hall Marks," an anniversary programme, on Tuesday.

HILL-BILLIES

FELIX GREENE, the B.B.C.'s representative in North America, has arranged a special programme from the mountain country of Tennessee for English listeners. Many of the unsophisticated hill-folk of this region are excellent, natural musicians, and in this programme they will be heard singing folk music and pastoral songs, and will tell some quaint stories in their local dialect. This should prove an interesting and enjoyable feature, which will be broadcast Nationally at 9.0 on Saturday.

MUSIC-HALL

THERE have been many criticisms in the Press recently on the music-hall programmes. One would think, after reading the critics, that John Sharman, who has put so much hard work into these programmes, had run dry of ideas. When told recently that a show was "dreadful," and asked why he did not get the best acts in the country, John Sharman asked the complainant to compile an ideal programme. Of the five acts listed, he pointed out that two were abroad, two were on tour, and the remaining one was too expensive. Such are the difficulties which he weekly comes up against. He endeavours to get the best artistes available in London at the time, and, seeing that he has been in the show business for over thirty years, he ought to know where to find them.

This week for Saturday's programme at 8 (Nat.) he has secured Hutch (Leslie A. Hutchinson), the famous coloured artiste. He is a brilliant vocalist, but his forte is the extreme sympathy of his voice and his polished performance. Listeners will also hear Teddy Brown, heavy-weight virtuoso; Jack Barty; Harry Tate and Company; Ronald Frankau; and the Southern Sisters.

THE SPORT OF KINGS

ON Thursday, the eve of the Grand National Steeplechase, a timely feature programme, "Straight from the Horse's Mouth," will be presented to National listeners at 8.10. A composite picture will be drawn of a typical day in a racing stable. A B.B.C. recording van will make a series of sound shots, which will be incorporated. It is hoped that a famous racing personality will take part in the programme. He will interview the various people associated with the stable and draw as accurately as possible a picture of the excitement and bustle in a racing stable the day before a big race. This programme should be interesting even to those who do not indulge in the sport of kings.

The previous day the microphone will visit, for the first time, Carholme, Lincoln, to broadcast the first classic race of the season, the Lincolnshire Handicap. The commentary will be broadcast Regionally at 2.30.

ON THE STOCKS

WITH the approach of the University Boat Race a special feature programme from Riverside, Putney, should be of interest to many listeners. At 6 (Reg.) on Monday they will be taken to a boat-builder's yard, where work will be proceeding on the building of racing eights and sculling boats. In the fifteen minutes allotted for this programme listeners will hear briefly of the various stages in the construction of these boats.

FIRST ENGLISH PERFORMANCE

ONE of the most important musical events of the year takes place on Wednesday. It is the first performance in this country of Ferruccio Busoni's opera, "Doktor Faust," at the Symphony Concert in the Queen's Hall, to be heard Nationally from 8.15-11, the news being given during the interval at 9.15. The English translation has been carried out by Edward J. Dent, who will give a fifteen-minute introductory talk prior to the concert.

"Doktor Faust" is generally considered to be Busoni's masterpiece, but he died before the score was completed. This was done eventually by his friend and pupil, Philip Jarnech, and the opera was performed for the first time in Dresden in 1925, the year after the composer's death. Busoni's widow, who lives in Berlin, has accepted the invitation from the B.B.C. to be present at the performance. The B.B.C. Choral Society will join forces with the Symphony Orchestra for this presentation, which will be conducted by Sir Adrian Boult.

Details of the week's Television programmes will be found on p. 256.

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the Week

"TICKET-OF-LEAVE MAN"

THIS terrific melodrama packed full of scenes and situations of heart-rending poignancy will be produced by Peter Cresswell with a strict regard for the necessity of preserving the true atmosphere of the Victorian theatre. It will be heard on Tuesday at 7.45 (Nat.) and Thursday at 8.45 (Reg.).

The plot, though serenely guiltless of any relation to reality, can certainly be described as "meaty," and the figures of the hero, who contrives to get himself wrongly accused of a variety of misdemeanours, and of his faithful beloved, must cause a responsive throb in all but the stoniest hearts. Ballads of the period sung by the heroine will add colour to the show, and the sense of listening to an actual theatre performance will be strengthened by the use of only one studio, complete with cast, orchestra and audience.

First performed at the Olympic Theatre in 1863, the play created a profound impression. Its author, Tom Taylor, secured with it a definite place in theatrical history.

SHAMROCK

ON Wednesday, March 17th, Irishmen will be wearing the shamrock in honour of their Patron Saint, who used the shamrock as a symbol when he preached to the Irish so many years ago. Simplicity is the keynote of the St. Patrick's Day programme, which will be broadcast to both Northern Ireland and National listeners at 7.30. It aims at giving listeners an authentic sound picture of life and work in the more remote districts of Ulster.

The first part of the programme will come from Rathlin, a lonely island lying off the coast of Antrim. It will be recorded in advance, and the speakers will include a district nurse and a fisherman, who helped Marconi to erect the apparatus for one of his early wireless experiments between Rathlin and Ballycastle. The second part of the programme consists of a scene from Shakespeare's "A Midsummer Night's Dream," played in the dialect of County Tyrone. The third part of the programme is set among the Sperrin Mountains, in one of the loneliest and most beautiful parts of Northern Ireland.

Athlone offers special programmes throughout Wednesday evening. The Dublin Metropolitan Band and Irish Radio Orchestra with a Gaelic quartet and soloists give a special Irish concert at 8. Following this at 9.15, President De Valera will speak to the people. From the Mansion House, Dublin, will be relayed part of the National Festival at 11.

OPERA

HAMBURG, for its 7.10 programme to-night (Friday), favours Cornelius, a composer of German nationality, who in the mid-nineteenth century was a prominent representative of the then new German school, the opera chosen being "The Barber of Baghdad," inspired by Boccaccio's "Arabian Nights." The usual court intrigues of the Persian legends receive fittingly intriguing music in this opera.

JACK BARTY, the breezy comedian, who returns to the microphone in this week's "Music Hall," in a characteristic pose in the British Lion film "In Town To-night."

At the same hour Munich gives the ether première of "Ulysses" by the Dutch composer, Brandt-Buys. This was his swan song, for he had not completed this comic opera at the time of his death a few years ago.

HIGHLIGHTS OF THE WEEK

FRIDAY, MARCH 12th.

Nat., 8, The White Coons. 9.20, I Was There: the Matabele Rebellion, 1896. 9.40, Contemporary Music Concert.
Reg., 8.15, Play: "Inspiration to a Poet." 8.40, The Leeds Philharmonic Concert. 9.30, Fred Hartley and his Sextet.
Abroad.
Warsaw, 8, Finals of the Third International Chopin Competition.

SATURDAY, MARCH 13th.

Nat., 2.30, Ireland *v.* Wales; Rugby Commentary. 6.45, Band of His Majesty's Royal Marines. 8, Music Hall. 9.20, Relay from Tennessee.
Reg., 4, The White Coons. 8.25, The London String Players. 9.30, Opera in the 'Nineties; From gramophone records.
Abroad.
Frankfurt, 7.10, Alsace-Lorraine in Songs and Music; Saarbrucken-Frankfurt Exchange Programme.

SUNDAY, MARCH 14th.

Nat., 4.20, The Black Dyke Mills Band. 5.45, Eugene Pini and his Tango Orchestra. 9.5, "The Blue Cross" (G. K. Chesterton). ¶Albert Sandler and the Park Lane Hotel Orchestra.
Reg., 5, Cheerful Songs: B.B.C. Men's Chorus. 5.45, "The Last Days of Sail." ¶Victorian Melodies—XII.
Abroad.
Vienna, 9.30, Scandinavian Orchestral Music by the Vienna Symphony Orchestra.

MONDAY, MARCH 15th.

Nat., 7.20, The Music Shop. 8, It's Happening Now.

Monday, March 15th continued.

Reg., 6, Boat-builders at Work: Relay from Putney. ¶Carroll Levis and his Discoveries. 9.15, British and Empire Heavyweight Boxing Championship.
Abroad.
Lille, PTT, 8.30, Symphony Concert by the National Orchestra.

TUESDAY, MARCH 16th.

Nat., 6.25, The Theatre Orchestra and Ina Souez. ¶A Nation of Shoppers—"The Staff." 7.45, "The Ticket-of-Leave Man."
Reg., 6, Mario de Pietro and his Estudiantina. ¶Gramophone Records: Conchita Supervia. 8, "Hall Marks."
Abroad.
Berlin, 7.10, Berlin Radio Orchestra with Helge Roswaenge.

WEDNESDAY, MARCH 17th.

Nat., 7, The Grosvenor House Dance Band. 7.30, St. Patrick's Day programme. 8.15, Symphony Concert.
Reg., 2.30, Lincolnshire Handicap Commentary. 8.15, Traditional Fame on Parade.
Abroad.
Athlone, 8–11, St. Patrick's Day Celebrations.

THURSDAY, MARCH 18th.

Nat., 6.40, Orchestre Raymonde. 7.30, Pianoforte Recital: Pouishnoff. ¶Dance Band Relay from New York.
Reg., 6.40, Extracts from the Wyndham Theatre production, "George and Margaret." ¶Strange to Relate. 8.45, "The Ticket-of-Leave Man."
Abroad.
Strasbourg, 8.30, Military Band Concert from Verdun.

Lille PTT is relaying a de Falla programme from the Théâtre des Arts at Rouen to-night at 8.30. London knows de Falla well; among other occasions he was at the piano in the performance of his suite, "Nights in the Gardens of Spain" in 1921. Lille's relay consists of his opera, "La Vida Breve" and his ballet, "El amor bruja."

Listeners will welcome the opportunity of hearing works of the composer who was responsible for such attractive music as is contained in that favourite of the Diaghileff ballet, "The Three-cornered Hat."

Donizetti's "L'Elisir d'amore" will be relayed from the Royal Opera, Rome, by Milan I on Saturday at 8. It is on record that the libretto was written in eight days and the music in fourteen days.

PIANOFORTE

THREE famous pianists who have appeared in the English programmes quite recently will be heard from foreign stations this week. On Saturday, at 9.20, Egon Petri will be heard from Vienna, whilst the following evening Walter Gieseking plays in the Deutschlandsender programme at 7. Rudolf Serkin will be heard in this week's Thursday concert from Kalundborg at 7.10.

GERMAN RADIO BALLAD

AN attempt at a new form of radio entertainment, similar in style to a short opera, comes from Cologne at 7.45 on Thursday. The story revolves round a young girl and her lover who has to leave for war and is reported killed. During the course of the action there are many deaths and suicides, but for all this I am assured that the programme promises to be interesting and musically perfect.

NORWEGIAN CHOIRS

AN interesting comparative broadcast by three leading Norwegian church choirs comes in the Oslo programme at 5 on Sunday. It will take the form of three consecutive O.B.s from Oslo, Bergen and Trondheim.

THE AUDITOR.

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Are Knobs Safe For Democracy?

All-Automatic Control?

By "CATHODE RAY"

"It is a foregone conclusion that if radio receivers are ever to be high-quality musical instruments, all controls having any effect whatever upon the tone quality must be kept out of reach of the user."—*Radio Engineering (U.S.A.)*

IT is rather startling when the thoughts that are surreptitiously gathering in one's mind are suddenly shouted aloud on a front-page headline. The above quotation in itself may be rather startling to some readers, who may judge it a bit too cynical or paradoxical to be taken very seriously.

Assuming the writer meant what he said, is he justified? If by "controls" he had chiefly in mind tone controls, and implied that the public want something different from true quality, and if provided with a tone control insist on adjusting it to give false quality, so that the only way to ensure that receivers are real musical instruments is to thwart this craving by omitting tone controls, then the old question arises—should the public be given what they ought to want or what they do want? The B.B.C. probably knows something about this, one way or another.

But he might have been thinking mainly of tuning and selectivity controls, which affect the tone incidentally; the argument being not that the public are wilfully depraved in their sense of tone but that they merely lack the skill or attention required to use the controls properly.

Few will dispute the latter contention. It is a matter of common observation that the ordinary listener lacks the skill or the will to tune-in accurately. If the receiver is one that suffers badly from side-band shriek you will hear it tuned to the side-band—presumably because the programme sounds loudest there—emitting the most foul reproduction. Admittedly, some sets sound almost equally foul at the opposite extreme of tone when they are tuned accurately, so that to obtain some semblance of intelligibility the more resourceful listener tunes slightly to one side; but that doesn't always apply. And admittedly, with certain types of AVC it is quite difficult to tell when the set *is* properly tuned.

So the manufacturer has tried in various ways to be helpful. There is the visual tuning indicator. It is generally agreed that this has not been an unqualified success. Some sorts fail to work well on stations of widely different strengths. And even when they do work well the public cannot be bothered to use them. Then there are less obtrusive methods—circuit devices that cause reproduction to weaken rapidly or even to disappear altogether when the receiver is slightly off tune. All of these devices rely to some extent on the listener's co-operation, and to that extent are only partially successful. So far there is every justification for a cynical attitude, and the logical solution is automatic tuning control (ATC), which ensures exact tuning in spite of unskilful or perverse operation. If an entirely reliable system could be incorporated at trifling cost, every receiver would surely have it.

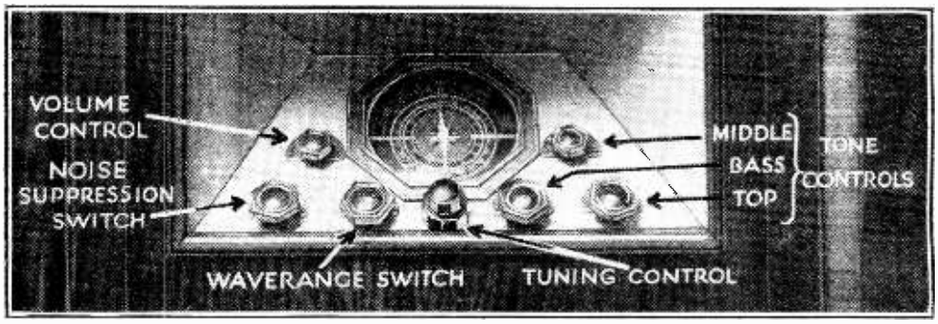
Much Depends on the Listener

Then there is the selectivity control; sometimes. It has a big effect on tone, so much so that when it is included a separate tone control is usually omitted. Variable selectivity is one of the most valuable devices yet introduced. But when the listener cannot be relied upon to tune accurately, he certainly cannot be expected to use a selectivity control properly, if for no other reason than that it is ineffective unless the receiver is very accurately tuned. What happens is that when there is interference, and the listener tunes the knob to the most selective position, instead of the interference going the wanted programme goes! Then, when an undisturbed local programme is next turned on there is no guarantee that anyone will have the intelligence to move the selectivity knob back again so as to take advantage of decent quality.

You may say that if the people who listen to the thing care so little about what they hear, why bother? It is their funeral. But some of the listeners may not actually be aware of how much better it could sound; and others are irritated by the poor tone, but not quite irritated enough to get up and adjust it. So here again the only logical solution is automatic selectivity control. And that is *really* asking for something. ASC of a sort can be provided almost as simply as ATC—not more than a couple of extra valves and a dozen or so of components for the simpler systems—but in this form the selectivity is adjusted in proportion to the weakness of the wanted signal, on the assumption that such a signal is invariably subject to jamming (i.e., interference from another station, for the benefit of readers who don't know that good old-fashioned term), whereas strong stations are invariably free from it. That being a false assumption, the only proper way is to let the jamming control the selectivity; and that is a *very* complicated business. It would mean doubling the size of the popular types of receiver.

Lastly, the tone control itself. This can be cheap and rather bad, or complex and highly adaptable; but never approaches in complexity the automatic devices mentioned. And at the lowest estimate of public intelligence it cannot be held to be too difficult to understand and work. One merely has to turn the knob to the position that sounds best, or least objectionable. Yet I know people who persist in making an already boomy reproducer sound even more boomy and muffled.

"Diallist" evidently finds this phenomenon rather perplexing, too; for recently he took the trouble to record the most favoured settings given to a tone control by fifty people, and remarked on



An excellent example of a multi-knob control panel which caters for the critical listener.

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Are Knobs Safe For Democracy?—

the wide differences in taste displayed in this way. It would have been still more interesting if he had gone farther and repeated the process on another programme. It is a fairly safe bet that the settings would have been quite different, and the difference probably not all in the same direction.

Recently a large manufacturer got me, with some others, to listen to a switch-over test between two sorts of loud speaker, to help decide which was the better. I think he must have been rather annoyed by my indifference to the whole performance. Quite apart from the fact that I have long since ceased to suppose I can tell what sort of sound pleases the public best, the kind of test referred to is almost completely useless for deciding between two sorts of tone. After you have solemnly pronounced judgment on the matter the operator has only to tune to a different programme or put on another record to make you reverse your opinion.

A combination that wraps the announcer up in a velvet shroud in a vault sounds fine on dance music. And so on. The only way is to live with the reproducers for a few weeks and then decide which is the better on balance. That is because all popular-priced outfits depart from entirely faithful reproduction, and the imperfection may happen to touch a programme at a rather sensitive spot in the frequency scale, or it may more fortunately help to counteract some fault in the acoustic conditions in the studio or listening room, and so actually improve the result. But that is a fortuitous circumstance that the receiving apparatus really can't be expected to undertake; therefore perfect reproduction of what is given to it from the aerial is its proper business. And as that is impossible under present broadcasting conditions, the next best is to do as well as is possible in the conditions prevailing at each moment, and to do it independently of help (or hindrance) from its owner. That, of course, is more easily said than done, but it is what the fellow in *Radio Engineering* means; and, in my humble opinion, in principle he is right.

DISTANT RECEPTION NOTES

WLW, the Cincinnati giant, had a narrow squeak during the Ohio floods, but luckily escaped undamaged. At one time, when vast quantities of petrol released from overturned storage tanks took fire whilst floating on the flood waters, it seemed that the station was doomed. The outbreak was near the plant, but owing to fine work by firemen and volunteer fire companies the station escaped undamaged.

It did not even close down, save for a few minutes when the fire was at its fiercest. An announcer and two engineers returned to their posts almost as soon as the building had been evacuated—and seized the opportunity to broadcast a description of the blaze!

WLW still remains the U.S.A.'s only 500-kilowatt broadcasting station. I mentioned some time ago that two or three others had made application to the Federal Communications Commission for permission to increase their plants to similar power. It seemed then that the Commission was likely to consider such applications favourably, but there has been no further news. In any event, if licences are given they will not be permanent. WLW has still only a provisional licence, which may be revoked at any time.

One would have thought that the United States urgently needed more stations of the 500-kilowatt order. As it is, stations have tended to concentrate in and round the bigger towns and there are large, thinly populated areas that must be not too well served for two reasons. The first is that some of the drier parts of America are notoriously bad for reception; the second, that atmospherics in many places are far worse than any that we wot of. In these only a giant station can supply a signal powerful enough to override the terrific background of interference.

I dare say that you have picked up the Spanish Nationalist Station operating in the lower part of the medium waveband, which styles itself "Radio National" and gives news bulletins in a variety of languages between 9 and 10 p.m. and sometimes later. Its wavelength has varied considerably. I have, in fact, found it on at least four different channels between 260 and 295 metres.

This dodging about is not, I believe, due to attempts at jamming by Government stations. Radio National, which is situated at Salamanca, is said to be rated at 50 kilowatts, and its signal certainly seems strong enough to drown any of the Government stations. Whoever is running the station is, I think, engaged in the rather hopeless task of trying to find a channel clear of interference from French, German, Italian and other firmly established broadcasters.

I don't know whether any alteration has been made in Jerusalem's aerial system to avoid the background to North Regional of which listeners in several parts of the country complained (some in the West Country reported that Jerusalem completely spoiled N.R.), but the Palestine station seems to be less strongly received at the moment. I mentioned recently that I had never been bothered by the background and could, in fact, hear it only when the volume control was turned right over. Now I don't hear it at all.

D. EXER.

The Radio Industry

WESTINGHOUSE equipment, which naturally includes metal rectifiers, is to be used for battery charging at the new L.C.C. Fire Brigade Headquarters.

W. F. Rayner and Co., Ltd., 162, Farringdon Road, London, E.C.1, have been appointed sole distributors in this country for the McMurdo Silver "Masterpiece V" receiver.

The telephone number of Haynes Radio, Ltd., Queensway, Enfield, Middx, has been changed to Howard 1171.

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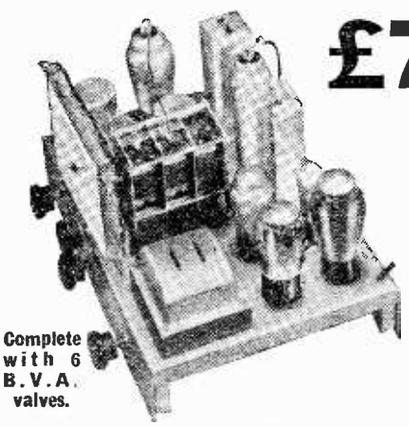

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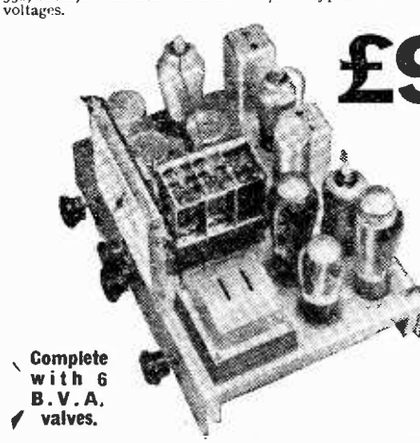

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Random Radiations

By "DIALLIST"

More in Sorrow . . .

WITH some pain I observe that "Free Grid," forgetful apparently of the motto of our common *alma mater*, "Dogge Doth Notte Eate Dogge," has attacked me for my recent comments on the smallness of the television screen. He would have readers believe that the last word on the subject was said between us whilst we were for some little time fellow, if involuntary, guests of His Majesty. He claims that we agreed that the real trouble was that if you sat close enough to see the television pictures clearly, you must perforce also sit close enough to have your eardrums shattered by the loud speaker. He seems to have forgotten entirely (and frankly I do not wonder) that the argument was reopened at this year's Old Borstalian dinner and subsequently continued in one of Vine Street's cosy twosomes. It was then decided that the best way out of *that* difficulty was to sit at the far end of a long room and to watch the viewing screen through opera glasses. One word more from "Free Grid" and I'll give the world the story of what happened when he offered to repair the Chief Warder's wireless set.

"Working Spain"

MY best thanks to the Staffordshire reader who writes to tell me that he has recently "worked" a station belonging to General Franco's army and located in the front line trenches. The call sign, in case you feel like trying for it, is EARR and the frequency is round about 14,300 kilocycles. The best time appears to be between 3 p.m. and 5 p.m. and I am told that good 'phone reception is to be expected. My correspondent doesn't say what language the operator was using, but I deduce that it was English, since he refers to an exchange of messages about future transmissions. If so, one should be able to glean some interesting news straight from the horse's mouth. There must be a great many of these field transmitting sets in use by both sides in Spain, but hitherto I've had very few reports of good reception—deliberate jamming by the other side may account for that—and no previous one of two-way working.

Wavelet Reception

IN almost every part of the world remarkable things are being done just now with the ultra-short waves between 8 and 10 metres. Amateurs using minute power have been received at almost incredible distances, whilst broadcast relays, experimental transmissions and police car messages are regularly picked up from America. One wonders whether such ranges will prove to be normal or whether it will be found during the next eleven years that they are more or less freakish and occur only at times when a sunspot maximum is approaching or has not long been passed. We can't say yet, for though the use of ultra-short waves is as old as wireless itself it is only recently that their distance-spanning qualities have been realised. Little, if any, long-distance work was attempted on such wavelengths during the last sunspot minimum period and therefore we have not much data to go upon. The coming years, as we reach the maximum and recede from it, should be full of interest, for there are now countless users of these wavelengths who will pile up a mass of valuable information.

The Transatlantic Relays

FOR further sidelights on the transatlantic relay problem I am indebted to readers at Portsmouth, Tunbridge Wells and Blackpool. Each of them reports having heard relays from the U.S.A. to this country being done by the transatlantic radio service. There can't be any doubt about it because they all agree (1) that they have heard the engineers at the other end asking London how it went over, and (2) that after each relay the station reverted to "scrambled" speech. This knocks hard on the head the stoutly maintained assertions that the B.B.C. always takes its relays from ordinary short-wave broadcasting stations. Curiously enough though, each of these three kind readers gives a different wavelength. A heard his transmission on 30-31 metres, B, his on 28-29, and C, his on approximately 25.

Water-pipe Earths

ONE water supply company has a bill before Parliament which contains a clause that would make it illegal to use water mains as earth connections. I suppose its promoters have some good reason for wanting such a restriction, but I really can't see what it is. There must be hundreds of thousands, if not millions, of sets earthed in this way, and I've never heard of a case in which it was responsible for any damage. I understand that an I.E.E. committee is investigating the subject of water-pipe earths. Gas mains are a different business altogether—and, anyhow, no sensible person would use a gas-pipe earth since it often leads to a very poor contact owing to the way in which the joints are made. So far the bill, which is being opposed strongly, has not achieved a second reading and there seems at present to be little likelihood of its becoming law. If it did reach the statute book it might raise some difficult problems for flat dwellers.

The Television Show

TELEVISION'S own exhibition, which is to open at the Science Museum, South Kensington, at the beginning of June, is to continue for about three months. It may thus still be going on whilst the Radio Exhibition at Olympia is under way. As all the chief makers of television sets as well as the R.M.A. and the B.B.C. are going into partnership to make it a success it should be a show well worth seeing. There will be no charge for admission, so it will no doubt be visited by big crowds. In addition to Londoners and those spending a day or two in London during the summer it will be popular with those who have come from overseas for the Coronation. If, as one hopes, it is still going on during Olympia's ten radio days, many who have come up for the Wireless Show will no doubt devote a little of their time to the Television Exhibition. I hear that some very interesting "working models" are likely to be on view to illustrate the principles of television.

Extension Loud Speakers

BEFORE starting to fix up an additional loud speaker for a mains set the old hand makes sure as a matter of course just how the "extension" terminals are arranged in the output circuit. Others, if the extra loud speaker has a variable-ratio transformer, run out a pair of wires, hoping for the best, and go on fiddling with the transformer's switches until reproduction seems to be the best obtainable. Whether you're an old stager, a medium-stager, or a novice it's always as well to make sure about those terminals, quite apart from consideration of quality. There are sets in which they are connected straight across the primary of the output transformer and unless you use a filter circuit in such cases the extension leads (sometimes of bell-wire) may be at an undesirably high voltage to earth. The precaution suggested is doubly necessary where headphones are worked from the extension terminals.

Battery Sets, Too

The battery set seems such an innocuous thing that any such precautions as those suggested in the last paragraph might seem to be unnecessary. As a result of one or two experiences I don't think they are, by any means. It's true that in the ordinary way the voltage is lower, but suppose that you get a short-circuit to earth, as I once did, from the lead connected to HT+. Even a small-capacity dry H.T. battery of good quality will "flash" 5 amperes or so when new; one of large capacity may kick the ammeter needle to 15 amperes or more at the instant when a short occurs and go on delivering current at an average of 8-10 amperes for some seconds. I have never been in a sufficiently extravagant mood to flash an accumulator H.T.B.! Anyhow, 10 amperes at 150 volts is 1½ kilowatts, and that is a good bit too much for bell-wire leads—to say nothing of the battery itself.

Hanging On

CURIOUS how people who could well afford up-to-date receivers *will* hang on to old sets. Quite a number write to me on these lines: "I have a 1933 X.Y.Z. superhet, which gives splendid reception though its original valves are still in use(!). I find now that some stations fade rather badly. Could you tell me how to have the set fitted with AVC? I would like also to have it converted into an 'all-wave' receiver. Can this be done?" Now, there are very few 1933 superhets whose value to-day is much greater than the sum which it would cost to revalve them. Their low value is due to several factors. Few have AVC; *all* have a multiplicity of second-channel whistles; most of them are noisy; many give reproduction of the local station that falls far below 1937 standards. I know that it is a wrench to part with an old and tried friend, but the bringing up to

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Random Radiations—

date business just isn't worth while—and it may cost more than giving the old set in part-exchange and buying a new one. In any event, a set which has had four or five years' service is getting into the cranky stage, and the repair bills begin to mount up.

* * *

Television Futility

SATURDAY television programmes should be the best efforts of the week from the point of view of entertainment, because sets are likely to be in use then to a greater extent than on other days. What, then, can be said about the efforts of the programme compilers on Saturday last, March 6th. Whilst a violinist and the Television Orchestra are interesting enough to look at once, the television cameras showed us first one and then the other with a monotonous regularity which was little short of exasperating. There was no other change of scene throughout a rather long musical performance, and the vision seemed only to serve to mar enjoyment of the music. Surely some better use of the television medium could be found without straining the imagination of the programme compilers!

Correx Kitchen Call System

Equipment for Two-way Communication

IN all large establishments where the kitchen is located some distance from the dining-room means of communication so that orders and messages can be passed is most essential. Speaking tubes have for long past been used for this purpose, though small telephone sets are sometimes installed. Both of these systems require that one member of the kitchen staff be always on the alert for a message which must then be relayed verbally to those concerned.

A new system of more than usual interest has now been evolved by Correx Amplifiers, Pickford Place, Brixton, London, S.W.9, and it is known as the Kitchen Call System. A hand telephone set similar to that used on ordinary telephone circuits is installed in the dining-room, or close to the service hatch, while a microphone and loud speaker are fitted in the kitchen.

The amplifier used can be operated either from AC or DC supplies of from 200 to 250 volts, though it can be modified for any other supply voltage if required.

Two amplifying channels are employed, one with a single valve suffices for operating the hand set, and the other, which has two stages, is used for feeding the loud speaker.

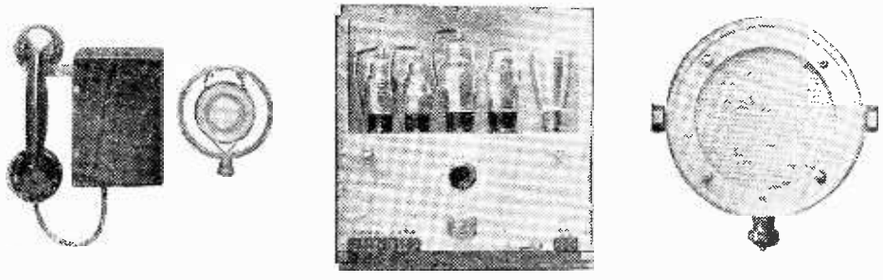
The idea of using a hand set at the service end is to avoid inconvenience to diners. Messages and orders spoken into the hand set are amplified and can be heard by the kitchen staff in all parts of the room, and replies or acknowledgments may be given without approaching the microphone and they will be clearly audible in the hand set. A small buzzer is incorporated in the latter unit should the kitchen staff wish to communicate with the dining-room.

In the design of the equipment due consideration has been given to the fact that it may be required to withstand a hot, steamy atmosphere, which at times is unavoidable in kitchens.

The Correx call system is, of course, equally applicable to restaurants and hotels as it is to private residences, and in view of its simplicity in operation it should prove a valuable adjunct in all establishments where reliable communication of this particular kind is needed.

It would not be a difficult matter to enumerate many other purposes for which a call system of this nature could be applied, but from this brief description the reader will be able to judge its usefulness for any case in which he may be particularly interested.

The price of the apparatus is 20 guineas, and a small charge is made for installation.



Component parts of the Correx Kitchen Call System, showing the hand set unit, the kitchen microphone, the amplifier with front removed, and the loud speaker.

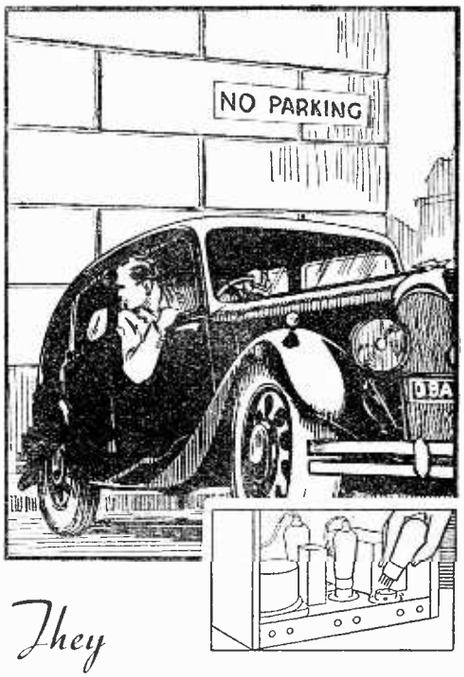
Ferranti Battery Sets

THREE new receivers for battery operation are announced by Ferranti, Ltd., Moston, Manchester, 10.

Model 637B is a straight receiver with pentodes throughout. It has two wavebands, medium and long, and the price is 6 gns. A special model incorporating a rejector circuit for Droitwich is available at £6 10s. 6d.

In the Model 1137B at 11 gns., a superheterodyne circuit with a QPP output stage is employed, and there are three wavebands, including a short-wave range from 19 to 51 metres. The set is housed in a moulded cabinet and is fitted with the Ferranti "Magnascopic" dial.

The same chassis is used in the Model 1237B at 12½ gns. This receiver is provided with a handsome walnut cabinet with macassar ebony inlay, and has accommodation for batteries of somewhat larger capacity.



They SHOULDN'T DO IT— BUT **THEY DO!**

'NO PARKING'—but a switch is turned—an engine fades out, and another inconsiderate takes a risk. "Obstruction" they call it—and it costs 30/- or more.
Another switch is turned—on the "wireless" this time. There isn't even a "NO SWITCHING—the pentode is out" notice. Another risk is run. "SURGE-VOLTS" they call it, and the set 'won't work'—and the setmaker is blamed. Safeguard yourself against this thoughtless switch-turning. Fit T.C.C. "Wets" and high-voltage switching-on surges cannot pass, they are kept within safe limits—no need for calls on SERVICE DEPARTMENT.

FOUR TYPICAL TYPES

Type	Capacity	Continuous Working Volts
802	16 mfds.	440 volts Peak
602	8 mfds.	440 volts Peak
805	8 mfds.	500 volts Peak
809	32 mfds.	320 volts Peak

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Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Beat Oscillators

I WAS pleased to see Mr. P. K. Turner's letter in the issue of February 26th in which he stated very clearly the requirements for purity of wave form in beat frequency oscillators, and wish to take this opportunity of pointing out how these requirements were satisfied fairly thoroughly in the simplified beat oscillator described in the issue of January 22nd.

The fixed oscillator was made to give pure wave form by tapping down the coil to about a third and adjusting the reaction condenser for feeble oscillation.

As regards the frequency changer, the variable oscillator voltage must be regarded as the large input and that from the fixed oscillator the small input, of the order of half a volt. Under these conditions the wave form about 50 c/s is remarkably good and no departure from sinusoidal shape could be measured on a cathode ray oscillograph unless, of course, the output valve was overloading.

Unfortunately, I have not had access to a wave analyser for really precise measurements. Distortion detectable on the oscillograph only occurs from approx. 50 c/s downwards, i.e., on frequencies which are seldom needed, and this distortion is, of course, due to unavoidable coupling between the oscillators.

The oscillator has been used to supply AC bridges in which the condition for balance depends on frequency. The balance point, however, has always given dead silence in the phones, demonstrating very convincingly the freedom from harmonics.

C. P. EDWARDS.

University College, Nottingham.

Television Frequency Separation

IN a note in Current Topics appearing on page 105 of the January 29th issue of *The Wireless World* we note that the separation between the vision and sound radio frequency carriers of our experimental television transmitters was reported to be 10 Mc/s.

We wish to call your attention to the fact that this statement is in error, the actual separation being 2.25 Mc/s, vision on 49.75 and sound on 52 Mc/s. The transmitters are now in process of being readjusted to operate in accordance with recommendations of the Radio Manufacturers' Association, which makes the channel separation 3.25 Mc/s. In the case of the N.B.C. station W2XBS, the radio frequency carriers will under the new arrangement be adjusted, vision on 48.75 Mc/s and sound on 52 Mc/s.

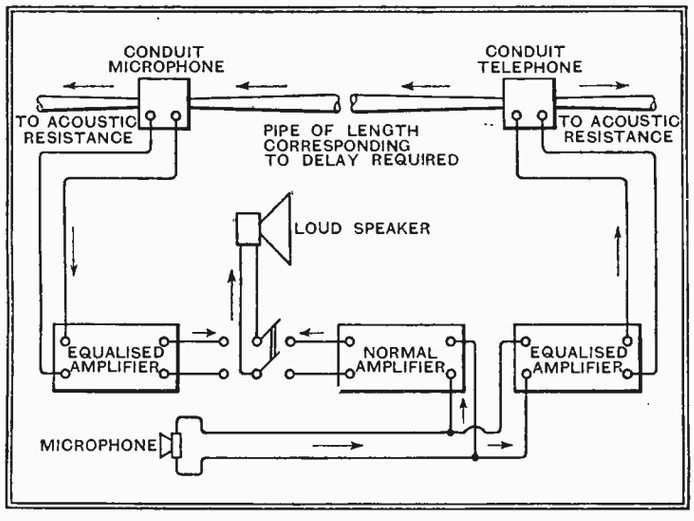
New York. C. E. PFAUTZ,
Radio Corporation of America.

Acoustic Delay Device

THE use of a delay device has often been proposed in connection with volume compression in broadcast transmission and for other purposes; your readers may be interested in a development along these lines.

For the purpose of obtaining a delayed but faithfully reproduced transmission of an audio-frequency signal, it has often been proposed to make use of a sound wave which is propagated down a pipe. The conduit microphone at present being manufactured by Messrs. Muirhead is an instrument which lends itself to this purpose with great advantage, particularly in view of the fact that it can be used reversibly, i.e., as a telephone receiver.

The complete device for producing a delayed signal consists of a conduit telephone and conduit microphone connected together by any desired length of pipe. The audio-frequency signal is passed into the ribbon of the telephone, generates a sound wave which is propagated down the pipe, and excites the microphone ribbon, thus recreating the audio-frequency signal. Acoustic resistances are provided at each end of the system for the purpose of ensuring that no standing waves are set up in the pipe, which would give rise to uneven frequency response.



General arrangement of acoustic delay system (suggested by Mr. Willans) set up for comparison of quality with direct amplification.

The limitations in a system of this kind lie in the attenuation of high frequencies which takes place down the pipe. This attenuation may be overcome by an excess of high frequencies introduced into the telephone and/or by the correction of the microphone output signal for loss of high frequency components. The former course is preferable, as otherwise high-frequency noise is likely to occur owing to the "Johnson noise" of the receiving microphone. Obviously there are limitations in respect of the amount of high-frequency energy which the telephone strip can handle without overload, but the results so far obtained with a small length (16 feet) of half-inch pipe show good promise.

A rough and ready test of the performance of a system of this kind consists in comparing the loud speaker reproduction of audio-frequency signals conveyed to the loud speaker, either directly or through the acoustic channel. Tests on these lines show good promise, as also the plotting of response characteristics through the equalised system, but the practical value of the device will be determined by the range of amplitudes of audio-frequency signal which it can be made to transmit without, at the one end, an excess of "Johnson noise" and, at the other end, undue non-linear distortion.

Work is in progress for the purpose of meeting demands in both these directions.

P. W. WILLANS.

London, W.C.1.

External Speakers

WITH reference to the letter from Mr. H. Moore (*Wireless World*, February 26th), I agree that to provide a 500 ohms winding on the output transformer would be a very satisfactory arrangement for extension speakers, but I hardly think it could be done so easily and cheaply as he suggests.

With 2 ohms output from the set the cost of a transformer on the extension speaker can be eliminated, whereas a transformer to match the 500-ohm load would cost between 5s. and 7s. 6d. Furthermore, it would be asking too much to expect all set makers to provide an additional 500-ohm winding in their output transformer, particularly as in many cases extra winding space would be required.

It would be simpler and cheaper to use a conductor of lower resistance for the extension leads. In the case cited by Mr. Moore it is evident that 14/0.0076 flex is used. Standard lighting flex in Bradford is 23/0.0076 and this would reduce the resistance from 1.9 ohms to almost 1 ohm. This flex costs 4d. per yard. By using 40/0.0076 twin flex at 6d. per yard the resistance could be reduced to about 0.6 ohm, and 18's V.I.R. at 2d. per yard would have about the same resistance. The power loss is then only about 2 db, and with all due respect to the decibel this is something and nothing, and is hardly noticeable to the ear.

I suggest that satisfactory working of 2-ohm external speakers can be achieved by using the following wire:—

Up to 10 yds. use 14/0.0076 or 20's bell wire.
Up to 18 yds. use 23/0.0076 or 18's V.I.R.
Up to 30 yds. use 40/0.0076 or 16's V.I.R.

It will be obvious that with 6-ohm or 15-ohm speakers longer distances can be covered with the same type of wire.

After struggling through these wire entanglements it is a pity to have to inform Mr. Moore that the trouble is not entirely, or even mainly, due to the loss of power in the extension wiring. It must be due largely to the fact that the set speaker is much more sensitive than the extension. This can easily be proved by inserting a 2-ohm resistance in series with any 2-ohm speaker. It will be found that shorting the resistance does not make the tremendous difference in volume about which Mr. Moore complains.

The only remedy is to fit a volume control across the set speaker. An Igranic rheostat of 20 ohms, costing 2s., works very well, but it should be connected as a potentiometer. The Wharfedale Truqual Volume Control

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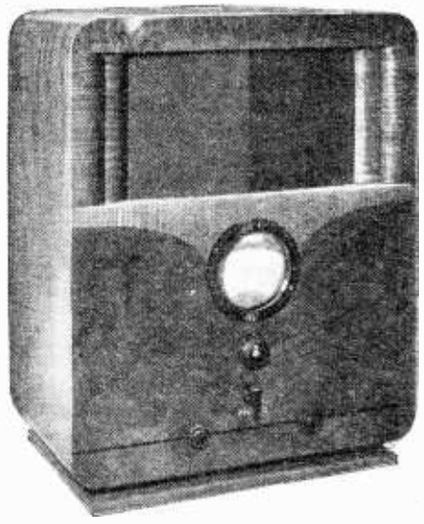
costs 5s. 6d., and introduces the minimum of distortion.

The advantages of having a volume control on the main speaker are so obvious that I am surprised it is so rarely adopted, particularly when an extension speaker is provided for a maid who is rather deaf.

Bradford. G. A. BRIGGS,
Wharfedale Wireless Works.

PHILCO EMPIRE EIGHT

THIS receiver, which will shortly be ready for delivery, is an eight-valve AC superheterodyne with a 5-watt output from pentodes in push-pull. It has four wavebands and every refinement in tuning, including a two-speed drive, shadow tuning on a "spread-band" dial and a "glow-beam" tuning indicator. The dial is calibrated in frequencies, wavelengths and with station names.



"Baby Grand" Empire Eight, Model A847

Special attention has been paid to the cabinet work, and in the "Baby Grand" table model burr and straight-grained walnut inlays are used on a solid walnut base. The price of this receiver is 29 gns., and there is also a radiogramophone with automatic record-changer at 60 gns.

SOUTHEND RADIO EXHIBITION

THE Southend and District Radio and Scientific Society is organising a Coronation Year Radio Exhibition, to be held on Friday and Saturday, April 2nd and 3rd next, in the Boys' High School, Southend-on-Sea.

There will be trade and amateur sections and prizes will be awarded as in the past to the best amateur exhibit in various classes, while the silver challenge cup is to be competed for as on past occasions.

Amateur apparatus will be arranged in six sections, viz., Ultra-short-waves receivers; Ultra-short-wave transmitters and transreceivers; Short-wave receivers; Short-wave transmitters; Broadcast receiving equipment and Auxiliary apparatus respectively.

Arrangements are being made for some interesting and topical demonstrations to be given on this occasion.

The exhibition will be open from 3.30 to 10 p.m. on the first day and from 11 a.m. to 10 p.m. on the Saturday.

News from the Clubs

Southall Radio Society

Headquarters: Southall Library, Osterley Park Road, Southall.

Meetings: Tuesdays at 8.15 p.m.

Hon. Sec.: Mr. H. F. Reeve, 26, Green Drive, Southall.

An unusual type of lecture was given by Mr. J. T. Tyrell, ex-Vu2BM, from Rawalpindi, at a recent meeting and was thoroughly enjoyed. He called his lecture "A Ham in the Himalayas," and he had some very interesting stories to relate. Mr. C. Rapsley's lecture on "Aerials" was of a theoretical rather than of a practical nature and provoked an interesting discussion. At a later date an interesting talk on his experiences in film and recording work was given by Mr. J. T. Pinsent. On the same evening Mr. J. J. Maling (G5JL) demonstrated the difference in the quality of an old-type gramophone and a modern reproducer.

Croydon Radio Society

Headquarters: St. Peter's Hall, Ledbury Road, South Croydon.

Meetings: Tuesdays at 8 p.m.

Hon. Pub. Sec.: Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

At the last meeting Mr. P. K. Turner, whose annual visit is always eagerly awaited, lectured on the Hartley-Turner loud speaker, illustrating his various points with a practical demonstration. An exceptionally large number of questions followed.

Ilford and District Radio Society

Headquarters: St. Alban's Church Room, Albert Road, Ilford.

Meetings: Thursday evenings.

Hon. Sec.: Mr. C. E. Largen, 44, Trelawney Road, Barkingside, Ilford.

Much appreciation was expressed by members on the occasion of their visit to the Union Cable Works at Dagenham. Mr. H. J. Shaw, of the G.E.C., provided one of the most interesting evenings of the session with a television demonstration. Seventy-six people were present, including several members of the Chadwell Heath Radio Society.

Golders Green and Hendon Radio Scientific Society

Headquarters: 69, Pattison Road, Hampstead, N.W.2.

Hon. Sec.: Mr. A. G. Griffiths, "Hornbeams," Priory Drive, Stanmore, Middlesex.

At a lecture on the elimination of electrical interference, Mr. F. R. W. Strafford, of Messrs. Belling & Lee, Ltd., discussed the various sources of interference and the paths by which it found its way into the receiver. He described many methods of attacking the trouble at the receiver-end in those cases where it was not feasible to eliminate it at the source.

Swansea Radio Club

Headquarters: Y.M.C.A.

Meetings: Alternate Wednesday evenings.

Hon. Sec.: Mr. R. J. C. Davies, c/o Watson and Davies, Mansel Lane, Swansea.

A new radio society has been formed at Swansea under the auspices of the local section of the R.S.G.B. The activities of the society will include lectures on the theoretical and practical aspects of amateur radio. Practical demonstrations of apparatus will also be given.

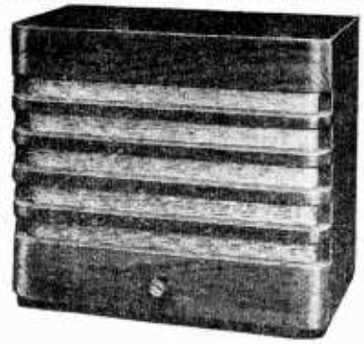
Radio, Physical and Television Society

Headquarters: 72a, North End Road, W. Kensington, W.14.

Hon. Sec.: Mr. M. E. Arnold, 12, Nassau Road, Barnes, S.W.13.

At a recent meeting of the Society, loud speakers were the subject of interest. Members brought their speakers for comparison and for test with an oscillator. A W.B. speaker was also kindly loaned by the manufacturers.

Concerning The ROLA 'REX' UNIVERSAL EXTENSION SPEAKER



"A THING OF BEAUTY . . ."

When you sink comfortably into your easy chair, switch on the radio, and settle down to enjoy good music or dramatic art, let no distracting doubt mar your perfect enjoyment of the evening's entertainment . . . experience the calm, unruffled satisfaction that the possession of a Rola "Rex" will give. There is real beauty in its faithful rendering of every note, real beauty in the graceful dignity of its appearance. It is a connoisseur's speaker inspired, designed and built by men who believed that radio enthusiasts would welcome an Extension Speaker such as this that can be matched to any radio receiver. 49/6 is a moderate price to men who remember that "a thing of beauty is a joy for ever."

BRIEF SPECIFICATION

SPEAKER — 8" Diameter. Special Nickel Aluminium Cobalt Magnet. Ten alternative impedance settings.

CABINET — Beautifully grained Walnut. Size 14" × 16" × 9". Volume control mounted on front of cabinet.

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Recent Inventions

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

RF TRANSFORMERS

ONE of the difficulties in designing a transformer for handling a wide range of high frequencies is to ensure a purely inductive coupling, free from any capacity effect between the windings. According to the invention the problem is solved by dividing the primary winding into two sections, each producing a magnetic flux in the same direction. The sections are connected in series, and one of the two inner adjacent terminals of the windings is connected to earth. The section not earthed is screened from the secondary winding so as to prevent capacity coupling. A transformer coupling of this sort is particularly suitable for the RF push-pull amplifiers used in a television receiver.

The Loewe Radio Co., Ltd. Application date February 8th, 1935. No. 456515.

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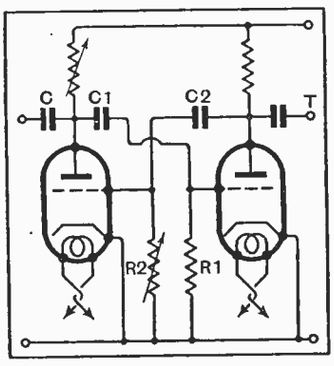
MULTI-VIBRATOR CIRCUITS

A PAIR of valves are reciprocally coupled together, the anode of one being coupled to the grid of the other, and vice versa, and the combination is used either to repeat or to change the frequency of an applied impulse. As shown, impulses are applied through a condenser C to the anode and cathode of one valve—though they may be applied across grid and cathode—and the derived frequency is taken off at the terminal T. The time constant of the coupling link C1, R1 is fixed, and is of a much higher value—say, from 20 to 100 times—that of the applied impulses.



Circuit that can be used for frequency dividing.

The time constant of the coupling link C2, R2 can be varied by means of the resistance R2. If it is made less than that of the applied impulses, the output will be of rectangular wave-form with the control impulses superposed. If the time constant of C2, R2 is set at, say, ten times that of the applied impulses, the period of the output current is correspondingly increased. The triode valves can be replaced by pentodes or other multi-grid types.

E. L. C. White. Application date March 12th, 1935. No. 456840.

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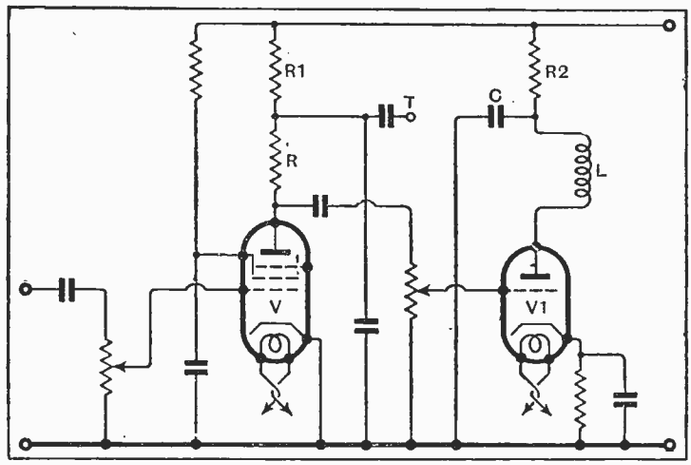
TELEVISION SYNC SYSTEM

COMBINED picture and synchronising signals are applied across a high-impedance input to a screen-grid valve V, the former driving the grid positive and the latter negative. The picture signals are suppressed by the grid current. The frame synchronising impulses reappear across the resistance R in the output circuit, whilst the line synchronising impulses occur across the resistance R1 and are tapped off at T. The framing signals are applied to the grid of a low-impedance amplifier



Method of separating frame and line sync signals in television apparatus.

V1, and pass to the synchronising winding L of a scanning generator. The anode circuit of the amplifier V1 is decoupled by a resistance R2 and condenser C.

G. R. Tingley and Baird Television, Ltd. Application date May 22nd, 1935. No. 457129.

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INTERLACED SCANNING

IT is known that the two successive images of a picture televised by "interlaced" scanning can be correctly sandwiched together on the screen by making the line frequency an equal multiple of the frame frequency, plus one. This so-called "odd line" method has, however, certain disadvantages.

In order to remove them, the line-synchronising signals are transmitted at constant frequency and of identical wave-form. The frame-synchronising signals, on the other hand, are of approximately the same shape, and are arranged to occur in substantially the same phase-relation with the line signals, but each has a slightly different wave-form from the one preceding it as well as from the one following it. All the framing impulses are of different wave-form from the line-synchronising signals. The result is that the scanning lines of one picture fall halfway between the corresponding lines of the interlaced picture, and the saw-toothed oscillator "locks" the two together so that they are correctly interlaced on the screen.

Marconi's Wireless Telegraph Co., Ltd. Convention date (U.S.A.) March 26th, 1935. No. 456564.

o o o o

IN one method of ensuring the correct "sandwiching" of successive pictures in interlaced scanning, the frame signals are transmitted in fixed phase-relation with the line signals, and interlacing is achieved at the receiver by causing the frame signals to control the generation both of a local framing frequency and of an auxiliary "frame-shift" oscillator. The two oscillations are then superposed upon one another and applied to control the framing operation at the receiver.

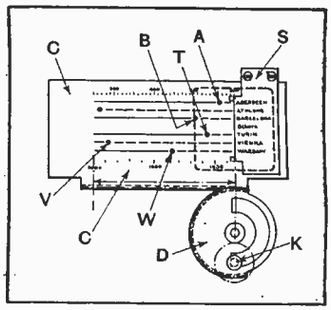
In a scanning system of this kind, according to the invention, the receiver is so arranged that the duration of each framing oscillation is equal to a whole number of "line" oscillations plus $1/n$th of a line, where n is the number of scanning lines in each complete frame. In this way the lines traced out in successive frames are accurately interlaced on the viewing screen.

M. Bowman-Manifold. Application date April 9th, 1935. No. 456651.

o o o o

TUNING DIALS

INSTEAD of being arranged in order of wavelength or frequency, the stations are printed on the tuning scale in alphabetical order, so that they can be more readily identified. As shown in the Figure, the slow-motion friction disc D is driven by the finger knob K, and, in turn, gears with an index carrier C so as to move it laterally to and fro. The stations are shown alphabetically on a fixed strip S, and each is associated with a "leading line" on which a mark A is printed for Aberdeen, B for Barcelona, and so on.



Tuning scale on which station names are arranged in alphabetical order.

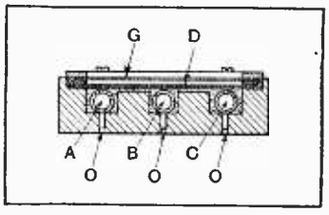
In operation the control knob is rotated until, say, the Mark V is brought close against the printed name Vienna on the fixed strip S. The circuits will then be in tune with the wavelength of the Vienna transmitter. The same applies to any other broadcast station required. Instead of printing the stations in column formation, they may be arranged around the circumference of a circular scale, in alphabetical order in the clockwise direction.

W. A. Burns. Application date May 20th, 1935. No. 457091.

o o o o

MICROPHONES

RELATES to the type of microphone in which the flow of current is transverse to the direction in which the sound-waves impinge upon the diaphragm. The casing is of circular form and the diaphragm D is inserted at the bottom of a shallow recess. Three deeper recesses are provided to take carbon rods A, B, C. Each rod is fitted with a central band, and these are connected by a wire passing through apertures O to a terminal (not shown). The space between the rods, the apertures, and the diaphragm is filled in with carbon granules, and a gauze cover G is stretched above the diaphragm D.



Constructional details of transverse current carbon microphone.

N. S. Rose and M. E. Angel. Application date April 17th, 1936. No. 457195.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of patents issued in U.S.A. is also included.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

EDITORIAL COMMENT

Sound Recording

Progress Stimulated by the Amateur

INTEREST in the recording of sound has grown so rapidly during the past few years that it already occupies a prominent position in the science of acoustics. The constantly increasing use to which recorded sound is being put, stimulated largely by the requirements of broadcasting and talking pictures, seems to indicate that it will play an even greater part in our everyday lives in the near future. Vast improvements have been made in the technique of commercial recording and reproduction whilst the development of comparatively simple equipment, suitable for use by private individuals, is also contributing to a large extent towards increased popularity.

A few years ago it might have been thought that the gramophone disc recorded and reproduced by mechanical means represented finality, but photographic and electrical methods have already eliminated mechanical recording and lifted the art to a higher plane altogether. Yet even to-day finality has by no means been reached.

In several instances we find laboratory developments far in advance of commercial practice. This is largely because reproducing equipment is distributed on so wide a scale that improvements which necessitate changes in the reproducing apparatus are uncommercial.

A year ago we referred to the advantages of the "hill and dale" system of recording for gramophone discs, and we expressed the view then that probably our present system for gramophone records might never have made much progress if the early "hill and dale" system had been introduced at a time when valves and amplifiers were available for electrical reproduction. If a change-over to "hill and dale" recording on disc were made, the new records would be capable of far greater contrast ; needle scratch would practically disappear ; records could have a longer playing time because the width of grooves would be uniform and could, therefore, be brought closer together ; and improved pick-ups of the moving coil type would be available for the first time.

The laboratory has long since produced a "hill and dale" system of high perfection, but this is not available to the public, in spite of the general clamour for better quality, because to launch such a system would mean the scrapping of existing reproducers and many other commercial complications. So, too, the recording of sound-on-film for general purposes may be difficult to popularise for home use however great the advantages of such a system may appear to be.

Importance of Amateur Efforts

These considerations which we have touched upon so superficially above tend to emphasise the importance of the development of recording by the enthusiastic amateur. It is the amateur, whether he is interested primarily in good reproduction of music, in the advantages of long playing, or in the technicalities of recording and reproduction itself, that we must look for the gradual creation of a demand for better systems than those available at present. Already there is a wide range of equipment for amateur use, as articles and descriptions of apparatus included in this issue indicate, and improvements in such equipment which have taken place in the last twelve months show how great are the potentialities which the future holds in store.

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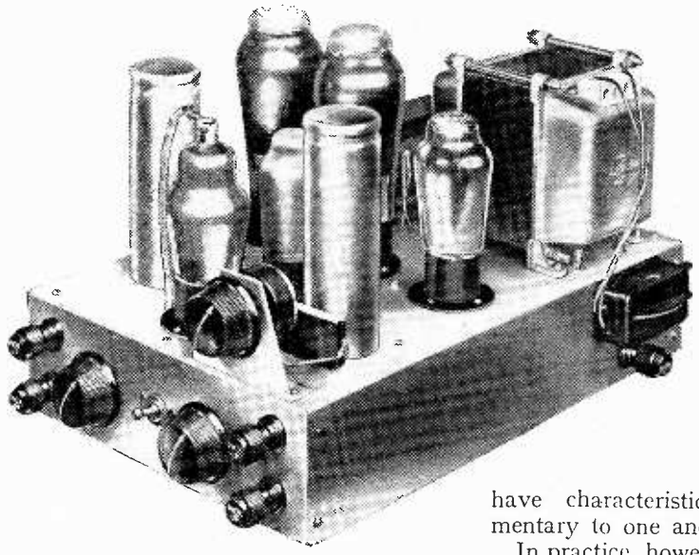
The Wireless World RECORDING

An Inexpensive High-Quali



In this view of the amplifier the independent volume controls can clearly be seen.

THE characteristics of an amplifier which is to be used for recording purposes are not very different from those of one the primary purpose of which is reproduction. It is, therefore, perfectly feasible to combine the requirements of each into a single amplifier, which is then suitable for both purposes.

An output of 4-6 watts is needed for high-quality reproduction, and it is a fortunate occurrence that most of the cutters employed for home-recording require an input of the same order. In the matter of frequency response, however, certain differences arise. Theoretically, of course, if the recording amplifier has a flat response curve, then the reproducing amplifier should have the same response, for we can well leave the question of the bass to the cutter and pick-up, which should have characteristics mutually complementary to one another.

In practice, however, the matter is complicated at high frequencies by the question of needle scratch, and it is found that the best results are secured by recording with an amplifier having a rising characteristic at high frequencies. In this way a better "signal-noise" ratio is secured on the record. If the reproduction is not to be excessively shrill, however, this demands that it be carried out with an amplifier having a characteristic which is the inverse of that of the recording amplifier. Fortunately, this resolves itself into little more than the provision of a *suitable* form of tone control.

The degree of amplification incorporated must be of a fairly high order, since with such apparatus it is often desired to employ a microphone giving an output of no more than 0.05 volt. Insensitive types of pick-up, too, are often used, and the output is likely to be especially small in the case of home-recording owing to the shallow cut usually adopted and to the use of fibre needles for playing. Fibre needles are, of course, often essential because of the comparative softness of the disc as compared with a commercial record.

For the output stage the writer favours the use of two 2.5-watt triodes in push-pull, for with such valves an output of some six watts can readily be secured with a very low degree of amplitude distortion, and the stage has a low output impedance so that the loud speaker or other output circuit is properly damped. Such a stage requires an input of about 70 volts peak, and if full output is to be secured from an amplifier input of 0.05 volt, the gain, measured between the input terminals and the grids of the output valves, must be 1,400 times.

Amplification

To obtain this gain with resistance-coupling throughout would necessitate the use of quite a large number of valves, and any improvement in performance over that obtainable with transformers would be quite small.

Small push-pull intervalve transformers for the resistance-feed circuit are obtainable quite cheaply, and give extraordinarily good results. A ratio of 1-4 can be employed, and one such reduces the gain to be obtained from valves to the more reasonable figure of 350 times only. A gain in the penultimate stage of 20 times

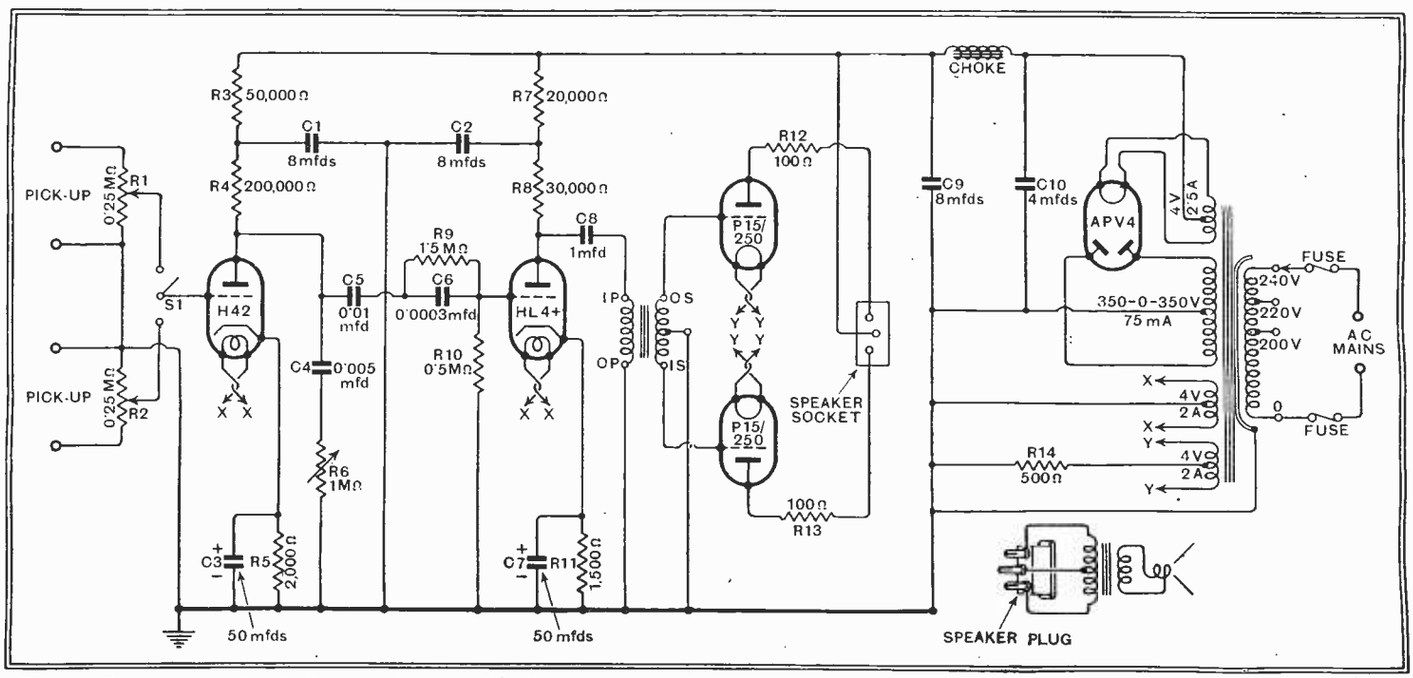


Fig. 1.—The complete circuit diagram of the amplifier is shown here. A push-pull output stage is used and independent input circuits are provided.

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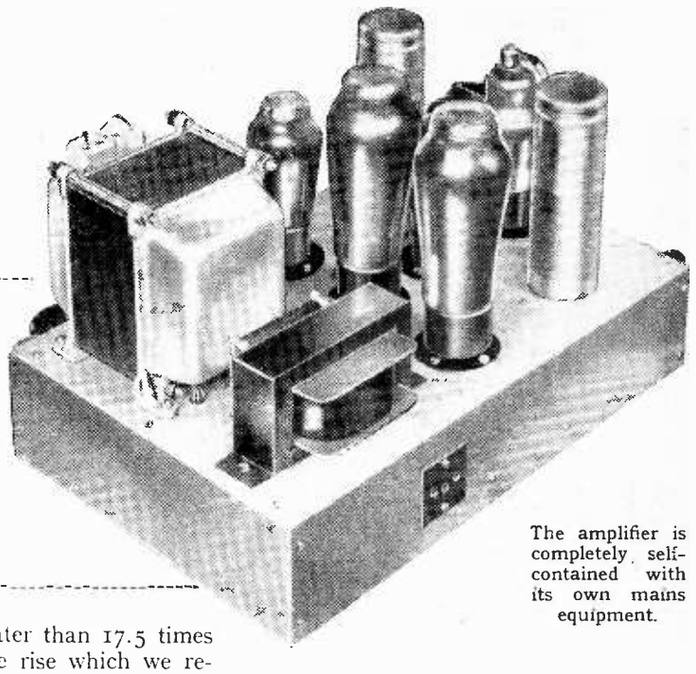
AMPLIFIER

Dual-Purpose Unit

HIGH quality reproduction calls for an undistorted output of 4-6 watts and the type of cutter usually adopted for home-recording requires an input power of the same order. It is consequently quite easy to employ the same amplifier for both purposes. Ideally, the frequency response should be different in the two cases and in the amplifier described in this article, this has been arranged by a special form of tone control.



The amplifier is completely self-contained with its own mains equipment.

can easily be secured with a single valve, and reduces the gain preceding it to 17.5 times. This, too, can easily be obtained with one valve.

We have not yet considered the question of the tone-control circuit, however. It is a simple matter to fit a control which

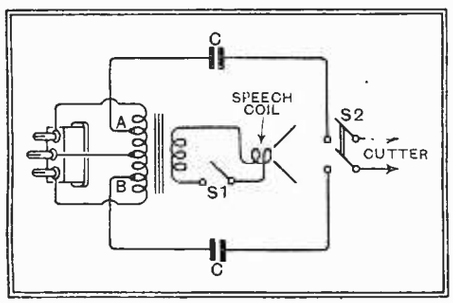


Fig 2.—A ready change-over from loud speaker to cutter can be made by adopting these connections which are explained in the text.

will reduce the high-frequency response, but it is much more difficult to include one which will accentuate it. In fact, it cannot be done to any important degree directly. We can only obtain the equivalent effect on the response curve by reducing the gain at low and middle frequencies only. It is easy to fit a control which will do this, but it is very unsatisfactory in practice, for its major audible effect is similar to that of a volume control.

There are various solutions to the difficulty, and the simplest is to build the amplifier with a normal-frequency response which is not flat but rising very considerably at high frequencies. The addition of a normal type of "top-cut" tone-control then permits the response to be reduced at will to any required degree. At one setting of this control, the overall response will approximate to flatness up to the highest frequencies; on either side of this point the response will rise or fall with frequency.

Since we must throw away amplification to secure a rising characteristic, the valves preceding the penultimate stage must give a gain greater than 17.5 times by the amount of the rise which we require. An increase in response at high frequencies of three or four times should be ample, so that the necessary gain must be some 52.5-70 times. Now, it is just possible to secure amplification of this order with resistance coupling if we use a valve such as the H42, so that we can conclude that, in spite of the high gain desired, only two valves will be needed in addition to those employed in the output stage.

The Input Circuit

The amplifier thus takes the form shown in the circuit diagram of Fig. 1. Two pairs of input terminals, each with its own volume control potentiometer R1 and R2, are provided, and a single-pole change-over switch S1 is fitted to enable either to be connected at will to the first valve. Experience shows that this is a more satisfactory arrangement in a recording amplifier than a fader, since each volume control can be left set at the level desired. In recording it is usually necessary to find the optimum volume level experimentally by making a few trial recordings and then playing them back. It is very convenient, therefore, to be able to leave the control set when once the correct level has been found, and it is consequently suggested that in normal use one pair of input terminals be reserved for recording only and the other pair used for play-back. The first valve is an H42 with a 2,000-ohm cathode bias resistance R5 and a 200,000-ohm coupling resistance R4. Decoupling is effected by the 50,000-ohm resistance R3 and the 8-mfd. condenser C1. The gain of this valve is about 70 times.

At low and medium frequencies the condensers C4 and C6 play little part, and the coupling is essentially resistance-capacity, with the grid of the second valve connected to a tapping on the grid leak. This tapping is at the junction of R9 and R10 of 1.5 MΩ and 0.5 MΩ respectively. The total value is 2.0 MΩ, and the coupling condenser C5 has a capacity of 0.01 mfd., so that a good bass response is assured. The connection of the grid to the tapping point, however, means that only a proportion of the total output is applied to the valve, the actual ratio being $0.5/2.0 = 1/4$ of the output of the first valve. The effective gain of this first stage is thus reduced by the correction circuit to $70/4 = 17.5$ times.

At high frequencies C4 and R6 have little effect when R6 is at maximum. The reactance of C6 in shunt with R9, however, falls as the frequency rises and in effect moves the grid of the second valve up the input potentiometer. In other words, as frequency increases C6 becomes more and more of a short-circuit on R9 and so reduces its attenuating effect. At very high frequencies the full gain of 70 times is secured.

When R6 is reduced in value the impedance of C4 and R6 in series falls as frequency increases to an extent which increases rapidly as R6 becomes smaller.

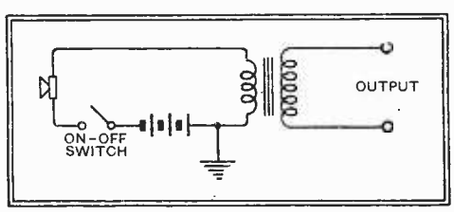


Fig. 3.—The connections for a microphone are shown here. A battery is advised for energising the microphone.

This circuit is in shunt with the coupling and thus attenuates the higher frequencies and permits the action of C6 and R9 to be offset when required.

The second stage is a valve of the HL4+ class, cathode biased by a 1,500-ohm resistance R11. The push-pull transformer is shunt fed from the anode circuit by the 30,000-ohm resistance R8 and the 1-mfd. condenser, C8, while decoupling is provided by R7 and C2 of 20,000 ohms and 8 mfd. respec-

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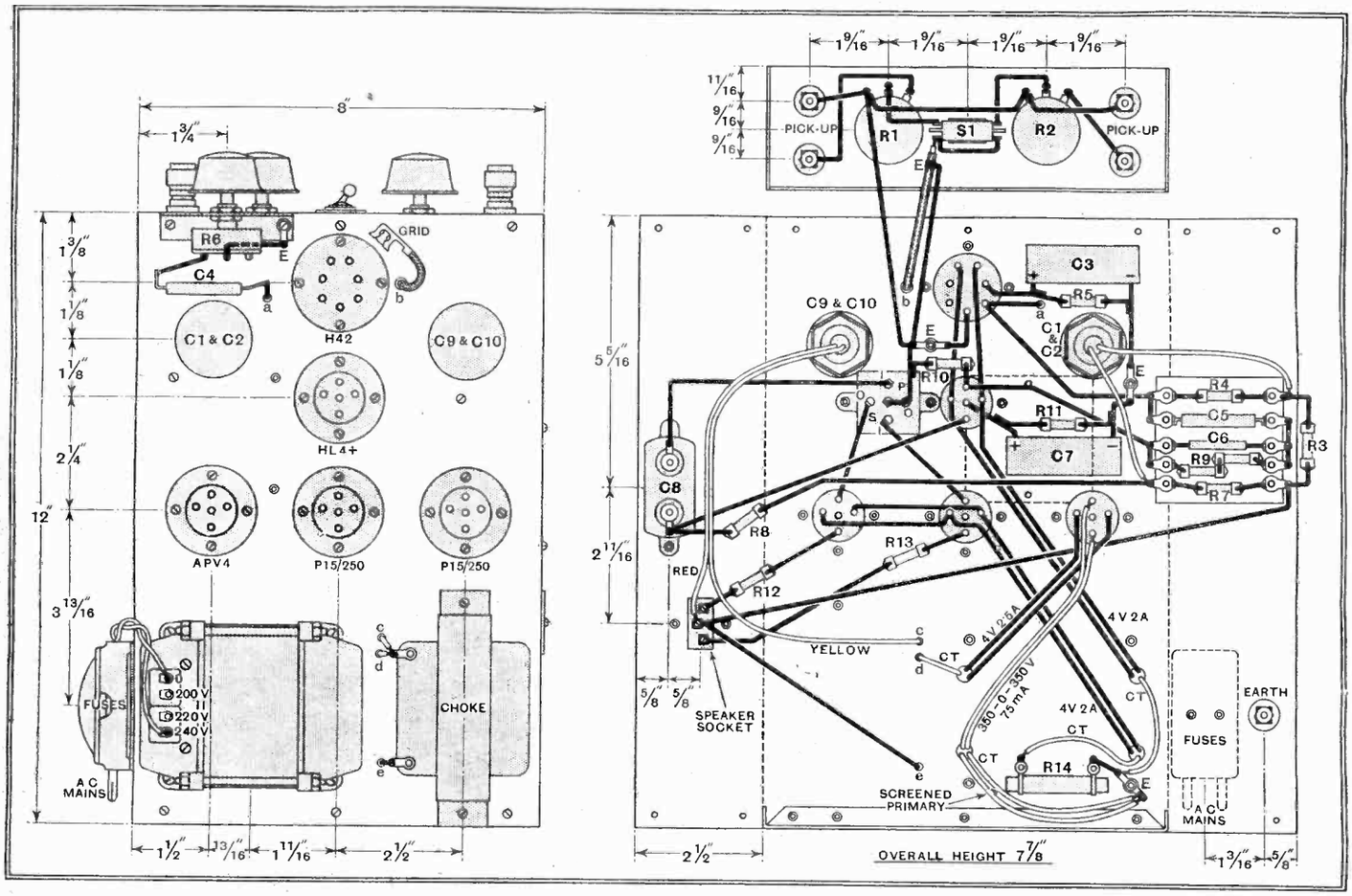
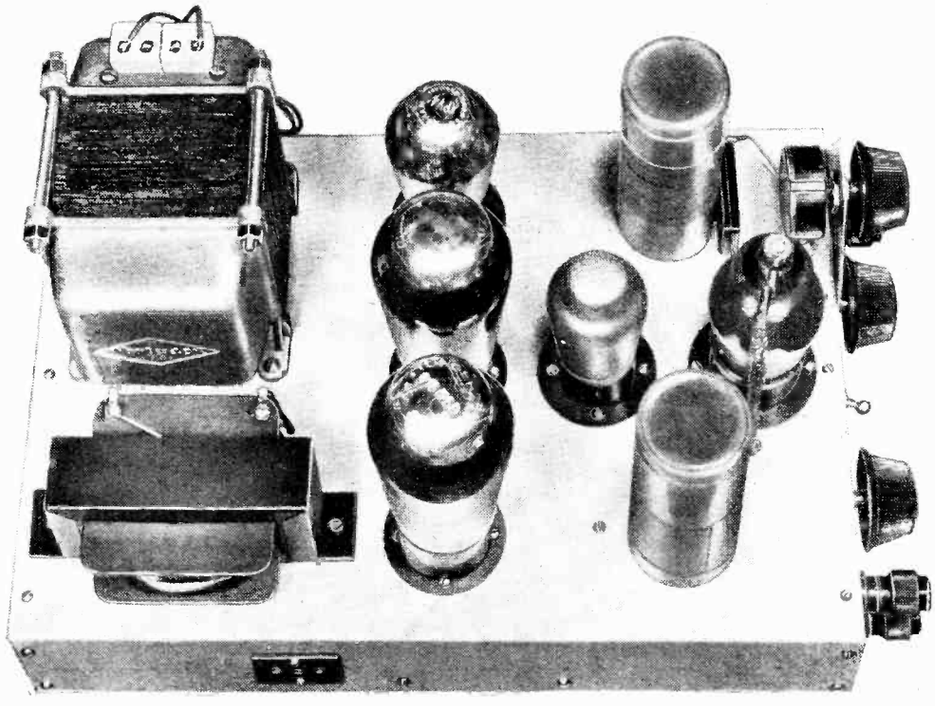
CHASSIS LAYOUT AND WIRING CONNECTIONS



The complete wiring diagram of the amplifier is given here. The wiring is nearly all beneath the chassis and readily carried out

tively. The output valves are of the P15/250 class and 100-ohm resistances R12 and R13 are included in their anode circuits in order to prevent parasitic oscillation. Bias is obtained by the voltage drop along the 500-ohm resistance R14 connected to the centre tap on the filament winding of the mains transformer.

The mains equipment is of simple nature and delivers only enough output for operating the amplifier, thus giving a maximum of economy. Smoothing is effected by a single choke Ch in conjunction with an 8-mfd. condenser C9. No provision is made for energising a speaker field, since many excellent types of permanent magnet speaker are available and it is unnecessary for recording, the primary purpose of the amplifier.



The layout of the chief components is clearly shown in this view of the amplifier.

Little need be said about the construction of the amplifier, since it is quite straightforward, but one must take care to see that a sound contact is obtained with the chassis for all leads returned to it and also for the cases of the electrolytic condensers. Incidentally, these condensers are of the double type, two condensers being in each can. One other point should be noted, the resistance R9 consists in reality of two (1 × 1.0 MΩ and 1 × 0.5 MΩ) in series, since the required 1.5 MΩ is not a standard value.

The uses to which the amplifier may be put are fairly obvious and call for little in the way of comment. The load impedance on the output stage should be some 6,000 ohms and the output transformer should have a suitable ratio to give this load. The ratio is easily calculated and is equal to $\sqrt{6{,}000/Z}$ where Z is the impedance of the circuit connected to the transformer secondary. A common value for speech coil impedance is 15 ohms, and the ratio should then be 20-1. A record-

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THE LIST OF PARTS REQUIRED

Certain components of other makes but of similar characteristics may be used as alternatives to those given in the following list

1 Mains transformer, primary; 200/250 volts, 50 c/s; secondaries; 350-0-350, volts, 75 mA., 4 volts, 2 amps., C.T., 4 volts, 2 amps., C.T., 4 volts, 2.5 amps., C.T.
Vortexion WW 350

1 Smoothing choke, 20 henries, 75 mA., 250 ohms. **B.T.S. CI 22**

1 Push-pull filter feed transformer, 4:1
Sound Sales "CT"

Fixed condensers:

1 0.01 mfd. **C5** **Dubilier 691**
1 0.005 mfd. **C4** **Dubilier 691**
1 0.0003 mfd. **C6** **Dubilier 690W**
1 1 mfd. 500 volts DC test, **C8** **Dubilier "BB"**
1 8+4 mfd., electrolytic, 500 volts peak, **C9, C10** **Bulgin EC7**
1 8+8 mfd., electrolytic, 500 volts peak, **C1, C2** **Bulgin EC8**
2 50 mfds., 12 volts, electrolytic, **C3, C7** **Dubilier 3016**

2 Potentiometers, 0.25 megohm, tapered, less switch, **R1, R2** **Centralab 72-121**

1 Potentiometer, 1 megohm, tapered, less switch **R6** **Centralab 72-116**

Resistances, ½ watt

2 100 ohms, **R12, R13** **Bulgin HW37**
1 1,500 ohms, **R11** **Bulgin HW4**
1 2,000 ohms, **R5** **Bulgin HW5**
1 20,000 ohms, **R7** **Bulgin HW19**
1 30,000 ohms, **R8** **Bulgin HW21**
1 50,000 ohms, **R3** **Bulgin HW23**
1 200,000 ohms, **R4** **Bulgin HW27**
2 500,000 ohms, **R10,** part **R9** **Bulgin HW31**
1 1 megohm, part **R9** **Bulgin HW33**
1 500 ohms, 10 watts, **R14** **Bulgin AR500**

4 Valve holders, 5-pin (without terminals) **Clix Chassis Mounting Standard Type V1**

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

1 Switch, S.P.D.T., **S1** **Bulgin S81**

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

1 Mains input connector, fused, with 1 amp. fuses **Belling-Lee 1114**

5 Terminals, ebonite shrouded, E, PU (4) **Belling-Lee "B"**

1 Group board, 5-way **Bulgin C31**

1 Length screened sleeving **Goltone**

1 Plug-top valve connector **Belling-Lee 1175**

Chassis, 12×8×2½in. **Peto-Scott**

Miscellaneous: **Peto-Scott**
2 lengths systoflex, 2oz. No. 18 tinned copper wire, aluminium for bracket, etc. Screws: 14 6BA ¼in. R/hd., 32 6BA ⅜in. R/hd., 4 4BA ½in. R/hd., all with nuts and washers, 2 6BA soldering tags, 2 lengths 6BA studding 1¾in. with 8 nuts.

Valves:
1 HL4+, 2 P15/250, 1 APV4 **Tungsram**
1 H42 **Osram**

ing head, however, may be 600 ohms, and the ratio should then be 3.16-1.

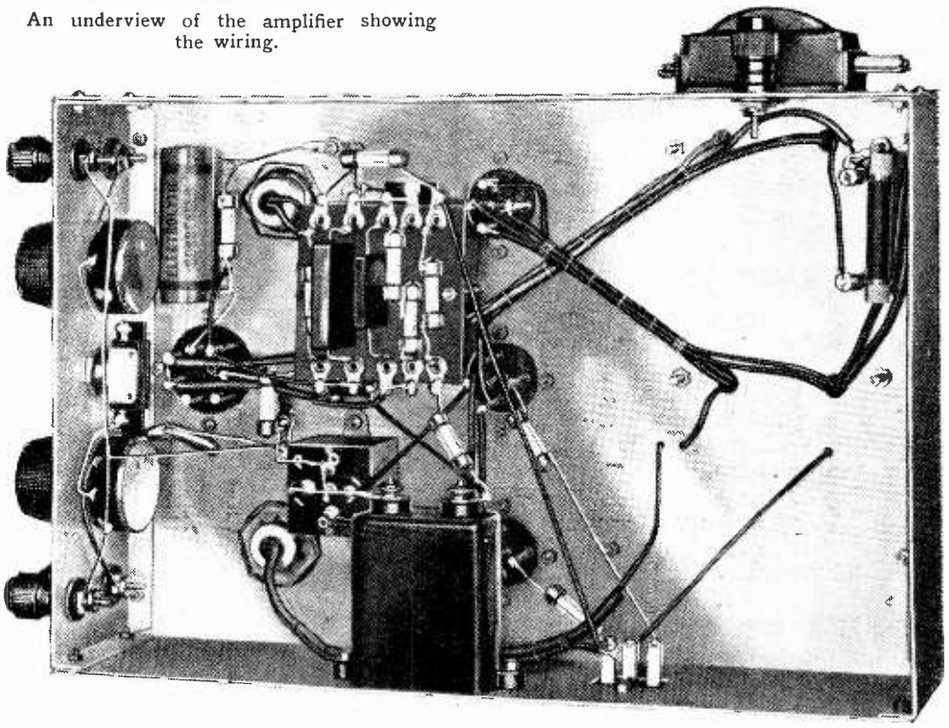
If the same amplifier is being used for recording and for play-back it is probably most convenient to use a special transformer arranged as in Fig. 2. Here the ratio between whole primary and secondary should be chosen to suit the speech coil impedance and the ratio between whole-primary and the portion AB to suit the cutter impedance. The capacity of the condensers C should be about 1 mfd. multiplied by the square of this last ratio. This may sometimes lead to rather large capacities, and as the circuit is purely AC, the electrolytic type is hardly suitable. In general, however, very little is lost by using smaller condensers than the values theoretically desirable and a maximum of 4 mfd. is usually satisfactory.

The switches included permit a change over from speaker to cutter to be made. The speaker is in circuit when S1 is closed and S2 open and the cutter is operative when S1 is open and S2 closed.

On the input side the connections are obvious and it is only necessary to remind users of the need for screening all external input leads. The screening must, of course, be earthed, and the amplifier itself should be earthed. The external connections for a microphone are given in Fig. 3; a battery is advised for energising the microphone since it is simpler than taking the necessary current from the mains equipment. Very thorough smoothing of the mike current is needed if it is taken from the mains, for this point is probably the most sensitive in the whole apparatus from the point of view of mains hum.

Separate full-size blue prints of the amplifier are available from the Publishers, Dorset House, Stamford Street, London, S.E.1. Price 1s. 6d. each post free.

An underview of the amplifier showing the wiring.



The ratio of the mike transformer necessarily depends on the impedance of the microphone. If this has the usual value of some 500 ohms, the ratio should be about 22.5-1.

Television Programmes

Transmission times are from 3-4 and 9-10 daily.

Vision 45 Mc/s. Sound 41.5 Mc/s.

FRIDAY, MARCH 19th.

3, Heraldry of Yesterday and To-day; talk by Archibald G. B. Russell, M.V.O., Lancaster Herald. **3.15,** Interval. **3.25,** Variety.

9, Repetition of 3 programme. **9.15,** Gaumont-British news. **9.25,** Looking Back: Henry Hall and the B.B.C. Dance Orchestra celebrate the Orchestra's sixth birthday.

SATURDAY, MARCH 20th.

3, Flight in Miniature: members of the Society of Model Aeronautical Engineers demonstrate model planes in Alexandra Park. **3.20,** Gaumont-British News. **3.30,** Pasquinade: a television revue by Dallas Bower.

9, Recital by Sidonie Goossens (harp) and Margot Fonteyn (dancer). **9.20,** British Movietonews. **9.30,** Repetition of 3.30 programme.

MONDAY, MARCH 22nd.

3, Marjorie Stedeford: songs. **3.5,** The World of Women—VI; illustrating verse. **3.20,** Gaumont-British News. **3.30,** Cabaret Cartoons—V.

9, The Composer at the Piano: Michael North. **9.5,** Repetition of 3.5 programme. **9.20,** British Movietonews. **9.30,** Cabaret Cartoons—VI.

TUESDAY, MARCH 23rd.

3, The Boat Race: eve-of-the-race discussion between John Snagge and Tom Brocklebank, illustrated by models and films. **3.20,** Panache, Part I: a miscellany of songs, mimes and sketches. **3.40,** British Movietonews **3.50,** Starlight: Steve Geray and Magda Kun.

9, Panache, Part II. **9.20,** Gaumont-British News. **9.30,** Repetition of 3.30 programme. **9.45,** Starlight: Renée Houston and Donald Stuart.

WEDNESDAY, MARCH 24th.

3, Musical Act. **3.5,** London Galleries: Young Artists and their works. **3.20,** Gaumont-British News. **3.30,** Thirty-ninth Picture Page.

9, Nancy Logan: songs at the piano. **9.5,** Repetition of 3.5 programme **9.20,** British Movietonews. **9.30,** Fortieth Picture Page.

THURSDAY, MARCH 25th.

3, Starlight: Phyllis Robins. **3.10,** Home Affairs—VI: discussion on the industrial belt round London. **3.25,** British Movietonews. **3.35,** Scenes from "Macbeth," with Margaret Rawlings as Lady Macbeth and Henry Oscar as Macbeth.

9, Starlight: Evelyn Dall and Sam Browne. **9.10,** Repetition of 3.10 programme. **9.25,** Gaumont-British News. **9.35,** Repetition of 3.35 programme.

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Fidelity of Disc Recording

By F. N. G. LEEVERS, B.Sc., A.C.G.I.

THE author describes a simplified method of measuring the frequency response of recording on discs; for the benefit of those who lack the apparatus for making actual measurements the application of the system to aural comparisons is also described. The published curves would tend to show that a high standard of fidelity is attainable from the modern coated disc.

IT is perhaps not generally realised by users of home recorders that with the coated type of recording blanks now generally employed by amateurs an increase in frequency range over that normally obtained with commercial discs is possible at the upper limit of the scale.

Although frequencies up to 8,000 cycles per second may be satisfactorily recorded on wax, a small amount of abrasive material is included in the shellac composition from which the copies are pressed in order to grind the needle point of the reproducer to the same profile as the groove. This is necessary to avoid chatter of the needle in the groove and also to avoid excessive wear on the bottom of the groove, since if the weight of the pick-up is supported on a very fine needle point the pressure of the needle point on the groove in pounds per square inch will be enormous.

The presence of abrasive material in the disc material unfortunately causes a certain amount of background noise or "needle hiss" in reproduction. This background noise is of a high-frequency nature and can be eliminated to a large extent by limiting the high-frequency response of the reproducer. Most commercial reproducers for discs are designed to cut off all frequencies above about 5,000 cycles, while many do not even approach this figure, low as it is.

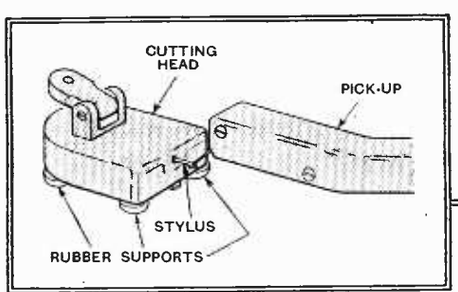

Fig. 1.—Details of set-up for measuring frequency characteristics.

Needle-armature pick-ups are particularly prone to reproduce needle hiss, as the main mechanical resonance occurs within the hiss region of frequency, and a low-pass or "scratch" filter has usually to be employed in conjunction with them. Pick-ups of the piezo-electric type, however, cut off fairly sharply at about 4,000 cycles and, therefore, give a very satisfactory result on commercial discs without the use of filters. See Fig. 3 (a).

The wax process of recording is unsuitable for amateur use, partly on account of expense, and the synthetic type of recording blank is generally used. There

METHODS OF TESTING

are now three main systems in which the disc can be completely processed in under five minutes. The M.S.S. disc consists of a hard aluminium blank with a softer coating of a cellulose compound which takes the cut. A steel cutting stylus is used and the disc is hardened by wiping with a special fluid. The Simplat disc consists of a glass blank coated with a compound of a bituminous nature. A sapphire stylus is necessary to obtain a really clean cut, and two processing liquids are used, one for hardening and the other for polishing. A new recording disc of German manufacture, the Decelith, will shortly be available in this country. It differs from the first two types in that no aluminium or glass blank is used to support the synthetic coating; in other words, the material is homogeneous throughout. Underneath a hard outer skin the material remains in a soft condition until the cutter exposes it to the air, when it immediately forms a new hard skin. The disc, therefore, requires no processing whatever and may be played back immediately.

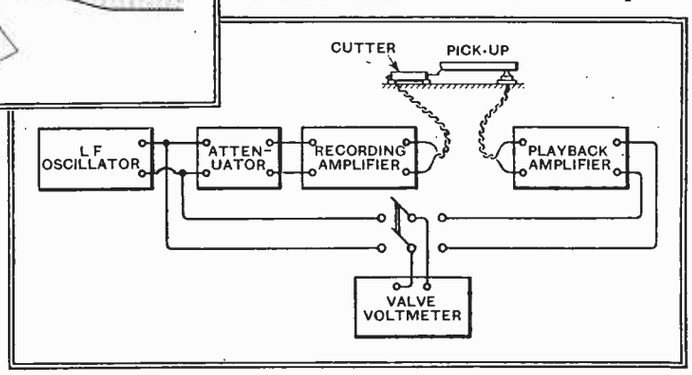

Fig. 2.—Connections of apparatus for measuring overall response.

In none of the types mentioned is any abrasive substance included in the material of the discs, and as a result background hiss is absent from reproduction. It is recommended that, when playing the discs, the needle point should be "ground in" by playing part of an ordinary disc first. The needle point will then fit the groove of the synthetic type disc and will not tend to dig in. If this precaution is taken, scores of playings may be obtained before wear on the disc becomes evident, and wear on the needle point itself is very slight.

Better High-note Response

The absence of needle hiss with the synthetic disc enables the higher frequencies to be reproduced with greater fidelity, but the cutting heads which are available commercially vary considerably in their ability to record the full frequency range on the disc. There is an almost complete lack of information as to the response of cutting heads, and anything in the nature of an accurate test is fairly complicated. It is usually necessary to connect an oscillator to the recorder and to make a series of cuts at various frequencies in the audible spectrum with a constant voltage input to the amplifier. Having done this, the problem of how to measure the amplitude of the cut presents itself. A micrometer microscope will be out of the question, but a simple optical check may be made by viewing the various cuts in the light of a lamp placed at a distance from the disc. Where there is no modulation the line of light seen across the grooves of the disc will be very fine. Where the groove has been modulated the line will be seen to broaden, and if the wave form of the oscillator is good the response curve of the amplifier and cutter may be calculated from the width of the band of light at various frequencies.

The response curve as far as the cutter, however, is only half of the story, and the final results on reproduction depend on the overall response curve which includes

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Fidelity of Disc Recording—

in addition the pick-up and reproducing amplifier. The amount of bass attenuation, cutter damping, etc., may be most conveniently found by reference to this curve.

If the disc cut as above is reproduced by pick-up and the voltage output of the amplifier on load is measured, this will, of course, give the required characteristic, but it is both tedious and expensive to cut a disc every time an adjustment is made to the recorder, and the writer has found the following alternative method to save much time when adjusting disc cutters.

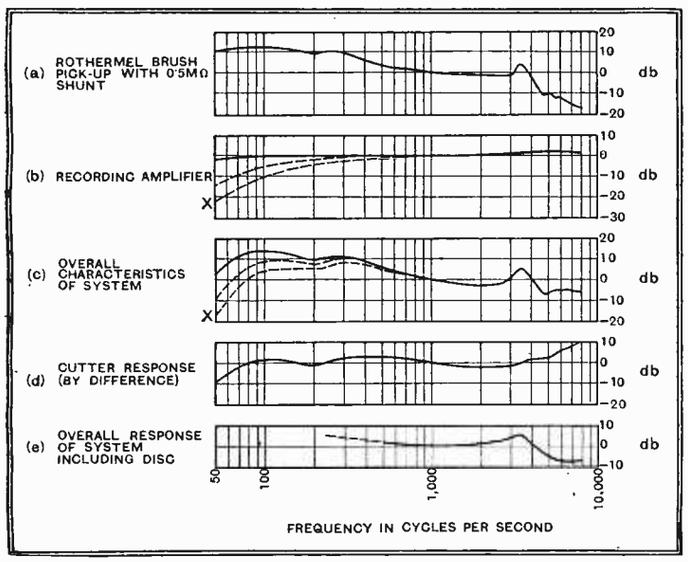

Fig. 3.—Response curves at various stages in the processes of recording and reproducing.

The cutting head is removed from the tracking arm and mounted upside down on three rubber supports as shown in Fig. 1. A cutting stylus is inserted in the chuck, flat side upwards, and a spot of glue placed on the flat and allowed to harden. The pick-up used for reproduction is then placed in position with its needle resting on the spot of hardened glue. Care should be taken that the pick-up head and cutting head are both on a common axis, otherwise chatter will occur between the needle and the stylus, in spite of the presence of the glue.

Cutter Characteristics

It will be seen that transverse vibration of the recording stylus will cause a corresponding movement of the needle point in just the same way as a moving record groove affects it, and the pick-up will, therefore, generate a voltage which may be amplified and measured.

The test oscillator is then connected through an attenuator calibrated in decibels to the input of the recording amplifier feeding the cutter, and the pick-up connected with its appropriate shunt to the reproducing amplifier. A valve voltmeter is arranged so that it can be switched across either the oscillator input or the pick-up amplifier output. The voltmeter need not be calibrated. (The layout is shown in Fig. 2.) Readings are then taken at various frequencies by setting the oscillator voltage at a suitable level by the voltmeter, and then switching the voltmeter over to the pick-up output and adjusting the input attenuator until the same reading is obtained. The gain or loss in decibels above or below a mean reference level is then read off from the position of the attenuator.

Fig. 3 (c) shows the curve obtained in a typical case using a Rothermel-Brush piezo-electric pick-up and an amplifier whose curves are shown at 3 (a) and 3 (b) respectively. The dotted lines in each case refer to two degrees of bass attenuation available in the amplifier. The cutter curve may be derived from these curves by difference, i.e., curves 3 (a) and 3 (b) are subtracted from 3 (c) to give 3 (d). The cutter was of the balanced armature type, wound to 15 ohms.

Referring back to curves 3 (b) and 3 (c), it will be seen that the best results will be obtained with the bass attenuator set to give the curve marked X. The amplitude of cut at low frequencies will therefore be reduced, as is usual with disc recording.

By way of a check on the results, a curve was taken by actually cutting and reproducing the disc in the manner explained earlier in this article, and is shown in Fig. 3 (e). This compares favourably with curve 3 (c), and the loss at high frequencies is due to a falling-off of the transmission factor of the disc at these frequencies.

The transmission factor of the disc may be expressed as the ratio of needle amplitude to recording stylus amplitude, and although high, is, unfortunately, not independent of frequency. It will be appreciated that, for a given linear speed of the disc past the needle point, the higher the frequency of modulation the shorter the distance between successive peaks of the sinuous groove, i.e., the shorter the wavelength.

Now, even assuming the inertia at the needle point is low enough to allow of its following such a wave form accurately, a point is reached where the wavelength is reduced to dimensions comparable with the size of the needle point. We therefore expect a loss of efficiency at high frequencies even at the speed of the outside groove of a disc. As the groove approaches the centre of the disc, the linear speed, of course, decreases in proportion to the radius, and hence the attenuation of high frequencies is increased.

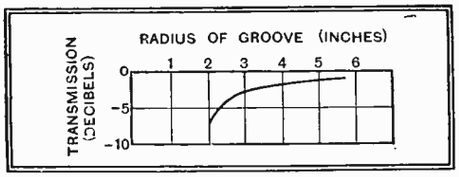

Fig. 4.—Variation of transmission factor with distance from centre of disc (frequency 8,000 c/s.)

Near the centre of the disc still another factor affects the result. It is usual to insert a stylus in the cutter with one side of the V-shaped cutting edge very slightly in advance of the other, in order to direct the swarf from the cut towards the centre of the disc. The two cutting edges are, therefore, very slightly out of phase, but near the centre of the disc this error of alignment becomes relatively important at high frequencies and may cause severe loss.

The amount of variation experienced in a typical case at 8,000 cycles per second is shown in Fig. 4. A 12-inch disc was used and readings taken at various distances from the centre spindle. The cutter was a 90 deg. sapphire at an angle of 80 deg. to the surface of the disc.

Testing by Ear

There must be many owners of disc recording equipments who are not equipped with the necessary oscillator, etc., for taking the above curves, and who rely entirely on aural testing to determine whether the recorder is correctly adjusted. Now the human ear is notoriously accommodating to sound reproduction of inferior quality, and a direct comparison test is the only aural test of any great value.

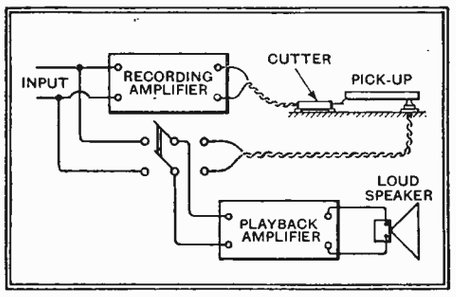

Fig. 5.—Arrangement for aural comparison test.

Such a test may be conveniently carried out using the set-up of Fig. 4, arranging the reproducing amplifier and loud speaker so that its input may be quickly switched to either the pick-up or the microphone direct. The gain control of the recording amplifier should be set so that the volume of sound is the same with the switch in either position, when any difference in quality between them will immediately become evident.

The results of these tests on the synthetic type of recording blank seem to indicate that, with good quality recording equipment, a much higher standard of fidelity is obtainable than is generally believed possible from discs.

PUBLISHERS' NOTE.
Good Friday, March 26th.
Next week's issue will be on sale on Thursday, March 25th.

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Recording Technique

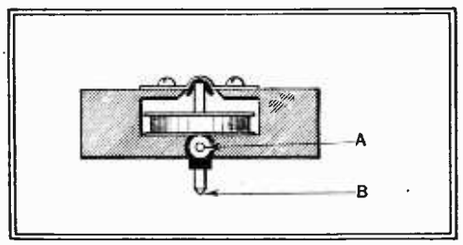
PRACTICAL WRINKLES FROM THE PROFESSIONALS

TO assist readers in achieving the best possible results with home recording equipment we have invited the makers of some representative types of record blanks to give their experiences of the precautions which must be taken to avoid the more obvious errors of manipulation and adjustment. With modern recording blanks it is not possible to go far wrong, but there are certain principles, many of them common to all types of record, which, if properly observed, will make all the difference between an amateurish and a professional result.

ALUMINIUM (Uncoated) BLANKS

By the Technical Staff of Linguaphone Ltd.

AN examination of some of the difficulties usually associated with recording on aluminium will show to what extent they are justified and how they can be overcome. First, and perhaps most important of all, there is difficulty of playing records which from the point of view of quality or material are excellent but which, for some apparently unaccountable reason, refuse to play



For good results with plain aluminium discs the distance between the pivot A and the cutting needle point B should be as short as possible.

through to the end and stick in a particular groove. Let us assume that the tracking equipment is blameless and that it is working, as it should, accurately to one 200th part of an inch. What are the most likely causes of the trouble?

The sketch shows an ordinary moving-iron cutting head in which A is the pivoting point and B the point of the recording needle. It is immediately obvious that the distance from A to B determines the amplitude of the recorded groove; very often failures are caused by the fact that this amplitude is too wide for the playing needle to follow. As a general rule, therefore, AB should be as short as possible (but make sure the base of the cutting head is not touching the disc).

Another cause of faulty reproduction, very easy to avoid with aluminium, is the accumulation of particles of dust on the surface of the unrecorded disc, which at one point of the recording are dragged under the recording needle. A soft cloth can be used to make absolutely certain that the disc is quite clean before commencing to record. Oil or grease used as lubricants can also be blamed for a great many spoilt records; they attract dust which invariably abrades the point of the playing needle. The chemically surfaced "Recordiogram" discs eliminate this last difficulty.

Next in importance perhaps is the question of surface noise, and here some reference must be made to the history of recording. The newer materials have never been associated, as has aluminium, with atrocious amplifiers and even the tin trumpets and acoustic sound boxes of a few years ago. Those who remember a faint voice piping through a battery of needle hiss can scarcely appreciate, without hearing, the relatively quiet background noise of a modern aluminium recording. For a minimum of scratch with "Recordiogram" discs it is necessary to make sure that absolutely no swarf or particles of metal are removed when recording. The angle of the styles should be sufficiently obtuse and with an adjustable recording head the weight rather than the angle should be adjusted to give the required depth of groove.

As with all other materials the frequency of the scratch is not constant and varies with the linear speed, which in turn varies as the diameter decreases towards the centre of the record. It is difficult, therefore, electrically to filter out the scratch alone. But if the point of the thorn playing needle is kept well sharpened any noise will be greatly reduced.

HEAT PROCESSED AND ACETATE COATED BLANKS

By the Chief Engineer, Musikon Ltd.

WHEN purchased "Permarec" records are of soft substance and care must be taken not to scratch or damage the surface as otherwise this will spoil the ultimate results. They can be stored for a long time if kept in sealed tins at a cool temperature but should never be left exposed in a warm atmosphere. This tends not only to harden them and reduce their storage life, but will also give very noisy results, i.e., the cut instead of being quiet and oily will be rough.

The cutting needle plays a most important part in getting the best results. It should be placed in the cutting head with a slight twist away from the centre. This is done in order to allow the cut material to clear itself from the needle. The material will then throw towards the centre of the disc which allows easy brushing with the minimum attention and without the chance of catching under the needle during the cutting period. One other important matter is the depth of cut; this is best seen under a magnifying glass and the appearance should be such that the cut groove is slightly less in width than the material left between the grooves. When cutting is commenced the cutting head should be gently lowered down on to the disc and not allowed to drop hard, as this will interfere with the starting of the recording when playing back.

Importance of Cleaning

Attention must be paid to the cleaning of the disc with a camel-hair brush before processing, to see that all particles of material are removed. Dust is also an enemy that must be guarded against. If this is allowed to settle on the surface of the new record it will give a gritty result when the finished disc is played over.

When cut the records are permanently hardened by baking at a temperature between a minimum of 160 dec. C and a maximum of 200 deg. C, for a period of three hours.

Other than the baking process the details given above apply also to quick-play-back acetate discs. These are for immediate playing after cutting and will give approximately 40 playings as against the 500 playings of the "Permarec." The acetate disc plays with a trailing steel needle, but the "Permarec" may be used with a standard loud-tone steel needle.

CHEMICALLY PROCESSED RECORDS

By the Research Staff of the V.G. Manufacturing Co., Ltd.

THE "Simplat" blank for so-called direct or instantaneous recording consists of a glass base or carrier of the same thickness as a commercial "solid stock" gramophone record, with a surface coating of a colloidal nature (not cellulose-acetate or nitro-cellulose).

These blanks when cut correctly will accept a wide frequency band with a high speech-to-noise (S/N) ratio, and will permit immediate play-back.

To obtain the best results, certain pre-

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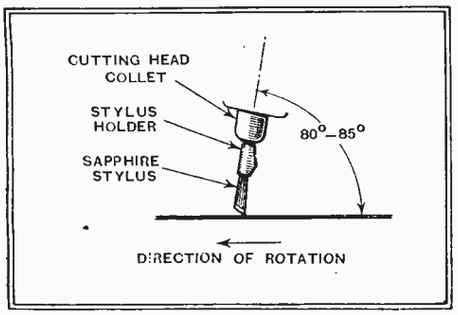
Recording Technique—

cautions are necessary. The surface area used for recording should not be handled before cutting and/or hardening, for such foreign contacts may cause parts of the surface coating to be irregular, producing a "crackle" surface-noise on play-back. Dust or heavy breathing on the surface of any blank are deleterious to its fine texture, and should be avoided.

A sapphire stylus should be used for cutting—although a steel stylus is permissible the results of its use are uncertain and it has a short wearing life. It is well known that a groove cut with a sapphire is more regular, clean and polished than that with a steel stylus. This fact can be ascertained by examining the cuts under the microscope or magnifying lens. The steel cut often leaves a rough,



Correct method of mounting sapphire stylus for cutting "Simplat" type records.

ragged edge, which is one of the causes of surface noise and distortion. An additional advantage is that the sapphire stylus will make a number of recordings —say twenty-four double-sided 10in. blanks—before needing replacement.

When fixed in the cutting head, the sapphire stylus in its holder should have an angle of about 80-85 deg. relative to the horizontal (blank surface). The stylus should be inserted in the cutting head so that the flattened side of the metal stylus holder faces the reverse direction to which the blank is rotating.

When cutting at the standard pitch of 90-100 lines (grooves) to the inch with the normal sapphire stylus the top width of the groove should be approximately equal to the width of the flat surface or "land" between grooves. To determine and control this a pocket microscope with, say, 60 diameters magnification, should be employed.

When using the "Simplat" special stylus the distance between two grooves may be slightly greater because of the more acute cutting angle. Another advantage of the acute-angled stylus is that less weight is required.

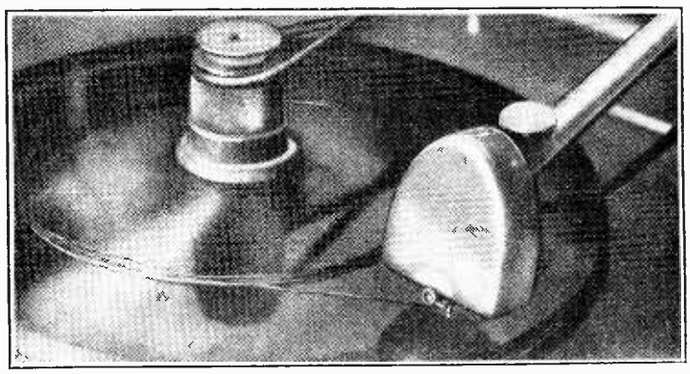
On account of the triangular shape of the cutting stylus the width of the cut is also a measure of its depth, which is dependent on the weight on the cutting head, and so to obtain the required cut, *e.g.*, 50-50 or 55-45, the pressure on the head should be about $3\frac{1}{2}$ oz., and capable of regulation (either increase or decrease) by means of counterbalancing. Another method of determining the depth of cut is to measure the thickness of coating material removed by the stylus with a micrometer.

Related to this depth-of-cut question is surface noise; very often a slight adjustment (increase or decrease) will reduce or eliminate groove hiss or whistle. One further point concerning surface noise: any audible hiss during the cutting of a "Simplat" blank will be apparent in the play-back, therefore, the cutting operation should be silent.

When the "Simplat" blank is cut correctly a continuous and clean thread comes off and collects at the centre, around the weight or clamping device for securing the blank to the turntable. After cutting the recorded blank should be cleaned with a soft camel-hair brush to remove residual swarf and dust particles. It can then be played back immediately, but will only last for about ten playing times.

To make a "Simplat" recorded blank permanent (at least 200 high-quality playbacks) it should be hardened and polished with the special "Simplat" fluids. The polishing fluid may be used on a hardened or unhardened blank and its use will lessen surface noise. The hardening fluid should *not* be used on a polished blank. This hardening and polishing process takes about five minutes, but the process may be accelerated by applying warm air—*e.g.*, from a hair-dryer.

To return to the remarks about swarf removal, some operators set the cutting stylus in the head with a slight bias so that the shavings are thrown off towards the centre. This practice is deprecated, for it results in badly shaped grooves, and we suggest the following method: Arrange the alignment of the tracking mechanism so that the cutting head in its transverse travel overlaps the centre spindle of the motor by about $\frac{1}{8}$in. This method, with centrifugal force, will ensure that the shavings collect in the centre of the blank. Of course, theoretically the head should traverse a radius of the blank, but the small overlap is of no practical significance.



With the tracking mechanism set parallel to and a little in advance of a radius of the blank, the shaving is automatically thrown off towards the centre of the record.

"Simplat" blanks may be stocked for years in any room which is not too dry or over-heated. The best condition is a temperature of about 50-55 deg. Fahrenheit. If while cutting a blank the shavings (swarf) are observed to be (a) brittle, even if the recording apparatus is well adjusted, (b) do not remove in the form of a continuous thread, and (c) on play-back an intermittent short groove hiss is noticeable, these symptoms indicate that the blank has become too dry. However, the surface coating can be renovated by leaving the blank for about twenty-four hours in an enclosure where the degree of humidity of the atmosphere is high.

It is not advisable to stock "Simplat" blanks with flasks of the hardening fluid in one small container, as this might preharden the blanks.

A short list of reasons for unsatisfactory results when using the "Simplat" blank is appended:

(1) Continuous high-intensity surface noise or groove hiss during play-back.
There are many reasons for this defect and one should observe whether (a) the cutting stylus is worn or roughened; (b) depth of cut is correct (this factor is variable); (c) stylus inserted absolutely straight in cutting head; (d) angle of stylus or head relative to the horizontal (blank surface) is correct, *i.e.*, 80-85 deg.; and (e) alignment of traversing mechanism correct.

(2) Non-continuous or periodic surface noise, sometimes only audible on each revolution of the play-back turntable.
Observe whether (a) the recording head carrying arm swings freely up and down in its bearings, without being too slack, and that the coating material leaves the surface of the blank in an unbroken thread, and not in fragments.

(3) Intermittent short-period surface noise or groove hiss, especially on the outer circumference of the blank, audible during play-back.
Usually caused by (a) the surface coating being too dry, due to storage of the "Simplat" blank in a hot and dry atmosphere, or (b) the heat radiated from an electric lamp in close proximity to the blank on the recording turntable.

(4) Groove-jumping—*i.e.*, the pick-up needle will not stay in the groove on play-back.
Usually caused by (a) insufficient depth of cut; (b) pick-up carrying arm out of alignment or stiff; (c) play-back turntable not level; or (d) unsuitable play-back needles.

(5) Groove-wall breakdown, cut-over or groove cross-over.
Caused by over-modulation, *i.e.*, too high volume level, or by insufficient damping in the cutting head. Reduce input to cutting head and carefully watch the volume-indicator or grooves, the latter through a microscope.

(6) Pattern-weaving—*i.e.*, wavy lines or a "watered silk" effect on the surface of a recorded blank, which may be seen with reflected light from the blank.
This effect is caused by a periodic variation in the width and depth of the groove, usually produced by some extraneous vibration transmitted to the recording turntable, cutting head or stylus.

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Random Radiations

By "DIALLIST"

Down in the West

DRIVEN from house and home by the advance of an army of painters and paperhangers and the threat that their visitation was to be followed by spring cleaning, I fled lately to Devonshire in search of peace, quiet and warmth. The first two I found (I couldn't help thinking a little sadly of Free Grid when I was salmon fishing near Princetown), but not the last; rain, hail, snow and a razor-edged East wind have been my portion. However, there was plenty of interest in the wireless way and that makes up for a lot. Down in the West, Radio Jerusalem is to be heard pretty strongly—at times so strongly that it spoils reception of North Regional. I'd read something about that, but hadn't quite believed it. There were plaints too that Penmon hadn't been doing any good to West Regional: either the synchronisation had not been perfect or one station was wobbling a bit on its wavelength. Recently there has been an improvement. I found West Regional perfect the night I tried it, but learned subsequently that Penmon had broken down!

"Service" Suggestions

TO readers at Kingston, Eastbourne and Lymington I am indebted for very interesting letters on the subject of radio work. All three are highly skilled professionals endeavouring to do good work at a fair price. They make sound suggestions and have some queer tales to tell of the happenings that befall them. An idea that I commend heartily is the adoption of a fixed charge for testing a set and locating a fault. The sum suggested is 3s. 6d. The reader who regularly makes this charge finds that it just pays him, since the breakdowns that are easily tracked down counterbalance those that take hours to locate. All are agreed on one important point; the nature of the work that is to be done, or has been done, should be explained to the customer. I would add that it might be even better to show him the extensive and expensive testing outfit that may be required and to mention that some skill is required for its use.

[Presumably travelling costs would be additional to the fixed charge. Even so, the sum suggested seems to us to be inadequate.—ED.]

Good Men and Others

Another point of agreement is that a detailed account should be sent in. I like the method of one correspondent, who makes a practice of returning the defective part or valve to the customer when a replacement has been made; there can then be no question that a new component or valve has been fitted and should the customer doubt the necessity for this, he can have the old one tested independently. These are servicemen after my own heart and I hope that their numbers are growing rapidly. They deserve to prosper and they will. Now, here's an instance of the other kind of service that came my way only a day or two before the writing of this paragraph. A friend was not satisfied with the volume or the quality obtained from an extension loud speaker worked from a set capable of about 5 watts undistorted output. He deduced that the matching transformer of the extension instrument was not of the correct ratio, explained to a local firm what he wanted and asked them to see to it. Next day they sent up a boy on a bicycle with a *volume control*—and had the cheek to send in a bill for half a crown for "demonstration of wireless apparatus"!

Modes in American Sets

THE February number of the Proceedings of the Institute of Radio Engineers contains some very instructive facts about the modern American receiving set. Its average price works out at 65 dollars, or say £13. A typical console is described as containing nine valves and costing 100 dollars (£20); a typical table model costs 40 dollars (£8) and has six valves. There are about seventy set manufacturing companies, of which rather fewer than half make battery sets as well as "socket-plug," or mains models. Only some 15 or 16 companies now make any "straight" sets, and these are in the lowest-priced class. One midget model for mains operation and containing five valves is listed at 10 dollars or £2 complete! Prices throughout may seem surprisingly low, but the enormous output of the manufacturers —9,000,000 sets for 1936—makes mass production possible in every department.

No Lack of Valves

What most interests me is the lavish number of valves employed. Including the rectifier, it works out at an average of something over seven for each American radio user as against a little over three in this country. As I've mentioned before, you can *do* things if you have plenty of valves to work with, and here is the kind of thing that the U.S.A. designer does in his more expensive models. Automatic tuning control is pretty widely used, and this makes "telephone dial" tuning possible with even highly selective and sensitive sets.

Other Features

Variable selectivity is common, the general method employed being to make the coupling of one or more of the IF transformers controllable by means of a knob. "High-fidelity reproduction" is claimed for all the higher-priced sets. All such sets have visual tuning indicators, one interesting type causing the colour of the dial illumination to change from red to green when resonance is reached. Genuine all-wave sets covering all wavelengths from about 5 to 2,000 metres are made by several companies.

Automatic volume expansion, limiting devices for cutting down or cutting out sharp interfering impulses of great magnitude and short duration, automatic selectivity control and genuine quiet automatic volume control are features that are becoming more and more widely used.

Now, these are just the kind of things that we want to see in British sets. Some sets already have done one or more of them, but there is as yet no set that I know with all of these good points. We are going to have bigger receivers this year. Let's hope that some, at any rate, of our manufacturers will try the experiment of putting on to the market the very best wireless set that can be made. I don't mean that they should go as far as the 37 valves that are found in one American set, but they needn't be afraid of a dozen or so. So long as they can offer sets of first-rate performance and will tell the public just how and why their performance is so much better than that of small ones, there'll be no lack of customers. But these receivers must be available as wireless sets pure and simple and not only as radiograms.

Transatlantic Relays

FURTHER letters from readers, this time from Easington, Cranwell and Wallasey, prove beyond a shadow of doubt that some, if not all, of the B.B.C.'s relays from the U.S.A. may be "taken" by way of the Transatlantic telephone service. The transmissions are to be heard on approximately 20, 30, and 34 metres. Before and after them you may hear American engineers calling London, fixing up details, and asking whether all is as it should be. If anyone now doubts this, let him search the 20-metre band just before a relay is due to start for a strong American signal. The odds are that he will hear the operator at the other end checking up times, quality, and so on. I'm told that these are R.C.A. transmissions, which confirms my original statement that I had heard "Radio City calling."

News from the Clubs

The West London Radio Society

Headquarters: "The Anchor," Uxbridge Road, W. Ealing, W.13; also at Ross and Robinson, Ltd., 16, Bond Street, Ealing, W.13.

Meetings: Tuesdays at 8.15 p.m. at Ross and Robinson, Ltd.

Hon. Sec.: Mr. D. Reid, 15, Tring Avenue, Ealing Common, London, W.5.

The Society has now obtained the use of the premises of Ross and Robinson, Ltd., 16, Bond Street, Ealing, W.13. Here members have the free use of a television receiver. Regular meetings are still held, however, at "The Anchor."

Southall Radio Society

Headquarters: Southall Library, Osterley Park Road, Southall.

Meetings: Tuesdays at 8.15 p.m.

Hon. Sec.: Mr. H. F. Reeve, 26, Green Drive, Southall.

Television was the subject of a recent lecture by Mr. Douglas Walters (G5CV). The lecturer gave a short history of the subject followed by a description of modern apparatus. There was a large attendance.

Golders Green and Hendon Radio Scientific Society

Headquarters: 60, Pattison Road, Hampstead, London, N.W.2.

Hon. Sec.: Mr. A. G. Griffiths, "Hornbeams," Priory Drive, Stanmore, Middlesex.

A lecture on the applications of short- and ultra-short waves to Medical and Bacteriological Research accompanied by demonstrations will be given by Dr. C. G. Lemon, F.Ph. Soc., A.M.I.R.E., to the Golders Green and Hendon Radio and Scientific Society on March 24th next at the Regal Cinema, Golders Green.

The Radio, Physical and Television Society

Headquarters: 72a, North End Road, W. Kensington, W.14.

Meetings: Wednesdays at 8.15 p.m., and Fridays at 8 p.m.

Hon. Sec.: Mr. M. E. Arnold, 12, Nassau Road, Barnes, S.W.

The recent television demonstration held at the premises of Messrs. Kamroe and Co., Ltd., was attended by thirty members and friends,

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who expressed their strong appreciation of the excellent results obtained. Dr. C. G. Lemon, the society's president, recently gave a very interesting lecture, entitled "Experiments in Light," in which he demonstrated how easily the human eye was deceived, more especially when it was fatigued. This lecture is the forerunner of a series of popular scientific talks which will be given from time to time. The society's headquarters have been redecorated, and a library inaugurated for the benefit of members.

The Nottingham Amateur Radio Society

Hon. Sec.: Mr. C. Lambert, 199, Sherwood Street, Nottingham.

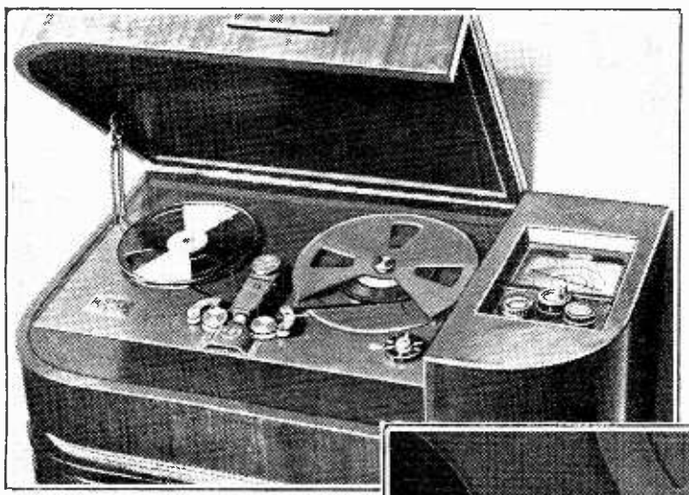
A radio society has been formed in Nottingham, and at present two club nights are held during the week and a further meeting on Sunday mornings for those who cannot come along at other times. A monthly meeting is to be held to discuss the affairs of the club. At present the society is chiefly concerned with short-wave work, but it is hoped to extend the scope to include all radio activities.

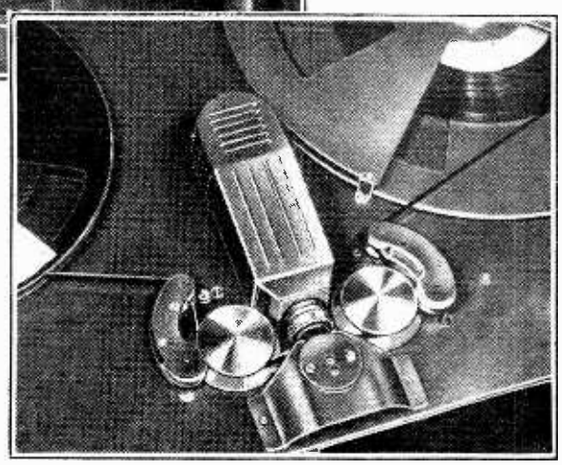
NEW SYSTEM OF

Recording on Film

DUO-TRAC SOUND PROJECTOR

THE average gramophone record gives a playing time at normal speed of about three to four minutes, and this naturally imposes a limitation on the amount of matter that can be recorded on a single disc even allowing for the fact that both sides can be used. The advent of automatic record-changers has gone a long way towards relieving the tedious business of replacing records, and with these useful machines it is quite possible to obtain half-an-hour's entertainment without any attention on the part of the user. It is inevitable that intervals occur in the reproduction while the mechanism is changing the record.





Sound and radio control panels on the console model Duo-Trac reproducer, and below a "close-up" of the sound cell and lamp housings.

In order to obtain a continuous recording for a longer time than is possible with the orthodox gramophone disc, the idea of using film, or its equivalent, and recording the sound on it, has occupied the attention of some research workers in the past, and though many of these systems have not progressed beyond the laboratory stage, a few, among which is the Duo-Trac Sound Projector system, have been developed to a state where they can rightly be regarded as practical commercial propositions.

The firm responsible for the development of the Duo-Trac system is British Ozaphane, Ltd., 72a, Carlton Hill, St. John's Wood, London, N.W.8. It derives its description Duo-Trac from the fact that on the film used two sound tracks are recorded. During reproduction the film unwinds from one spool to another, playing in the process one of the sound tracks. When this is completed, the driving mechanism is automatically reversed, and the film is wound back again on to the first spool, reproducing the second sound track in the reverse winding direction.

On a spool of 7in. diameter sufficient film can be accommodated to play for twenty minutes in each direction, but the standard length of film used gives about thirty minutes' total playing time.

One great advantage of the forward and reverse method of recording, using two sound tracks, is that on completion the spool is ready for the next time of playing, and does not require rewinding. The amount of film needed for a given playing time is also only half that which would be required were a single sound track used.

There is, of course, no definite limitation to a thirty-minute playing time, and should a particular recording not require the full amount of film, less can be used. Likewise, it is possible to extend the continuous run of the record beyond the half-hour period and provide an hour's continuous entertainment on one spool.

The material used is a narrow ribbon 4 mm. wide, and it is extremely strong. It can, therefore, be driven without the aid of sprocket holes, which, in addition to enabling the width of the film to be reduced to the bare minimum necessary to accommodate the two sound tracks, also gives smooth running free from snatch, and as a consequence the film has an indeterminate life. The material, which is described as Ozaphane, is non-inflammable.

No wear or tear is imposed on the sound tracks during reproduction, as this is effected by means of a lamp and a light-sensitive cell.

Reproduction from a piece of Duo-Trac sound ribbon four times actual size. The two white tracks are the sound recordings.

In making the film it is first dyed with a special light-sensitive dye and the sound tracks produced by a photographic process. The film is not coated with an emulsion as in the case of ordinary photographic film.

Duo-Trac sound film is very durable, and it appears impossible to damage it by scratching the surface, which is smooth and glossy on both sides, while the dye apparently penetrates well into the material.

An extensive programme, which includes a monthly release of new recordings, is planned, and the apparatus soon to be generally available consists of a Duo-Trac Sound Reproducer with which is combined an all-wave radio chassis. The radio receiver is of conventional though quite up-to-date design, and the cabinets in which the apparatus is housed are exceptionally well made. For Duo-Trac sound reproduction a small pre-amplifier is brought into use to augment the amplification provided by the AF stages in the radio receiver.

The frequency range that can be recorded on the film is very wide, and no mechanical considerations need be taken into account to restrict the upper limit.

As mentioned already, reproduction is by means of a light-sensitive cell, which in the illustration is enclosed in the dome-shaped housing immediately below the long metal casing with louvres which accommodates the lamp. The ribbon can be seen between the two, and shown also are the guide wheels to maintain sufficient tension on the ribbon to ensure smooth running.

Two Duo-Trac sound and radio receivers are in course of production; one is a table model and the other a console type.

H. B. D.

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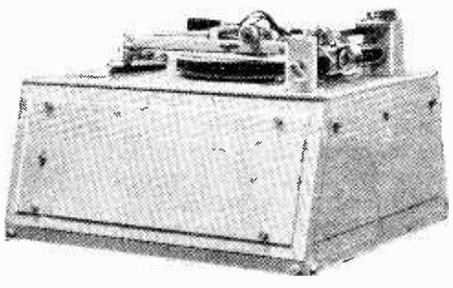
Recording Equipmen

Apparatus Suitable for Home and Commercial Use

IT is an exceedingly difficult matter to divide the available recording equipment into well-defined classes, and say this is for the amateur experimenter's use, and that is for the professional, though it will become apparent from the various brief descriptions that follow, and from the illustrations, that certain types have a marked professional appearance.

The high-grade nature of some of the equipment, and as a consequence its high price, must suffice as the only possible classification, for the most elaborate recorders are not so expensive that the amateur cannot acquire them, and having installed one will encounter any insurmountable difficulty in making good records. Admittedly, experience is needed before first-class recordings can be produced, but then the amateur is just as capable of acquiring the necessary skill as, for example, are engineers of broadcasting institutions and film companies, for whose use some of the equipment contained in this section is primarily intended.

A firm that makes a speciality of the precision-type of recording apparatus is the M.S.S. RECORDING CO., LTD., 99a, Charing Cross Road, London, W.C.2. Though the apparatus supplied by this firm is mainly to special order, there are some standard units that form the nucleus of the equipment.



M.S.S. recording machine.

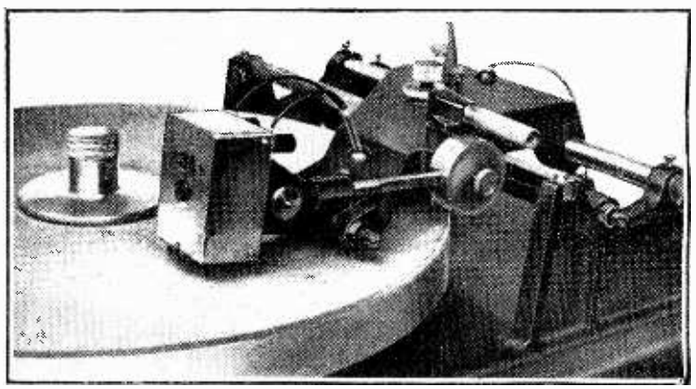
A recording machine described as the Type B36 provides three turntable speeds, giving 78, 60 and 33⅓ rpm, and it will accommodate discs up to 16in. in diameter. The discs used are the acetate variety, and can be played back immediately, no processing of the record being first necessary.

This machine is fitted with a reversible hand-feed traverse, and provides a pitch variation of between 40 and 120 threads per inch. The cutting angle and depth of cut are also variable. For driving this machine, which is of very massive construction, a powerful electric motor is used, and this can be supplied for operation either from the electric supply mains or from a 24-volt battery.

The overall size is 24in. by 22in. by 48in. high, and the price is £170.

The Model CA/36 recorder is a single-speed machine fitted with a 12-inch turntable, but will accommodate discs up to 13in. in diameter. It cuts 95 grooves to the inch, and is driven by a ⅛ hp electric motor, and special care is taken to ensure freedom from vibration. Incidentally, this feature is also embodied in the first model mentioned. Some idea of the massive nature of the construction of these machines can be gained from the fact that the 12-inch turntable fitted to the CA/36 recorder weighs approximately 25lb. It is assembled on a steel base-plate ⅜in. thick, measuring 24in. by 16in. The price is £75.

A special recording amplifier with three frequency-band attenuators for controlling the output in the bass, the middle and in the treble registers, also main and subsidiary volume controls, and with two input points is also available.



Cutting head and traversing mechanism of the Parmeko recorder.

Provision is made for use of a monitoring loud speaker, and by means of switching the amplifier can be immediately changed over from recording to play-back.

The undistorted output is 10 watts, and the price is £37 10s.

M.S.S. recording discs are made in seven sizes, from 6in. to 16in., both single- and double-sided. The last-mentioned style cost 1s. 3d. for a 6in., 2s. 6d. for a 10in., 3s. for a 12in., and 10s. for a 16in. acetate disc.

If required, hardening fluid can be supplied at 3s. per pint though, as already mentioned, the discs are of the pattern that can be played back immediately, but the hardening process will undoubtedly give a longer playing life.

In developing their recording equipment, PARMEKO, LTD., Percy Road, Aylestone Park, Leicester, have aimed for a very high standard, and all the apparatus is built on very massive lines. It is not, strictly speaking, a home recorder, though the advanced amateur experimenter prepared to meet the cost of high-grade apparatus will find no obstacles in the way of its installation in the home.

The recording machine and its driving motor are assembled as two separate units joined together by a shaft with flexible couplings. The former unit consists of a massive turntable, a gear box and traversing mechanism, the latter being very solidly made, and is driven by a belt from the gear box. Three pulley ratios are available for varying the speed of travel of the traversing cradle, so giving the choice of 85, 95 or 120 grooves to the inch on the record.

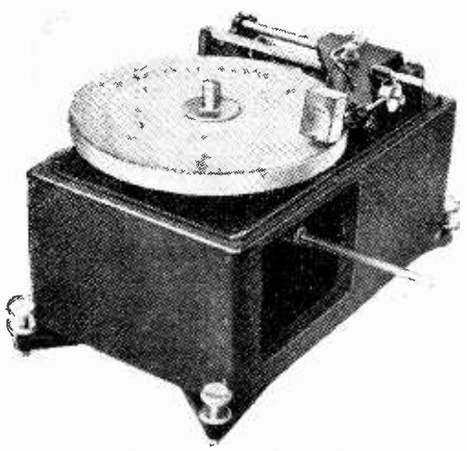
The traversing mechanism is driven by a split-nut, and a pawl is fitted to release and engage it with the worm screw. An adjustable weight is included for varying the pressure of the cutting head on the recording disc.

In the other unit is contained a large synchronous electric motor suspended on springs, and both units are built into strong teak cases.

Every part of the equipment is very massive, and the reason for adopting this form of construction is to ensure absolute rigidity and to prevent any variation in turntable speed during the process of recording.

The cutting head supplied with this recording machine requires approximately six watts for full modulation.

In addition to supplying the recording machine and motor unit, Parmeko also make a special amplifier for use with their equipment. This is a three-stage model, giving 10 to 12 watts output, and has two input points for microphones with separate attenuators, and switching is embodied so that the amplifier can be used for both recording and play-back. It also embodies frequency correction.



Parmeko recording unit.

Recording blanks are available in 7in., 10in., 12in., 14in. and 16in. sizes, which, prepared for recording on both sides, cost 2s., 3s., 4s., 5s. and 6s. each respectively.

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- A REVIEW OF UNITS & ACCESSORIES

Hardening and polishing fluids for the discs can be supplied at 2s. 6d. each per bottle, though the discs are of the type that enable immediate play-back to be effected.

The recording machine and motor cost £70, while the price of the amplifier complete with accessories is £68.

The apparatus supplied by the DENNIS PARISH RECORDING STUDIOS, Leicester House, 5, Green Street, London, W.C.2, can be divided into two classes, viz., parts for assembling one's own recording equipment and complete recording sets embodying a radio receiver.

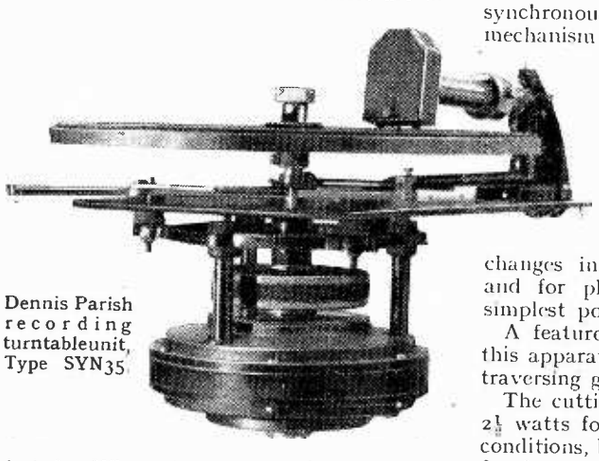
The principal component parts comprise special heavy-duty motors, cutting heads and, of course, blank recording discs.

Complete motor units for AC operation, which include turntable, tracking mechanism and cutting head, are available in three types, of which the SYN35 is the cheapest. This costs £14 10s., and it runs at 78 rpm. The SYN35a is similar in its equipment but has two speeds, giving in addition to 78 rpm a slower speed of 33 rpm, and it costs £26. Both these machines are fitted with 12in. turntables.

The largest model is the SYN36, to which is fitted a 16in. turntable, and like the 35a model, can be operated at either 78 or 33 rpm. Its price is £36.

The cutting head alone can be supplied wound to any impedance to suit individual requirements, and it costs £5.

It is possible to obtain the motor and recording equipment assembled in a case, and in some models twin turntables are included. When the amplifier is included in the equipment it is usually assembled in a separate case, and the standard model supplied gives between 6 and 8 watts output. A single turntable recording unit with separate amplifier is available for £47 5s., and this is complete in every detail. It is known as the Model 536R.

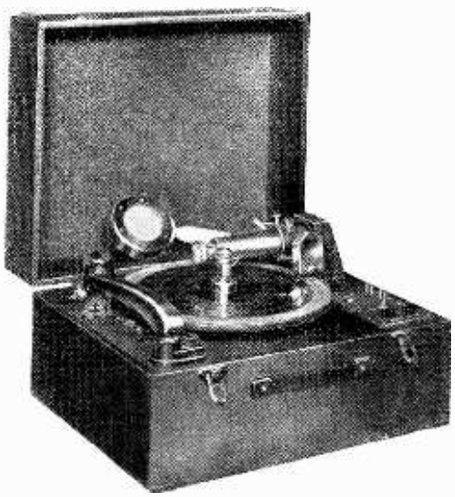


Dennis Parish recording turntableunit, Type SYN35.

A motor unit with recording head, tracking mechanism and a play-back pick-up assembled in a leatherette-covered carrying case for use in conjunction with a radio receiver costs £17 10s.

The recording discs used with the Dennis Parish apparatus are the acetate type and cost 3s. 2d. each for 12in. double-sided discs, and 2s. 8d. each for the 10in. size. These are the black-surfaced type, but a white surface variety is also available at 3s. each for 12in. double-sided and 2s. 1d. each for the 10in. size, also double-sided.

The home-recording apparatus made by MICROPHONE EQUIPMENT, LTD., Faraday House, 8, Charing Cross Road, London, W.C.2, is supplied either in the form of a complete recording machine or as parts for attaching to an existing gramophone.



Microphone Equipment home recorder.

The complete recorder is known as the M.E. Recorda, and consists of a powerful synchronous electric motor, traversing mechanism with a cutting head, a switchboard and a gramophone pick-up for reproducing records.

This equipment is mainly intended to be used in conjunction with a radio receiver, either for radio recording or by utilising the AF stages as an amplifier for a microphone. The switchboard enables changes in the connections for recording and for play-back to be effected in the simplest possible manner.

A feature of interest in connection with this apparatus is that the lead-screw of the traversing gear is totally enclosed.

The cutting head supplied requires about $2\frac{1}{2}$ watts for full modulation under normal conditions, but the damping can be adjusted for larger power inputs if necessary, the maximum power it will handle being of the order of 15 watts.

A transverse current carbon microphone is supplied, also one dozen M.E. recording discs in the inclusive price of 18 guineas.

The traversing mechanism and cutting head is supplied as a separate unit for £6 16s. 6d.

The discs supplied by this firm are the cellulose acetate-coated type and do not require hardening, so it is possible to effect immediate play-back. They are made in 10in. and 12in. sizes, and cost £2 10s. and £5 respectively in sealed tins containing twenty-five double-sided discs. Trailing needles are advised for play-back to avoid undue wear on the record, and they are obtainable at 2s. a hundred. The recording or cutting needles cost 4s. a dozen.

ARDENTE ACOUSTIC LABORATORIES, 11 and 12, Pollen Street, London, W.1, are well known as manufacturers of sound amplifying equipment, and to their many activities is also added that of supplying recording apparatus.

For this purpose one of their standard 12-watt amplifiers is modified and fitted with a slightly stronger electric motor and turntable and to it is fitted a traversing and cutting unit which is driven by a vertical shaft from the centre spindle of the motor.

It cuts approximately 90 grooves to the inch, and recording blanks up to 12in. in diameter can be used. The discs employed are the coated type on a glass base, and after cutting have to be hardened and polished by special fluids, though this operation can be carried out without necessarily removing the disc from the machine.

It is described as the Recordagraph, and complete with moving-coil microphone, loud speaker and all accessories for AC mains operation costs £60. A small rotary converter can be supplied for DC mains operation, when the price is increased to £70.

The special feature of the recording machine made by RECORD-IO-GRAM (Linguaphone, Ltd.), 24/27, High Holborn, London, W.C.1, is that the apparatus, which is entirely self-contained, can be used for making a record and for reproducing the finished article merely by turning a few switches and changing the needle.

Known as the Record-io-Gram, it comprises an electric gramophone unit especially adapted for recording, the traversing mechanism being very cleverly accommodated underneath the turntable. In external appearance it differs very little indeed from an orthodox electric gramophone unit, only a few switches having been added. Housed in the cabinet is also an amplifier and a moving-coil loud speaker,

Record-io-Gram complete self-contained home recording apparatus.

and by means of switching the former is utilised either for recording from a microphone or for play-back. Provision is made

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Recording Equipment—

for recording from radio, but in this case the output from the final amplifier in the set is applied direct to the cutting head which, incidentally, is of the high-impedance type.

For the Record-io-Gram recorder specially prepared aluminium discs are used. These have a very soft surface for aluminium, and they are not cut in the true sense of the word, but the surface is indented and no swarfe is produced by the needle.

The apparatus is AC operated and costs 24 guineas. Double-sided 10in. discs cost 10s. a dozen, and a high-grade carbon microphone for suspending in a stand is available at £3 3s. The polarising voltage for the microphone is supplied by the built-in amplifier.

Another firm that used plain aluminium discs for their home recorder is LESLIE DIXON AND CO., Electradix House, 218, Upper Thames Street, London, E.C.4.

This is a small unit for adding to an existing gramophone, and comprises a tone arm and cutting head, tracking gear, and a gear box unit for fixing to the centre spindle of the motor. The ratchet arm which conveys the drive from the gear box unit to the tone arm can be quickly detached so that the tone arm may be used for reproduction. For recording a diamond needle is used.

Leslie Dixon Feigh recording unit.

Known as the Feigh Recorder, the price of the complete unit is 37s. 6d.

The aluminium discs cost 4s. a dozen in 6in. size and 7s. a dozen in 10in. size. Sapphire cutting needles cost 3s. 6d. and diamond needles 7s. 6d. each. Wood reproducing needles for use with aluminium discs are obtainable at 2s. 6d. per dozen.

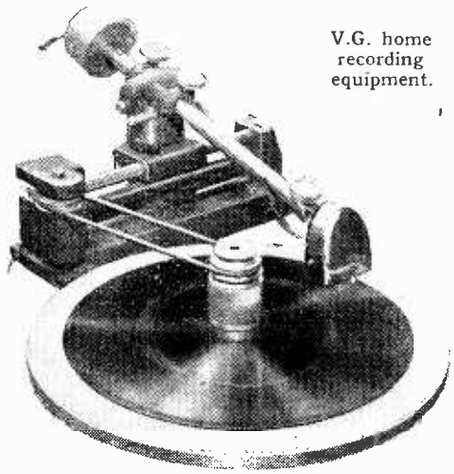
Aluminium alloy discs are used with the Silvatone Tracker, which is the description given to the recording equipment supplied by CAIRNS AND MORRISON, LTD., 6, New Compton Street, London, W.C.2.

A feature of this apparatus is that the makers state the machine is capable of producing positive masters from which shellac pressings can be taken.

The recorder is assembled in a portable case, to which is fitted a powerful double-spring motor. With this recorder the cutting head requires only 1½ watts for making a record, so that it can be used with practically any modern broadcast receiver.

The apparatus is sturdily made, and the price complete is £20. Aluminium discs are available in 6½in., 8in., 10in. and 12in. sizes, and they cost 4s., 6s., 9s. and 15s. per dozen respectively.

A unit that has been designed especially for the home recordist and is a sound engineering job is supplied by the V.G. MANUFACTURING CO., LTD., Gorst Road, Park Royal, London, N.W.10. The recording unit is compact and self-contained, and can quite easily be accommodated on the majority of motor boards of existing gramophones.



V.G. home recording equipment.

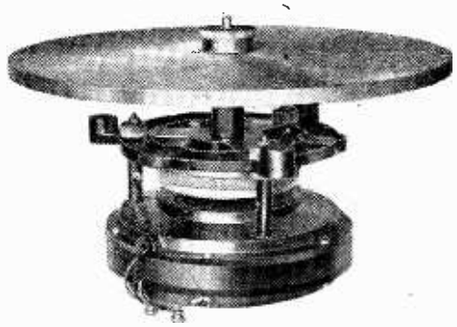
With the Simplat recording blanks which have a comparatively soft surface the drag imposed during cutting is not heavy, and this fact greatly facilitates the use of existing gramophone motors.

The V.G. recorders are driven by a belt from a cone pulley on the centre spindle of the motor. This pulley has three belt grooves of different size and provides driving speeds for cutting 80, 100 and 130 threads to the inch. It is possible to obtain a special pulley to cut up to 185 grooves to the inch if required, which will give a playing time with a 12in. record running at 78 rpm of about nine minutes on each side.

The traversing cradle carrying the cutting head slides on two polished steel rods and is driven by a split nut engaging with the lead-screw. It is put into action by means of a small lever, and it can be instantly stopped when required.

The cutting head supplied with this equipment requires only 2 watts input to give sufficient amplitude of cut for normal recording purposes. Its impedance is 2,500 ohms approximately.

The smallest recorder made is the Model T.30, which is capable of cutting records up to 12in. in diameter. Its price is £14. The other model is the T.40 which is larger, and will deal with records up to 16in. in diameter; this model costs £24. The cutting head alone is available at £4 10s.



Recording motor supplied by V.G.

Simplat recording blanks have as a base a glass disc which is coated with a special composition. Though the material is comparatively soft immediate play-back can be effected if required, but the life of the record will be short. It can be made more permanent by hardening and polishing the surface, for which purpose special fluids are supplied. Treated in this manner a record can be played 200 times or more before signs of wear become apparent.

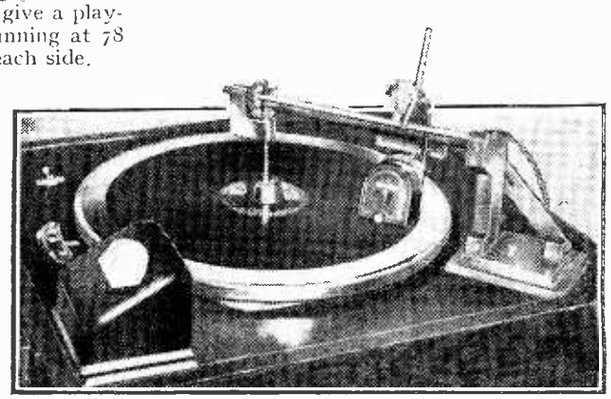
These discs are available in 7in., 10in., 12in., 14in. and 16in. sizes, and cost 2s., 3s., 4s., 6s. and 8s. each, double-sided.

V.G. also supply heavy-duty synchronous recording motors, the Model M.12 being for use with discs up to 12in., and it costs £6. The Model M.16 is a more powerful machine which takes up to 16in. discs, and its price is £16.

Home recording units in the form of quite inexpensive models as well as equipment of a more elaborate nature are made by MUSIKON, LTD., 19, Lisle Street, London, W.C.2. The cheapest model in the range is the Permarec Junior, which costs £3 17s. 6d., and has been designed for attachment to an existing gramophone. It will cut records up to 7in. in diameter. Despite the low price the apparatus is very well made and exhibits sound engineering practice; furthermore, it is simple to instal and operate.

A similar model but with a slightly longer lead-screw and with which records of 10in. and 12in. diameter can be made is also available at the price of £4 5s.

Among the more elaborate equipment is a complete recorder, which consists of a heavy-duty electric motor, tracking mechanism to which is fitted a high-grade cutting head, play-back pick-up and volume level indicator. This apparatus is contained in a carrying case with lid, and complete costs £45.



The Permarec Junior home recorder showing also the motor-unit and level indicator.

The various items comprising this recording machine are available separately for those who wish to include them with any existing parts that may be suitable for recording. The turntable unit alone can be supplied for £23, while the tracking mechanism and cutting head without the motor costs £15.

Musikon supply two types of record blanks; one is the Permarec disc, which has an aluminium base coated on both sides with a plastic compound, and it is claimed for this particular pattern that the minimum of power is needed for recording. The output from an average radio receiver is ample to give the full depth of recording on Permarec records.

After cutting the disc is hardened by baking and the finished record is then very hard and durable and can be played by

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Recording Equipment—

using ordinary steel gramophone needles without damage to the grooves.

Permarec discs are made in sizes of 7in., 10in. and 12in. diameter, and with both sides prepared for recording cost 1s. 6d., 3s. and 4s. 6d. each respectively.

The other style of disc supplied is known as the Musikon disc, and these do not require to be processed but can be played back immediately. Their useful life is shorter than that of the Permarec, and some fifty playings are possible before signs of wear become noticeable.

They cost the same as the Permarec discs for equivalent sizes.

Special containers known as processing units in which the Permarec discs can be assembled for baking either by gas or by electricity can be obtained to take all the standard sizes of discs, and cost from £1 7s. 6d. to £5 12s. 6d. each according to size. The largest will accommodate discs up to 16in. in diameter.

Motors made especially for recording purposes are also included among the Musikon equipment.

The Permarec Junior motor for AC only costs £3 17s. 6d., and a Senior model, which can be used on either AC or DC and gives speeds of 78 r.p.m. or 33 r.p.m., is obtainable for £10 10s.

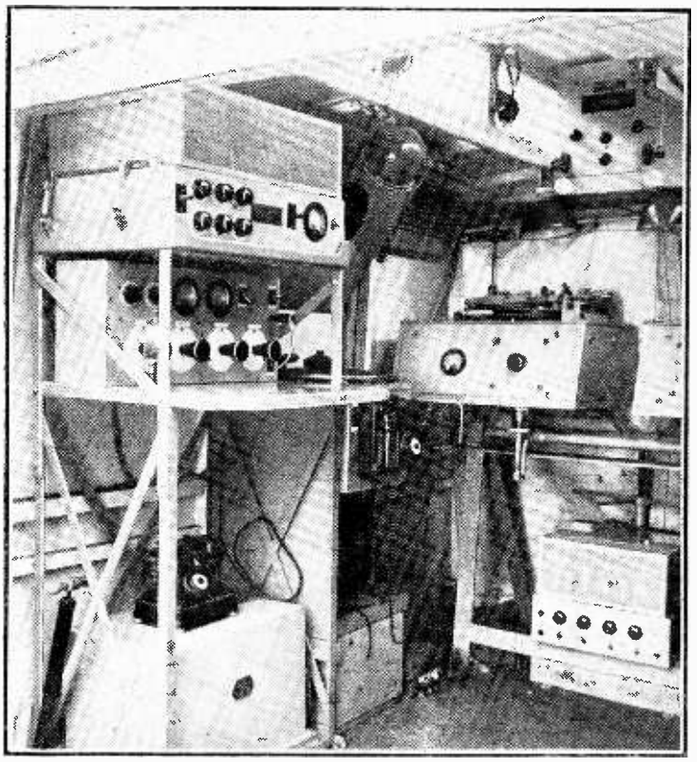
In addition, this firm supply numerous small accessories, such as, for example, soft brushes for cleaning the grooves before baking Permarec discs, cutting and playback needles for both types of recording discs as well as special recording amplifiers.

The recording apparatus supplied by HENRI SELMER AND CO., LTD., Davis Buildings, 12, Moor Street, London, W.1, is of American origin and is being marketed in this country as the Truvoice recorder. It is a very versatile unit, as it can be used for recording on acetate-coated discs or on aluminium discs, and as it embodies an amplifier it can be employed also for reproduction or play-back.

The amplifier is used whenever recordings are made from a microphone, but for recording broadcast the output from the radio set is applied direct to the cutting head, and as this has an impedance of 8 ohms it must, of course, be watched to the output stage. If the loud speaker is of this order of impedance then the cutting head can be connected to the secondary winding of the output transformer.

Alternatively, a transformer of suitable ratio can be employed and the primary winding of the existing output transformer used with a condenser to form a choke-capacity feed circuit. Another method recommended by the makers is to place the microphone near the loud speaker of the set and record as with ordinary microphone input.

The Truvoice apparatus is so arranged that all the changes for the different methods of recording and play-back are effected by switches, and, furthermore, particular care is taken to ensure that the user shall obtain satisfactory recordings in a simple and straightforward manner. A meter giving indication of volume level at the cutting head is also included, and the correct level indication for both acetate-coated discs and the aluminium style is given in the instructional booklet which, incidentally, is most explicit and informative.



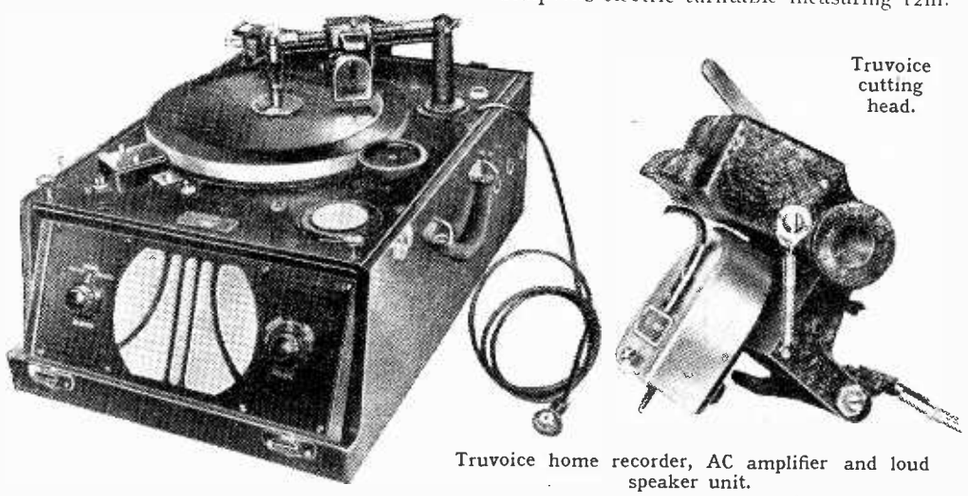
Interior of motor van used by Disc Recording. On the left is the main control panel and shown also is one of the two recording machines. The radio receiver can be seen in the top right-hand corner.

The recording outfit is AC operated, consumes about 75 watts, and costs £95 complete. Acetate discs with which immediate play-back can be effected cost 2s. 6d. each, and the special cutting needles for them 3s. per dozen. For recording on aluminium discs a special head is used and the needle is diamond-tipped.

Among the various recording units and accessories supplied by KINGSWAY ELECTRICALS, LTD., 3/9, Dane Street, High Holborn, London, W.C.1, is a heavy-duty Simpsons electric turntable measuring 12in. in diameter. It is of the synchronous AC type, and runs at a constant speed of 78.9 r.p.m. Being a more powerful model than that supplied for ordinary gramophone reproduction, it is well suited for home-recording work. Its consumption is about 30 watts at 220 volts AC, and the selling price £5 5s.

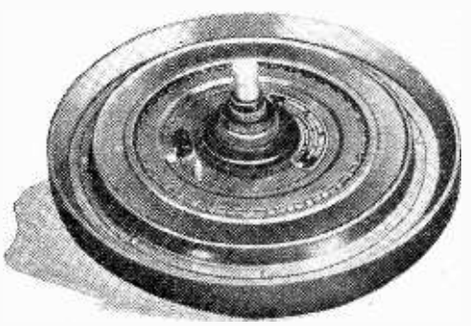
Occasions often arise when a recording of some function, or of one particular item in a concert programme, is required, or one may desire to make a record for some special and private reason. There are certain firms that specialise in this service, and among those actively engaged in this class of work are the M.S.S. RECORDING CO., LTD., MUSIKON, LTD., and DISC RECORDING, LTD., 8, Kew Bridge Arches, Kew Bridge, London.

The last-mentioned make a speciality of recording where it is not possible or convenient for a visit to be made to a studio, and so they have equipped a motor-van with all the apparatus necessary for recording. It contains two recording machines driven from a 24-volt 100-amp.-hr. accumulator battery, main and subsidiary amplifiers, monitoring loud speaker, play-back gramophone, microphone cables so that recording can be done with a microphone inside a building, and a portable two-way telephone. The latter is a most useful adjunct, as the engineer in charge of the recording equipment can be in direct communication with the one at the microphone without leaving his controls.



Truvoice home recorder, AC amplifier and loud speaker unit.

Truvoice cutting head.



Heavy-duty Simpson recording turntable.

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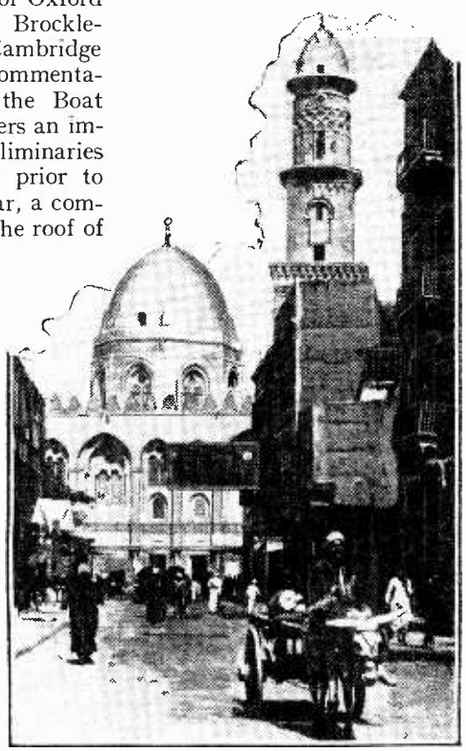
Listeners' Guide for the

Outstanding Broadcasts at Home and Abroad

THE O.B. of the year, as the University Boat Race has been called, comes into the National programme on Wednesday at 11.15 a.m. The procedure of the running commentary will be similar to last year, with John Snagge, the veteran of boat race commentors, in the launch *Magician*. He will be accompanied by Edgar Tomlin, who rowed for Oxford in 1935, and Tom Brocklebank, who stroked Cambridge from 1929-1931. Commentators will also be at the Boat Houses to give listeners an impression of the preliminaries and the personalities prior to the race. As last year, a commentator will be on the roof of Harrod's Depository, where the ultra-short wave receiver is situated, and for a minute or two will take up the narrative as the crews pass.



AN EGYPTIAN SYMPHONY will be heard in the European Concert which comes from Cairo to-night (Friday). This picture shows a street scene in the city.

◇ ◇ ◇

ATHLETICS AND RUGGER

ANOTHER inter-Varsity meeting will provide commentaries for National listeners on Saturday. From 2.40-5.0 they will be kept in touch with the progress of events at the Inter-University Athletic Meeting at the White City Stadium by H. M. Abrahams. Alternating with these comments will come those of Captain H. B. T. Wakelam from Murrayfield, Edinburgh, where the International Rugby Match between England and Scotland will be in progress.

As a preliminary to this match, on Friday at 9.40 Regional listeners will hear from Captain Wakelam and Arthur Wemyss the story of the Rugger matches between England and Scotland. The match on Saturday will be the fifty-ninth. Each has won twenty-four and ten have been drawn.

◇ ◇ ◇

"ENTRE NOUS"

EARLY in 1927 Gordon McConnel was transferred from Cardiff to Savoy Hill to produce plays, sharing the straight dramatic productions with Howard Rose. Somebody suggested that a new type of concert party, something on a higher plane than the weekly revues, an intimate, slightly sophisticated type of entertainment, be tried out. So Stanford Robinson and McConnel set to work, wrote some numbers and collected a cast consisting of four straight vocalists, a comedian, a comedienne and two pianists, and produced "Let's Sing Something—Entre Nous." For the first time burlesques of current B.B.C. programmes were introduced into light entertainment. Throughout the entertainment the comedian and comedienne did their best to lead the high-brow vocalists on to conventional concert party lines.

The second revival of the ten-year-old title comes in the programme for Regional listeners on Tuesday at 7.45. The cast of 1937's "Entre Nous" is unusually strong. Ivy St. Helier will be the commère, a role that she filled so admirably in the 1935 revival, and Davy Burnaby will be the compère.

The vocalists will be Irene Eisinger, making her début in Variety Department light entertainment; Arnold Matters, the Grand Operatic artiste; Webster Booth, and Esther Coleman, who has already experienced the incongruities of an Entre Nous production.

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MUSIC HALL

AN exceptionally good bill is arranged for this week's Music Hall, which comes to National listeners at 8 on Saturday. After protracted negotiations, John Sharman has booked Sir John Martin-Harvey for this week. He will be accompanied by his wife, who is known professionally as Miss N. de Silva, in excerpts from "The Only Way." Hughes and Lever, who were complimented in the Press on their last Music Hall performance, will again be heard. Albert Whelan, always a favourite both at music halls and on the radio, will be heard opening his act with his famous signature tune, which has been announcing his act since well before the War. That amusing song and patter act, Ethel Revnell and Gracie West, who are so delightful as the two kids at school, are booked, as is also that clever Scots character comic, Scott Sanders.

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SUN SPOTS

READERS will be familiar with the effect of sun spots on wireless reception and will undoubtedly book the time to listen to a talk on the subject on Sunday at 5.55 (Reg.). The talk will be still more interesting seeing that it is to be given by E. V. Appleton, F.R.S., Jacksonian Professor of Natural Philosophy at Cambridge. Readers will remember him for his work on the reflecting layers of the upper atmosphere.

HIGHLIGHTS OF THE WEEK

FRIDAY, MARCH 19th.

Nat., 3, The Grand National from Aintree. 6.25, Berlin College of Music Singers. 7.15, European Concert from Cairo. 8, Songs from the Films.
Reg., 7.30, Variety from the Winter Gardens, Morecambe. 8, Snooker and Basket-Ball commentaries.
Abroad.
Warsaw, 8.35, Moniuszko opera music.

SATURDAY, MARCH 20th.

Nat., 2.40, Commentaries on inter-University Athletics and England *v.* Scotland Rugger. 8, Music Hall. 9.20, Discussion: Hire Purchase.
Reg., 6, Songs from the Films. 8, Relay from La Scala, Milan.
Abroad.
Bucharest, 6.35, "Carmen" from the Royal Opera.

SUNDAY, MARCH 21st.

Nat., St. Matthew Passion from York Minster. 9.5, The Story of the English Channel.
Reg., 5, Eastbourne Municipal Orchestra. 7.10, "The Forsaken City." 9.5, Sunday Orchestral Concert from the People's Palace.
Abroad.
Cologne, 7, "Spring": an orchestral concert.

MONDAY, MARCH 22nd.

Nat., 7.45, The Vagabond Lover. ¶It's Happening Now. 8.30, Van Phillips and his two orchestras. 10.5, "Beauty Queen," a radio play.

Monday, March 22nd, continued.

Reg., 6, Reginald King and his Orchestra. 7.55, Relay from the Berlin State Opera. ¶Recital: Antonio Brosa (violin). 9.25, "Delores."
Abroad.
Radio-Paris, 8.45, Ex-Service Authors' and Composers' Concert.

TUESDAY, MARCH 23rd.

Nat., 7.25, A Nation of Shoppers; Shopping To-morrow. 9.20, World Population.
Reg., 6.15, "Beauty Queen." 7.45, "Entre Nous." ¶Talk: Sailing in London.
Abroad.
Rome, 8.3, "Katje the Dancer,"—operetta (Gilbert).

WEDNESDAY, MARCH 24th.

Nat., 11.15 a.m., the Oxford and Cambridge Boat Race. 6.40, "Granite," a tragedy in four acts. ¶Palace of Varieties.
Reg., 7.30, Music from the Movies. 9, Cabaret with coloured artistes.
Abroad.
Leipzig and Rome, 8, "The Girl of the Golden West" (Puccini). from La Scala, Milan.

THURSDAY, MARCH 25th.

Nat., 6.40, Laurie Wylie's "Wireless Puppets." 7.40, Maundy Thursday Programme.
Reg., 8, Stanelli's Bachelor Party—12. 8.40. "Granite."
Abroad.
Königsberg, 7.10, Military Band Concert: the National Anthems of many lands.

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Week

"DELORES." Eve Becke, the radio and film star, who plays the name part in this play by Bruce Sievier which comes to Regional listeners at 9.25 on Monday.

1665

"THIS was that yeare of wonder, when this land was ploughed up into graves, and graves did stand from morne till next morne gaping still for more." These are the words quoted by the B.B.C. to describe the programme, "The Forsaken City," which gives an impression of London during the year of the Great Plague. It will be heard by Regional listeners on Sunday at 7.10.

It was first heard in 1932, and provoked considerable interest and discussion. Certainly the theme is macabre, but it is also inherently dramatic as well as being historically significant. One of the most picturesque figures of the time was Solomon Eagle, whose fiery words of admonition should wring listeners' hearts almost as much as they did the distracted citizens of seventeenth-century London.

FIRST AID

IT is the intention of the B.B.C. to give a series of brief practical hints on what to do in emergencies when even a slight knowledge of first aid would be an advantage. An officer on the staff of the St. John Ambulance Association will give the first of these talks, "Have You Been in an Accident?", to-night (Friday) at 7.45 (Nat.). He will cite actual cases where a knowledge of first aid has prevented accidents from becoming fatal, and will tell listeners how and where they may obtain this knowledge. The second talk, headed "First Aid Do's and Dont's" will be given on Monday at 9.35 (Nat.).

Details of the week's Television programmes will be found on p. 271.

THE CHANNEL

ENGLAND'S guard and wall, the English Channel, is the subject of a feature programme which comes to National listeners on Sunday at 9.5. The historical story of the Channel, which is a rich and varied one, will be traced from the earliest days. It will be followed through the Dutch wars, the Napoleonic and Victorian eras to the present day. Laurence Gilliam, the producer, promises a surprising ending, but declines to divulge any details. Music will play an important part in the programme, and in addition to special orchestral arrangements there will be a chorus singing sea-shanties.

BEETHOVEN

THE week's Danish Thursday Symphony Concert will be advanced to Wednesday, owing to the Easter Holidays. It is the last of the season, and will be devoted to the works of Beethoven, the main feature being his Ninth Symphony. This is a speciality of Fritz Busch, the conductor, who is said to know the whole score by heart. Two famous foreign opera stars have been engaged for this concert, Erika Rokyta, of Vienna, and Julius Patzak, of Munich.

OPERA

Home: In the Regional programme on Saturday at 8 comes a relay from La Scala, Milan. It will consist of Acts 1 and 2 of "Francesca da Rimini," by Zandonai, who is one of the most esteemed of contemporary Italian composers. Those who wish to hear the remaining two acts can do so by tuning in Milan.

On Monday, at 7.55, another foreign opera relay graces the Regional programme. This time it comes from the Berlin State Opera, and will consist of the second act of Wagner's "The Flying Dutchman."

The usual five-minute introduction precedes both of these relays.

Abroad: Pergolesi, who will be much in evidence during the next fortnight for his immortal Holy Week Cantata, "Stabat Mater," which Bellini called the "divine poem of sorrow," is represented to-night (Friday) by a very different work, one of his comic operas, "Il geloso schernito" (The Jealous Man Scorned), of which the Berlin station is transmitting excerpts at 9.30. From Warsaw at 8.35 comes a notable programme of the opera music of Moniuszko, most Polish of Polish composers. So much is he the soul and voice of Poland that his melodies have been chosen as the Polish stations' interval signals.

Saturday's novelty in opera is "Hänneles Himmelfahrt," the two-act work of the living Berlin composer, Paul Graener. This will also be heard from Frankfurt on Sunday at the same hour, with the composer conducting.

Sunday brings a little-known Mozart opera, "Titus," from Stuttgart at 6.30, and Smetana's ever-delightful peasant romance, "The Bartered Bride," starts from Brasov five minutes later. One expects to hear "Parsifal" as Holy Week approaches. Warsaw is giving the first act of this last and greatest of Wagner's works on Sunday. The second and third acts will be heard from Brussels II at 8.15 on Thursday.

Puccini's delightful opera of the stirring days of the California gold rush, "The Girl of the Golden West," comes from La Scala, Milan, relayed by Rome and Leipzig at 8 on Wednesday. The same evening from Bordeaux and Radio-Paris at 8.30 comes Rossini's "William Tell," from the Grand Théâtre, Bordeaux.

The main opera event of Thursday is the second half (Acts IV and V) of Debussy's one and only opera, "Pelléas et Mélisande," from Eiffel Tower and Lyons at 8.30. The first half of this opera is being broadcast from Paris PTT on Tuesday at the same hour.

FROM A 'VARSITY CITY

ROMAN Catholic Church music will be heard from the Swedish stations at 9.20 on Monday. It will be rendered by the Collegium Cantorum Choir of the ancient Swedish Cathedral, Uppsala Domkyrka.

MISCELLANY

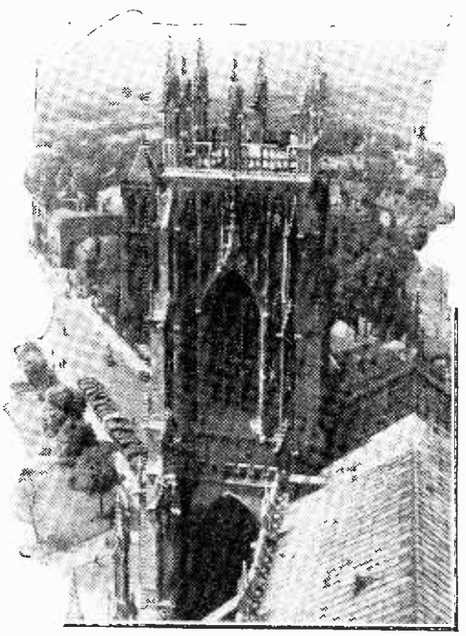
A RETROSPECTIVE programme, "Dance Rhythm, 1920-1937," comes from the Swedish stations at 9.15 on Saturday.

Eight conductors will be in charge of the choir of 900 school children which will be heard from the Danish stations on Monday at 8.

"In Spring, when the Snow Vanishes," is the title of a programme of Salzach and Inn folk songs coming from Munich at 7.10 on Tuesday.

The 250th anniversary of the death of the composer, Lully, is being commemorated by many European stations this week. On Monday by Strasbourg at 8.30, and Athlone at 7, and on Tuesday by Eiffel Tower and Lyons at 8.30.

THE AUDITOR.



THE ST. MATTHEW PASSION, by Bach, will be relayed from York Minster on Sunday at 3 (Nat.). The latter part will be heard in the Northern programme only from 4.15.

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Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents.

Service

WE found the letter from "Alter Ego" in your issue of February 12th very interesting, and, having been in the radio trade since the inception of broadcasting in this country, we can say that the public use almost every opportunity to "twist" us on service. We have tried very hard for many, many years to give honest and competent service, and it can be said without fear of contradiction that it has been hard work. In our experience, however, only by straight and direct methods is it possible to "catch" those who try to "twist" us and show them the error of their ways. After all, anything that is worth doing is usually difficult to do. The education of the public to accept only a high standard of real skill in radio servicing will take years.

The trade, too, requires educating, and by that we mean being made fully aware of the fact that unless they are equipped with knowledge. apparatus, premises and personnel the manufacturers will not consider them as service agents. At the moment we do not know of one single British manufacturer of national repute who demands a really high standard from his dealers. Until such a demand is made by the manufacturers the public will have no sure way of separating the "sheep from the goats."

A. J. FAIRBAIRN,
Ayr. (Director, Fairbairn, Ltd.).

I AM sorry that "Diallist" (*The Wireless World*, February 26th, page 214) does not see eye to eye with me in this matter, but that is probably because he does not grasp the significance of my letter.

I do not *defend* the practice; I *deplore* it vehemently, as I deplore so many of the unmoral practices of the business world between 9 a.m. on a Monday and 12.30 p.m. on a Saturday. My letter explained the reason for the less honest type of dealer entering this vicious circle.

To say that nobody in his senses would object to paying for a man's time, fares, and expenses against a clear statement shows, I suggest, with due respect, a lack of experience of the general public where wireless sets are concerned. The only thing to do is to try it in a large store or a manufacturer's service department for a few weeks.

Mr. T. J. E. Warburton's experience (*The Wireless World*, March 5th, page 242) is simply a local affair of incompetence or irresponsibility unfortunately common to so many trades dealing in intricate or technical articles. The car trade, for example, is undermined and worm-eaten by it, as every *honest* dealer knows.

ALTER EGO.

Horn-Loaded Moving-Coil Speakers

WHILST agreeing with the general principle of the increased efficiency of a horn-loaded moving-coil loud speaker, as put forward in a recent advertisement of Messrs. Voigt's Patents, Ltd., I should like to draw attention to a few other factors regarding the merits and demerits of horn and baffle type loud speakers.

It will be agreed that before a loud speaker can truthfully be termed a "high fidelity" unit it must be capable of reproduction down to 40 c/s. Unless the "cut-off" frequency is at or below this figure, such frequencies will be seriously attenuated. The "cut-off" frequency is governed, (a) by the rate of expansion of the air column in the horn, and (b) the diameter of the mouth or flare of the horn. The usual simple formula for calculating the diameter is:—

$$2 \times \frac{\text{wavelength}}{4} = \frac{1130 \times 2}{\text{frequency} \times 4} \text{ feet}$$

For a 40 cps. "cut off" this works out at approximately 14ft. for a circular mouth. Actually in practice about 4/5 of this figure, i.e. about 11ft., is satisfactory.

Assuming a throat diameter of 5in., this would necessitate a horn about 15ft. long. To me, such a horn does not appear to be entirely suitable for the average domestic room.

Although, theoretically, a baffle should have a diameter equal to half the wavelength of the lowest frequency, about 12ft. to 14ft., such a size is not of paramount importance, since the attenuation of frequencies below the "cut-off" frequency is much more gradual in the case of the baffle loud speaker than in the horn type. Actually, reproduction of frequencies down to 40 c/s can be obtained from a 5ft. baffle, provided that it is carefully used. The baffle should be placed at right angles to a wall, with its edges in contact with the wall and floor. The unit should then be mounted in the corner formed by the baffle, wall and floor. This arrangement quadruples the effective baffle area, and is equivalent to a baffle 10ft. in diameter.

I am willing to agree with Mr. Voigt that his Tractrix horns probably have a lower "cut-off" point than the more orthodox exponentially shaped horn. This, however, does not materially affect the discussion regarding the impracticability of horn speakers for domestic use, since for a given diameter of mouth the length of a Tractrix horn is greater than that of an exponential type.

Referring to the question of impedance variation with frequency, I should like to point out, first, that Mr. Voigt appears to have confused impedance with resistance, in his formula for acoustical efficiency. This should read:—

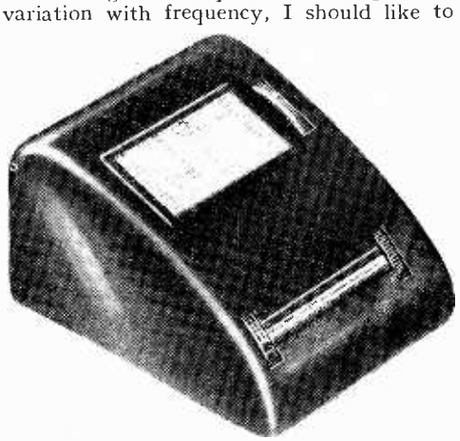
approx. acoustical efficiency =

$$\frac{\text{motional or dynamic resistance}}{\text{dynamic resistance} + \text{static resistance}}$$

the static resistance being the AC resistance at the frequency under consideration. Secondly, I entirely disagree with the statement that a baffle affects the loading at high frequencies only. As is well known, a baffle has no appreciable effect above about 1,000 c/s. Its loading effect *increases* with increase of wavelength, hence the use of a baffle to increase the output at low frequencies.

To obtain a constant air loading at all frequencies it is necessary to have a correctly designed horn of approximately the dimensions given above. Where a considerably smaller horn is used, it is very doubtful whether there is any material advantage to be gained over a flat baffle. Actually, where a small horn is used in conjunction with a bass chamber, I should consider it highly probable that the baffle speaker offers a more uniform load, since the bass chamber must introduce undesirable acoustical resonances, which will be reflected as peaks in the impedance frequency curve.—Yours faithfully,

For Goodmans Industries, Ltd.,
Wembley, Middlesex. G. A. BARDEN, Chief Engineer.



STATION-FINDING MADE EASY.—This "rotary station log" contains a 12-ft. length of tape, on which is printed information relating to over 1,600 broadcasting stations throughout the world. Stations are listed in order of frequency, and, as the device is of American origin, in order of call-signs as well. One knurled disc rotates the drum carrying the tape, while the other controls an indicator showing standard zone time.

The Military Band Harp

I SEE that the writer of "Broadcast Brevities" in your March 5th issue has noticed the appearance of a harp in the B.B.C. Military Band. I had heard this harp many months ago, and have been wondering ever since why, if this instrument is admitted, they do not send along the corridor, rope in a few fiddles, turn the thing at once into an orchestra complete and have done with it. The classics could then be played as they were written and intended to be played, with the additional advantage that no longer would time, energy, and money be wasted on arrangements which, though admittedly clever, are not only needless but necessarily inferior to the original.

The moral, of course, is that there is no justification for a military band playing any music written for other instruments—such as strings—which are not included in it where those instruments are available and can be used. A corollary to this is that there is no place in the B.B.C. organisation for a military band at all, and it should have long since been disbanded as a dreadful mistake.

Perhaps I might make one suggestion. When your contributor complains that a harp could not be played while marching along the road, might it not be mounted on a horse? I understand that the Marines are proverbially good horsemen.

Brighton. A. H. BRIDGES.

Valve-Testing Service

MAY I, through your columns, make a suggestion to reliable radio dealers in possession of accurate valve-testing apparatus that they show in their window a notice something like this:

Have your valves tested, 1d. each.

Besides being about 99 per cent. profit in itself, it would be very much appreciated by every amateur enthusiast, and would bring increased sales to the dealers.

London, S.W. J. BARKER.

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AVC Circuit

I SEND details of the AVC circuit I have developed for battery receivers, and the following explanation may assist an understanding of the circuit diagram:—

Referring to Fig. 1, a Westector is used for the second detector (assuming the receiver is a superhet), connected so that an increasing signal makes the "live" end more positive. After suitable filtering and decoupling, this positive potential is applied to the grid of the screen grid valve V, and it is the unusual conditions under which this valve operates that constitute the feature of the circuit. An anode resistance of five megohms or so is used, the screen voltage required being about 30 volts with the valves I have used. The Westector W is biased negatively so that under normal working conditions the grid of V is very slightly negative. Under these conditions V will work as a DC amplifier (giving a quite prodigious degree of amplification) with anode voltages between 0 and 9, and thus the negative end of a 9-volt bias battery whose positive end is connected to the anode will be always negative with respect to earth, and can therefore be used to supply the AVC voltage to the controlled valves. To prevent the AVC line becoming highly positive in the absence of a signal, another Westector X is connected as shown between the AVC line and $-1\frac{1}{2}$ volts on the main GB battery.

So close is the control obtained that there is absolutely no audible difference in strength between the local transmitter* and the weakest which will supply the initial delay voltage (the delay voltage, by the way, is most conveniently controllable by means of the screen potentiometer of V), and there may be a tendency for "hunting" to occur about the steady bias point. I have overcome this by connecting the condenser C3 and resistance R6 in series between the AVC line and earth. The values given are those I happened to have by me, and they proved effective; other values might be better in more stubborn cases.

Fig. 2 shows an alternative method of supplying the DC voltage in the required phase (if it is permissible to speak of the phase of a DC voltage!) to the grid of valve V, if a valve is used as second detector in the receiver. A potentiometer P, which can be of a very high value, is connected between the anode of the detector and the negative end of the G.B. battery. The tapping is taken far enough down on this potentiometer to keep the grid of V slightly negative. The closeness of control obtained is of the same order as with the first method, but it is not so good, for the delay voltage becomes very sensitive to changes in the HT voltage, and with dry HT batteries past their prime (as they often are) there may even be a noticeable drift in the delay voltage during reception.

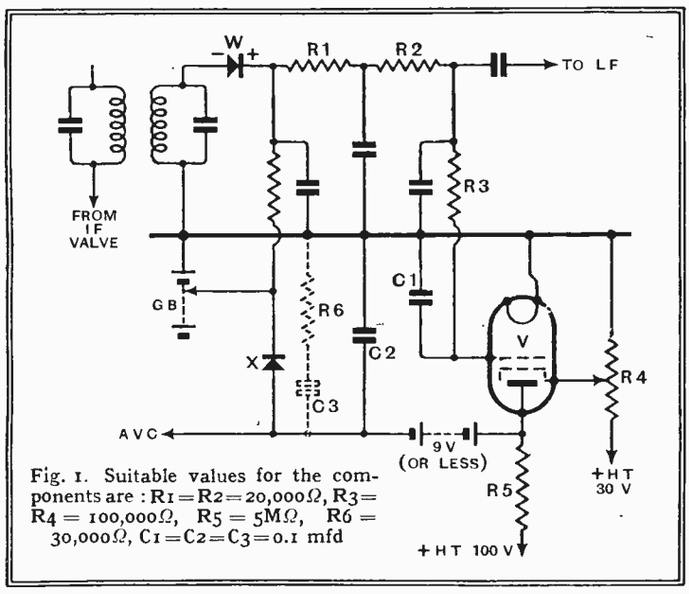

Fig. 1. Suitable values for the components are: R1 = R2 = 20,000Ω, R3 = R4 = 100,000Ω, R5 = 5MΩ, R6 = 30,000Ω, C1 = C2 = C3 = 0.1 mfd

The advantages of this AVC circuit for battery sets are many. The only extra battery required is a 9-volt bias battery, with, of course, an indefinite life (especially if the non-sal ammoniac type is used). There is some extra drain on the LT battery, but if a Hivac XSG valve is used this is very small. The screen current taken by the AVC valve is a fraction of a milliampere, and the anode current is a few microamperes. Besides these advantages a fraction of a volt input to the second detector is, owing to the high amplification obtained, enough to provide almost perfect AVC, a great advantage for receivers required to work with very small aerials.

Sussex. A. K. GORDON.

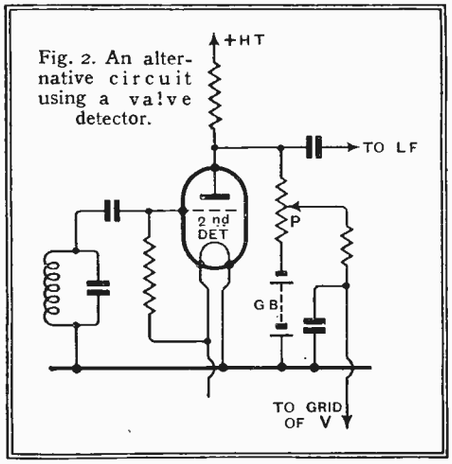

Fig. 2. An alternative circuit using a valve detector.

* Droitwich, not very "local" of course, here, but it would be equally effective on any transmission capable of being held in check by biasing RF and/or IF valves.

USW Broadcasting

I FEEL that a large body of your readers will disagree with your correspondent, Mr. T. J. E. Warburton, on his criticism of the practicability of ultra-short-wave broadcasting in his letter published in your issue of March 5th last, but I am sure that he is not fully acquainted with the difficulties entailed with high-fidelity reception on the medium- and long-wave bands. (This is more or less borne out by the remark in the last sentence of his letter.)

As an example of one of the problems encountered, I would like to give him my own case. I possess a high-quality local-station receiver with a frequency response well maintained up to 10,000 cycles, but, despite the fact that I am situated well within the service area of the London National transmitter, the reception of this station becomes intolerable after nightfall owing to side-band "splash" from the adjacent Italian stations.

My case is in no wise an isolated example, and it would seem apparent that, unless one's receiving equipment is located in very close proximity of a transmitter, high-fidelity reception is impossible on the present broadcast bands.

I cannot agree with your correspondent when he calls for more standardisation. Surely, when one realises the number of present-day receivers that differ in minor detail only, it is time to call a halt to this craze for uniformity.

The public need never fear that ultra-short-wave transmissions will render their present sets obsolete. Medium-band transmitters will always be required for more distant listening, but their reception will be improved owing to the fact that the present multitude of stations radiating the same programme will be reduced to a single high-power transmitter, thereby alleviating the existing congestion. This is, of course, assuming that all regional transmissions are carried out on ultra-short waves and that other European countries follow suit.

Whilst on this subject of "ultra-shorts" may I suggest that now is the time for the B.B.C. to bring into effect some system of automatic volume contraction? Alternatively, since a wide frequency response presents no difficulties on this band, could not some form of monitoring note, say, 20-30 kc/s, be superimposed on the transmission and varied in step with the microphone control? This note could be separated from the musical frequencies after detection in the receiver and utilised in the form of automatic expansion control of the AF amplifier after the style of the familiar AVC on RF circuits. Perhaps some of your more technical readers will point out the "snags" of such a system, but it would at least appear to be comparatively inexpensive to embody in a microphone circuit, provided the frequency response of the transmitter was sufficiently wide, and at the same time allowing the retention of manual control.

London, S.W.8. ARTHUR S. BALL.

"Sensitive Valve Voltmeter." A Correction.

I SEE that there is a minor error in the circuits illustrating my description of the sensitive valve voltmeter in the issue of March 12th. As shown, the "backing-off" current flows through the meter in the same direction as the anode current instead of in the reverse direction as required.

Actually, the meter should be tapped down the battery and the backing-off resistance connected to the end. In the Fig. 1 circuit the meter is shown at the positive end, while in the complete circuit of Fig. 3 it is at the negative end, but the same remarks apply in each case.

The backing-off tap mentioned in the remarks on setting up the meter on page 248 is actually the connection to the meter, but, since adjustment of this tap does effectively alter the backing off, the description is quite correct as it stands.

I may add that the Electradix Microammeter at £2 is particularly suitable for the instrument described. J. H. REYNER.

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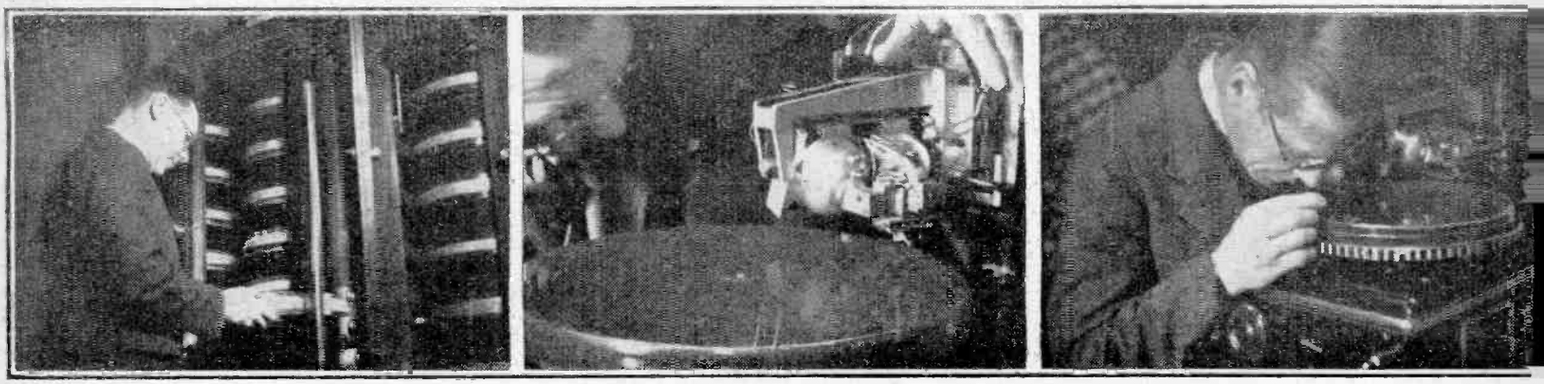
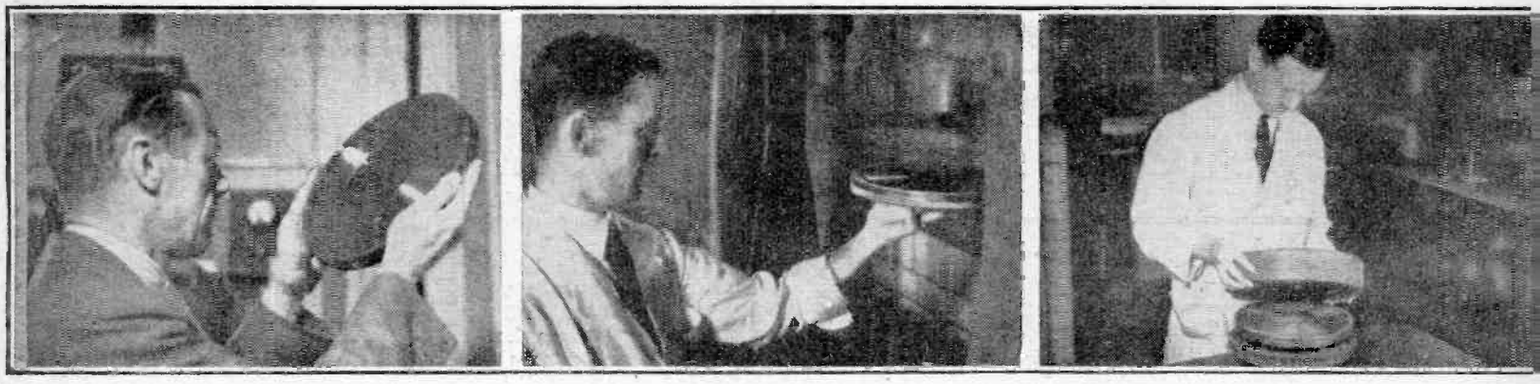
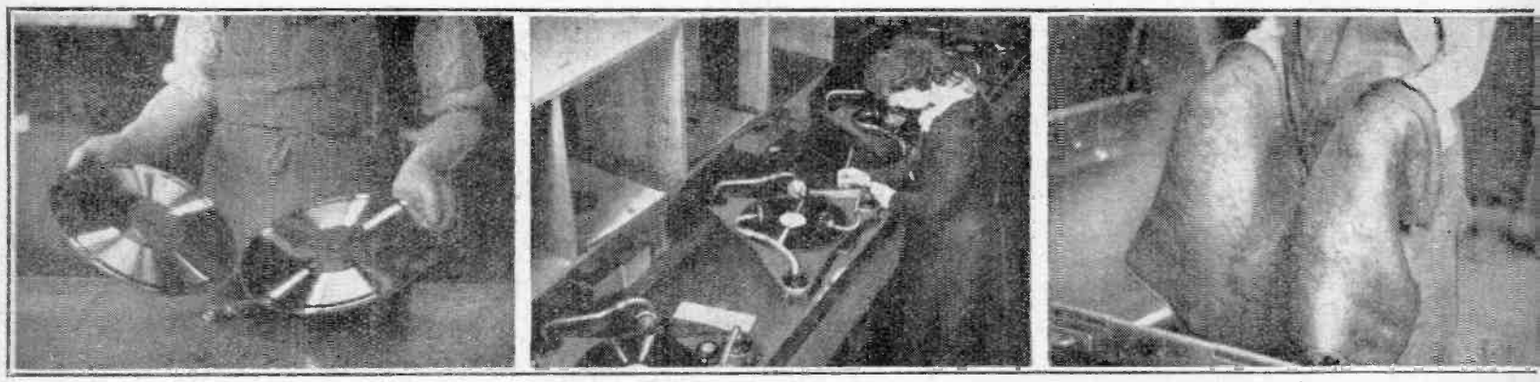
PICTORIAL STORY O



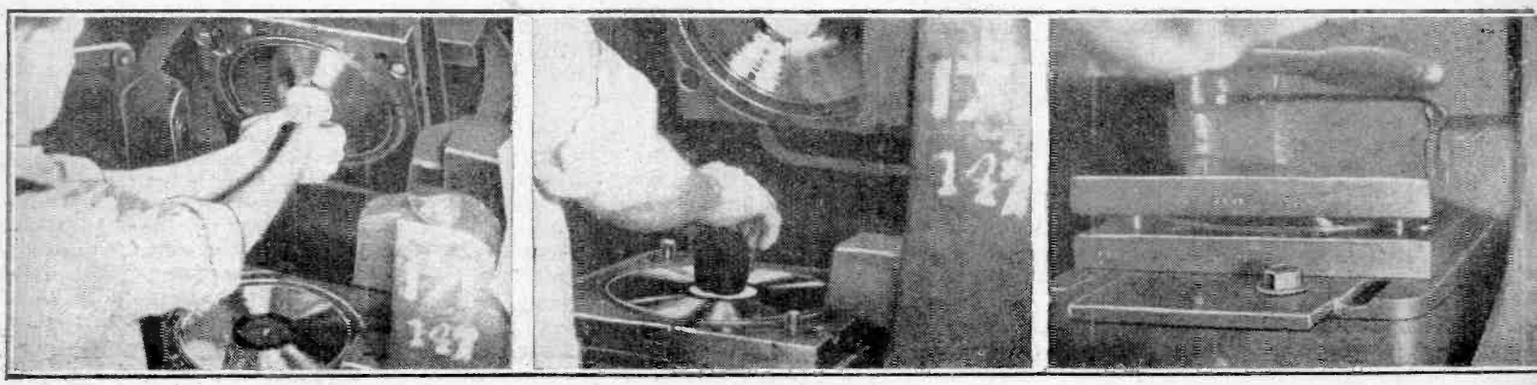
Wax blanks are kept in a specially heated store, from which one is removed when everything is ready for a record to be made. A few test grooves are cut w
is employed to rotate a turntable carrying the wax ; the weight used for this machine is shown in the fourth picture above. Whilst the record is being cut
recording instrument is lifted from the wax and th



The finished record is next held up to the light to see how loud it has been recorded, and when satisfied with the finished product bronze powder is whisked
above. The purpose of the bronze powder is to provide metallic contact for electro-plating. The wax is next mounted in an ebonite shell and, in this containe
form of ridges instead of grooves. This master negative is too valuable to be used f



The new negative, which will be used for pressing records, is now stripped from the original positive, and sample records made from this are next tested for wea
and passed through cooling conveyers preparatory to being cut into " biscuits " of the correct shape and size for 10-



Next we see the appropriate record labels being placed on the upper and lower matrices in the press, and the rolled " biscuit " is placed in the
cold water for cooling, and the record is ready to be withdrawn. The record is then placed under the cooling press for a

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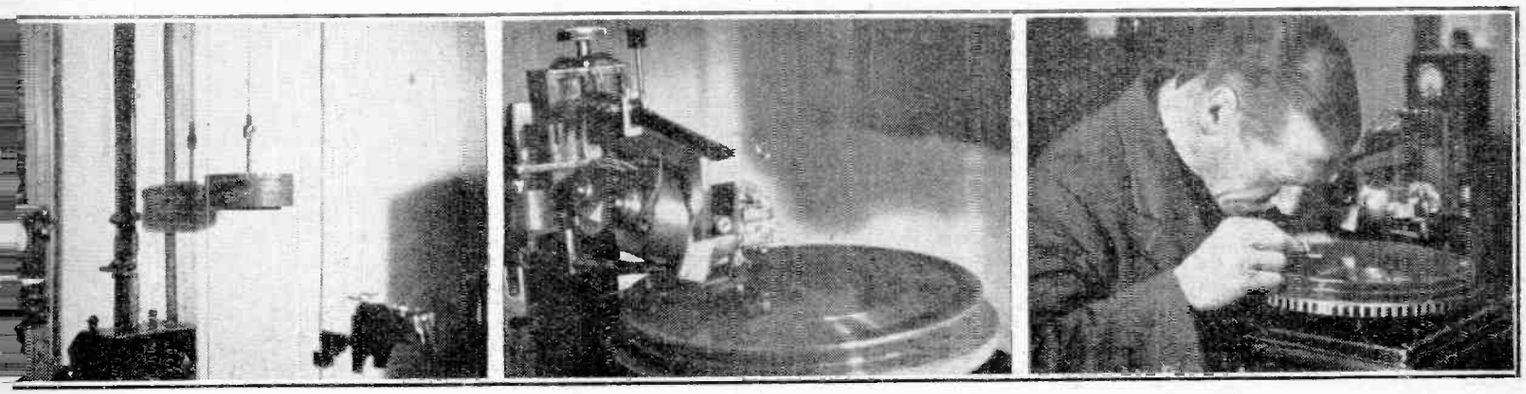
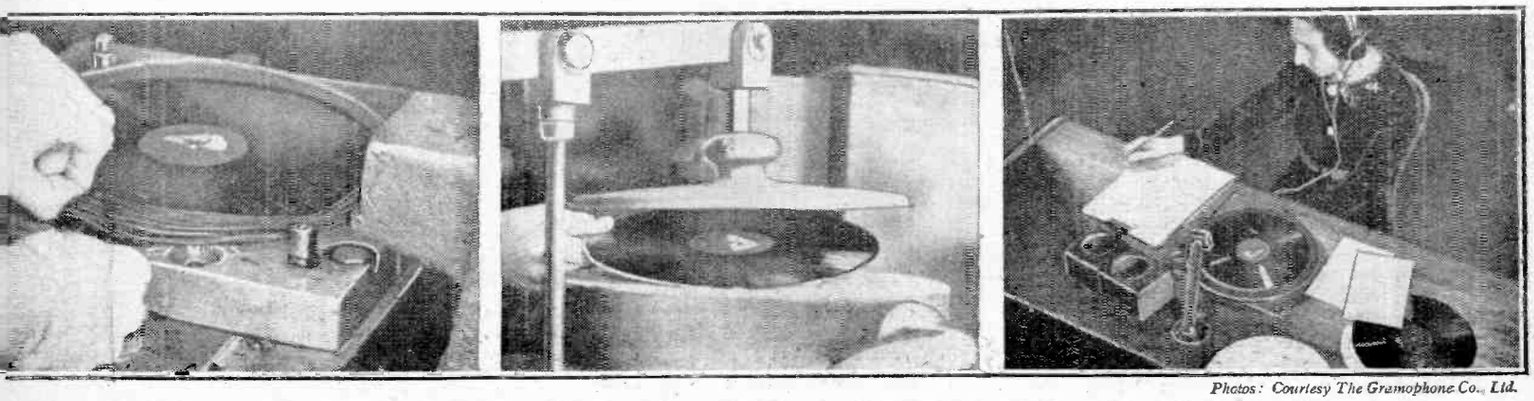
THE H.M.V. RECORD



apphire point and the wax is then examined through a magnifying glass to see that everything is in order. So as to ensure smooth running a gravity motor ineer keeps an eye on it to see that the fine spiral cut by the sapphire point is being drawn off correctly by suction, and when the record is completed the eer examines the grooves under his magnifying glass.

ıshes on to the face of the wax and surplus powder brushed off by means of revolving brushes rotating so quickly that they are not visible in the photograph placed in the electro-plating bath. Here it is kept revolving to ensure an even deposit. Next we see the sound track as it appears transferred to metal in the ssing records, so in its turn it is placed in a plating bath and a "positive" is "grown."

e then see the ingredients from which records are made brought to a plastic state after passing through the Rolling Department. The material is then rolled and 12-inch records. The "biscuit" is next heated again to a plastic state and rolled up ready for use in the presses.



Photos: Courtesy The Gramophone Co., Ltd.

e of the press, the faces of which automatically come together with a pressure of 64 tons. Steam circulates between the matrices, followed by ute or so, after which specially trained girls test the first record off each pair of matrices before further copies are made.

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CURRENT TOPICS

Improved Programmes from Ireland

GREAT improvements are anticipated in Irish broadcasting in the near future. This year there is to be an increase of nearly £3,000 in programme expenditure. The cost of salaries, owing to increases in the staff, will account for a further £4,000. The Irish Radio Orchestra is to be increased from 19 to 28 players. These figures would not, of course, be considered noteworthy in relation to the expenditure of a large broadcasting corporation like the B.B.C., but Irish broadcasting is at present carried out on a comparatively small scale.

British Transmitters for Turkey

BY August, 1938, Turkey will have a 120-kilowatt transmitter in operation which will be able to take its place in the front rank of the world's stations. The contract for this station together with another of 20 kilowatts power has been won by Marconi's Wireless Telegraph Co., Ltd. The two stations will cost about £200,000.

Restaurant Music "Off"

FOR some time past, listeners in Denmark have enjoyed the relaying of orchestral music from various Copenhagen restaurants, but this is likely to come to an end shortly owing to a dispute between the restaurant proprietors and the broadcasting authorities. Hitherto the musicians have been receiving special fees for those periods in which their efforts were being broadcast, these payments being made by the broadcasting organisation. The restaurant proprietors have been content with the publicity given to their establishments, but now they are demanding payment, which the broadcasting authorities are unwilling to give. Unless the dispute is soon settled restaurant music will be "off."

Edible Gramophone Records

IT is reported from Warsaw that Ivan Erenew, a Polish chemist, has discovered a special process whereby chocolate can be hardened so that it can be used for making gramophone records. The only benefit derived from this material appears to be that the nutritive properties of the chocolate are not destroyed, and it can, by a simple home process, be restored to edible form, thus forming a war-time emergency ration of similar kind to that supplied in times past to members of the fighting forces.

The Leipzig Fair

ACCORDING to a correspondent, consoles and full-size radiogramophones were not much in evidence in the wireless section of the Fair; table models were almost universal. Such radiograms as were shown generally embody a gramophone unit mounted in a sliding drawer under the radio chassis. Many public-address speakers have a directive baffle arrangement for confining the sound output substantially to the horizontal plane, while the cone surrounds of ordinary speakers seemed to be very stiff compared with the suspensions of corresponding British speakers, and the free movement of the diaphragms appeared to be less.

Some Surprising Statistics

RECEIVERS of the table-model type are still the most popular in the U.S.A. as they are over here, this being due to their comparative cheapness. It is noteworthy, however, that in both countries the number of consoles in use is steadily increasing. In the U.S.A. well over 3¼ million consoles were sold in 1936, the figure for table models being nearly 4 millions. It is astonishing, however, to find radiogramophones so unpopular, only 88,000 of these being sold. The figure for car radio sets was 1½ millions.

Miscellaneous Advertisements and Easter

WITH the approach of the Easter holidays slight alterations are necessary in our printing arrangements. Miscellaneous advertisements intended for the issue of April 2nd must be received not later than first post on Thursday, March 25th.

It should also be noted that the issue of *The Wireless World* dated March 26th will be on sale on Thursday, March 25th.

THE NEW H.M.V. SETS

DELIVERIES have already commenced of three additions to the range of receivers made by the Gramophone Co., Ltd.

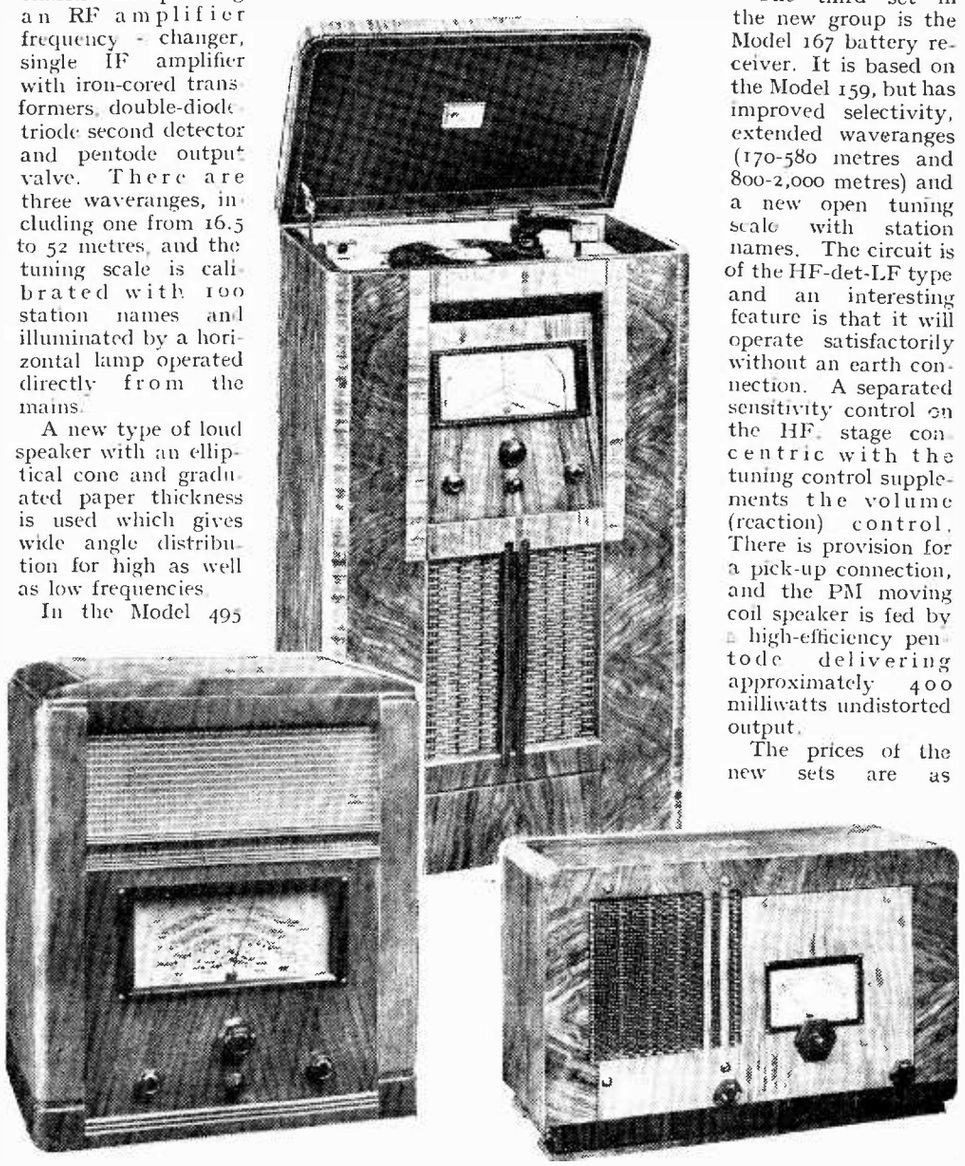
The table Model 494 for AC mains is a successor to the Model 425, and has a new chassis incorporating an RF amplifier frequency - changer, single IF amplifier with iron-cored transformers, double-diode triode second detector and pentode output valve. There are three waveranges, including one from 16.5 to 52 metres, and the tuning scale is calibrated with 100 station names and illuminated by a horizontal lamp operated directly from the mains.

A new type of loud speaker with an elliptical cone and graduated paper thickness is used which gives wide angle distribution for high as well as low frequencies.

In the Model 495 radiogramophone which uses the same new chassis, the tuning scale and controls are mounted outside on the front panel instead of on the motor-board, as is usual. Thus the set may conveniently be operated from an armchair. The total height is under 3½ft. and the floor space occupied is only 23in. × 14¾in.

The third set in the new group is the Model 167 battery receiver. It is based on the Model 159, but has improved selectivity, extended waveranges (170-580 metres and 800-2,000 metres) and a new open tuning scale with station names. The circuit is of the HF-det-LF type and an interesting feature is that it will operate satisfactorily without an earth connection. A separated sensitivity control on the HF stage concentric with the tuning control supplements the volume (reaction) control. There is provision for a pick-up connection, and the PM moving coil speaker is fed by a high-efficiency pentode delivering approximately 400 milliwatts undistorted output.

The prices of the new sets are as follows: Model 494, 12 gns.; Model 495, 22 gns.; and Model 167, 7½ gns.



An elliptical type moving-coil loud speaker is fitted in the Model 491 (left). The Model 495 radiogram (top) has outside controls and occupies very little floor space. A station calibrated dial, and improved selectivity are features of the Model 167 battery receiver (right).

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DIRECT RECORDING BLANKS

Essential information relating to the principal makes in this country and abroad is given in this table which has been compiled by D. W. Aldous. No prices are given in the case of foreign blanks and enquiries should be addressed directly to the manufacturers or through their agents in this country.

S.S. Single-sided. D.S. = Double-sided.

Name.	Type.			Diameter.	Prices. Each.	Manufacturer.
	Base.	Surface Coating.	Processing.			
Duralotone ...	Metal.	Synthetic resin.	Heat treatment.	Standard sizes.	—	Sound Apparatus Co., 150, West 46th St., New York, U.S.A.
Electradix ...	Aluminium-alloy.	—	Before cutting, a lubricant may be applied, e.g., thin oil or vaseline.	6in. (D.S.) 10in. (D.S.)	4s. (doz.) 7s. (doz.)	Electradix Radios, 218, Upper Thames St., E.C.4.
Dr. C. G. Lemon	Unbacked, i.e., flexible.	Cellulose derivative.	Chemical treatment, i.e., softened before cutting, then hardened and polished by fluids.	10in. (D.S.)	—	Dr. C. G. Lemon, 19, Lena Gdns, Hammersmith, W.6.
M.E.	Metal.	Cellulose compound.	None.	10in. (D.S.) 12in. (D.S.)	2s. 4s.	Microphone Equipment, Ltd., 8, Charing Cross Rd., W.C.2.
Melograph ...	Unbacked, i.e., flexible.	Gelatine.	Hardened by paste containing formaldehyde.	Standard sizes (D.S.)	—	Wiener Gelatinewaren Industrie, XVII/3, Hernalser Hauptstrasse, 130, Vienna.
Melograph (K)	Backed with cardboard.	Gelatine.	,, ,, ,,	,, ,,	—	
Melograph (M)	Backed with aluminium.	Gelatine.	,, ,, ,,	,, ,,	—	
M.S.S.-Watts ...	Metal.	Cellulose acetate.	Chemical treatment, i.e., hardened and polished by acetic acid.	6in. (S.S.) 7in. ,, 8in. ,, 10in. ,, 12in. ,, 13in. ,, 16in. ,, 6in. (D.S.) 7in. ,, 8in. ,, 10in. ,, 12in. ,, 13in. ,, 16in. ,,	11d. 1s. 1s. 3d. 1s. 9d. 2s. 0d. 3s. 0d. 6s. 0d. 1s. 3d. 1s. 6d. 1s. 9d. 2s. 6d. 3s. 0d. 4s. 3d. 10s. 0d.	M.S.S. Recording Co., Ltd., 99a, Charing Cross Rd., W.C.2.
Parmeko ...	Aluminium.	Cellulose compound.	None.	10in. (S.S.) 12in. ,, 10in. (D.S.) 12in. ,,	1s. 9d. 2s. 0d. 2s. 6d. 3s. 0d.	Parmeko, Ltd., Percy Rd., Aylestone Park, Leicester.
Permarec ...	Metal.	Synthetic resin, with plasticiser.	Heat treatment.	7in. (D.S.) 10in. ,, 12in. ,, 16in. ,,	1s. 6d. 3s. 0d. 4s. 6d. 15s. 6d.	Musikon, Ltd., 19, Lisle St., W.C.2.
Permarec ...	Metal.	Cellulose acetate.	Chemical treatment, optional.	7in. (D.S.) 10in. ,, 12in. ,, 16in. ,,	1s. 6d. 3s. 0d. 4s. 6d. 15s. 6d.	
Presto ...	Metal.	Cellulose compound.	Chemical treatment.	Standard sizes.	—	Presto Recording Corporation, 139, West 19th St., New York, U.S.A. Agents: Henri Selmer & Co., Ltd., 12, Moor St., London, W.1.
Ranger ...	Aluminium.	Nitro-cellulose, plus a synthetic resin.	Before cutting, softened by vapour from organic solvent, and the surface hardens on exposure to the atmosphere.	Standard sizes.	—	Rangertone, Inc., 201, Verona Ave., Newark, New Jersey, U.S.A.
Silveroid ...	Aluminium.	Cellulose acetate.	Chemical treatment. Softened by a gas-liberating chemical previous to cutting, then grooves polished and preserved by chemical that seals on newly exposed surface.	Standard sizes.	—	Universal Microphone Co., Ltd., Inglewood, California, U.S.A.
Simplat ...	Unbacked, i.e., flexible.	Gelatinous composition.	Chemical treatment, i.e., hardened and polished by fluids containing formaldehyde.	7in. (D.S.)	1s. 0d.	V. G. Manufacturing Co., Ltd., Gorst Rd., Park Royal, N.W.10.
Simplat ...	Glass.	,, ,,	,, ,, ,,	7in. (D.S.) 10in. ,, 12in. ,, 14in. ,, 16in. ,,	2s. 0d. 3s. 0d. 4s. 0d. 6s. 0d. 8s. 0d.	

The Radio Industry

FILM INDUSTRIES have received a contract for a permanent public address installation at the G.W.R. Snow Hill Station, Birmingham.

-:- -:- -:-

The current issue of the Bulgin Monthly Bulletin deals with testing equipment for servicemen, anti-interference devices, vibratory HT generators and automatic grid bias, etc. Copies will be sent to readers by A. F. Bulgin and Co., Ltd., Abbey Road, Barking, Essex.

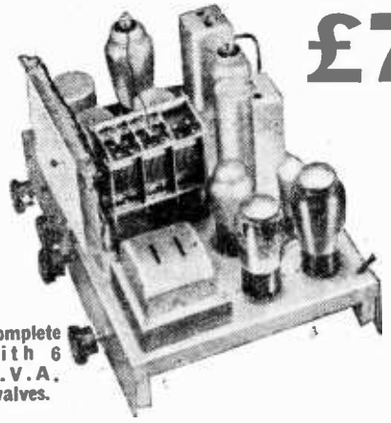
By reason of the increased cost of manufacture, it has been found necessary to increase the prices of Radiolab equipment by 10 per cent. Instruments shown in the Radiolab catalogue sheets 701-719 are affected.

-:- -:- -:-

A new catalogue of interference-suppressing devices is now available from Belling and Lee, Ltd., Cambridge Arterial Road, Enfield, Middlesex.

McCARTHY

new series better than ever —no increase in prices!



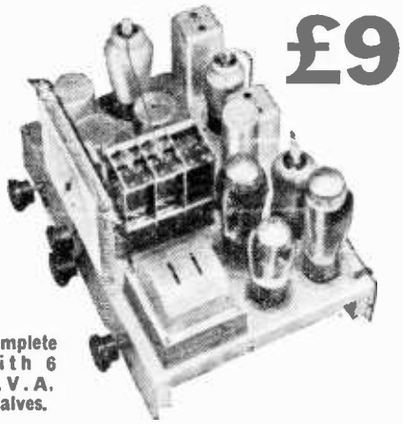
Complete with 6 B.V.A. valves.

£7

IMPROVED ALL-WAVE SIX

Revised specification includes many new refinements, at no extra cost. Heavy-gauge cadmium-plated steel-chassis. Iron-cored coils give still better performance. First-class workmanship and components throughout.

Brief Specification: 8 stage, all-wave band-pass superheterodyne, 7 tuned circuits, employing iron-cored coils. Triode-hexode frequency changer. Double diode detector provides D.A.V.C. Separate L.F. stage. 3½ watt pentode output. Variable tone control. Switch connects gramophone pick-up terminals. Illuminated "Airplane" dial. Wave ranges: 16.5-50, 200-550, 800-2,000 metres. A.C. or A.C./D.C. types for all usual voltages.



Complete with 6 B.V.A. valves.

£9

"PUSH-PULL" ALL-WAVE SIX

6 valve all-wave superheterodyne with similar specification, performance, etc., to above, but with triode push-pull output giving 5½-6 watts. Illuminated "Airplane" dial with principal station names, tone control and volume control (both also operative on gramophone), full provision for gramophone reproduction.

A really high quality receiver, with exceptionally large undistorted output, and fine performance on all 3 wave ranges.

All McCarthy receivers supplied complete with valves, knobs, pilot lamps, leads, mains cable and plug. 12 months' guarantee.

Deferred terms on application, or through London Radio Supply Co., 11, Oat Lane, E.C.2.

Cash with order on 7 days' approval. Also write for illustrated catalogue of complete range of all McCarthy receivers.

McCARTHY RADIO LTD.
44a, Westbourne Grove, London, W.2

Telephone: Bayswater 3201/2.

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On the Short Waves

NOTES FROM A LISTENER'S LOG

IN conversation with W1COO, of Weston, Mass., on 28 Mc/s, between 4.30 and 5 p.m. on Saturday, March 6th, I learned about some very interesting ultra-high frequency achievements of the Harvard Research Group. Arthur E. Bent, of W1COO, told me that they have in successful operation a 142-mile ultra-high frequency link between Blue Hill Observatory and Mt. Washington, the former working on 53 Mc/s (5.66 m.) and the latter on 60.6 Mc/s (4.95 m.); surely this must be one of the longest U/SW links in regular service, apart from the Hawaiian telephone network.

Another interesting achievement mentioned by W1COO, who, incidentally, puts in perhaps the best 28 Mc/s U.S. signal heard here, is the Harvard "Radio Meteograph," which is a very small U/HF transmitter weighing 1 lb. only, and which sends out automatically on 68 Mc/s (4.4 m.) continuous records of pressure, temperature and humidity during its rise into the upper atmosphere attached to a free hydrogen balloon.

Clear signals have been recorded from this device for durations of three hours, representing distances horizontally up to 200 miles and heights of 100,000 feet.

The transmitter employed by W1COO uses 125 watts input to a pair of 808's in push-pull, Class B modulated, fed to a horizontal long-wire antenna four waves long and fed in the centre with a $\frac{3}{4}\lambda$ open-wire matching transformer. The aerial runs east and west, so that one lobe of the radiation pattern is directional on England.

Vision Signals from Alexandra Palace Received in America

Another point of interest picked up on 28 Mc/s was the information that on February 23rd good reception was obtained in New York of the *vision* signals from the Alexandra Palace transmitter; though a picture was not obtained, only a small alteration would be necessary to a R.C.A. 441-line 60-frame interlaced receiver in order to take 405-line 50-frame pictures.

In spite of a decline in sunspot activity during the first week in March, the remaining activity, some five or six spots, has, because of the increase in daylight with the change in season, been able to keep the 28 Mc/s band open on most days until 7 p.m. or later.

Reception from the U.S. and Canada on "10 metres" does not fade out until some two hours after signals from this country fade out there.

This discrepancy in fade-out time seems to become less and less as the working frequency is lowered and is probably negligible on 7 Mc/s (40 m.).

Dealing with conditions during the fortnight under review, we find that on Thursday, February 25th, W2XE was a good signal on 21.52 Mc/s at 11.40 p.m., and, earlier, the 28 Mc/s U.S. amateurs had been very good and audible up to 10 p.m.

Conditions were good again on Friday, February 26th, but poorer than on Thursday.

At 10 p.m. on Saturday evening reception on 28 Mc/s was again most interesting, and, in particular, W1IAO was a very good signal.

Both W3XAL and W2XAD were also excellent during the evening, and even W3XAL on 6.1 Mc/s was an improved signal later.

Good reception of PCJ on 9.59 Mc/s was obtained at 8.05 p.m. on Tuesday, March 2nd, and, judging from the announcer's replies to listeners' letters, PCJ has a large audience in this country.

Conditions were apparently improving, and yet W3XAL was poor, in spite of a strong carrier, at 8.10 p.m.; W8XK on 15.21 Mc/s was R7/8, but not a particularly good signal, at 9.45 p.m.

At this time very good reception was noticed of the 14 Mc/s T.A.T. transmitter (WMF?).

More improved conditions than during the earlier part of the week were experienced on Wednesday, March 3rd, and at 7 p.m. the second harmonic of WQF on 8 metres was R7, with W9XAZ, Milwaukee, on 26.4 Mc/s at R9+, a very fine signal and noticeably superior to W3XAL on 17.78 Mc/s.

At 8.30 p.m. JZ1, Tokio, on 9.53 Mc/s was good at R7/8, but GSC, paradoxically enough, was an enormous signal on 9.58 Mc/s; W2XAD was good, too, and DJD was strong but heterodyned by OER3, Vienna, on 11.775 Mc/s.

Good U/HF signals were still being obtained at 8.35 p.m., both W1XAO and W3XES being audible on 35.6 Mc/s.

Pödebrady OLR was an extremely strong signal, signing off on 9.55 Mc/s at 9 p.m. on March 4th, W2XAF being faint in this band, but W3XAL was good on 17.78 Mc/s.

Signals on 28 Mc/s seemed to have just disappeared at 9 p.m., but practically no signals were heard in this band on the following night, Friday, March 5th. On this evening conditions were quite poor, corresponding to a minimum in sunspot activity during the past weeks.

Probably the best signals from the U.S. on Saturday afternoon, March 6th, were W9XAZ on 26.4 Mc/s (11.35 m.) and W1COO on 28.3 Mc/s (10.6 m.).

The quality of the high-fidelity relay of WTMJ (W9XAZ) is really excellent and the programme material good and interesting.

One of the best signals in the late evening was LRX, Radio El Mundo, Buenos Aires, on 9.66 Mc/s, and this station was especially good at 1 a.m. on March 7th.

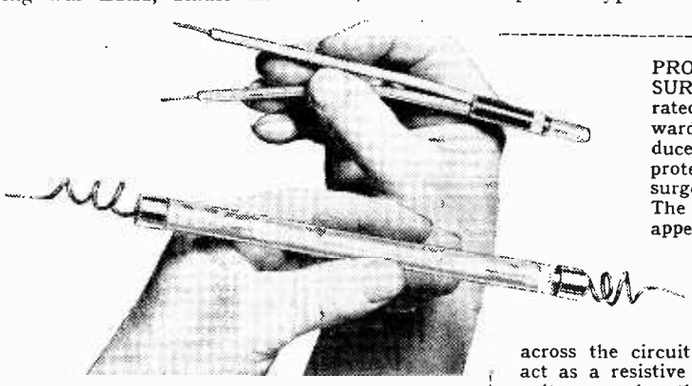
Both W1XK and W2XAF were good in the 9 Mc/s band at this time, but W3XAU on 9.59 Mc/s was badly heterodyned. Several South American stations in the neighbourhood of 5.9 Mc/s were of programme value.

Really outstanding results were again obtained from W9XAZ on Sunday afternoon, a particularly pleasing item being dance music by Red Mackenzie and his Rhythm Kings.

The best signal later in the evening, at 11 p.m., was W8XK on 15.21 Mc/s, this peaking to R7/8, but of good clear merit; W2XAF was actually stronger on 9.53 Mc/s, but less clear.

One of the most consistent signals during the past fortnight has, however, been W1XAL, Boston, on 11.79 Mc/s at 11 p.m.

ETHACOMBER.



PROTECTION AGAINST SURGES. Gas-filled tubes rated from 100 volts upwards, have been introduced in America as protective devices against surges or voltage rises. The tubes, which would appear to have several applications to wireless receivers and television apparatus, are, of course, connected across the circuit to be protected, and act as a resistive shunt as soon as the voltage reaches the value at which the tube becomes conductive. The smaller tube shown is used as an indicator for test purposes.

BOOK REVIEWS

Testing Radio Sets. Third edition. By J. H. Reyner, B.Sc., A.M.I.E. Pp. 239+xi. 115 photographs and diagrams. Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 10s. 6d.

IN some ways it is more difficult to revise a book for another edition than to write a new one on the same subject, especially when that subject is radio. The book under review, originally published in 1930, in its latest edition gives one the impression that it has not altogether escaped from the trammels of past history.

Thus, in the first half of the book (Fault Testing) after more than 100 pages in which the examples are exclusively drawn from straight receivers, generally of the variable reaction type, the superheterodyne is dismissed in seven pages. Even in the second half, under the heading of Laboratory Tests, devoted to more advanced work, the superheterodyne receives only eight pages. These proportions can no longer be held to do justice to the relative importance of the respective types.

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It is true that much information in the earlier chapters applies to the superheterodyne; but it is also true that many of the difficult points which most need comprehensive explanation relate exclusively to the superheterodyne—such things as oscillator tracking, the frequency-changer and the several varieties of whistles. The detailed treatment of whistles in Section II promised in Section I, does not materialise.

Other modern practices such as noise suppression, QAVC, variable selectivity, short-wave and "all-wave" superheterodynes, QPP, Class "B," and even ordinary push-pull, are not even mentioned; while no circuit diagrams show RF pentodes, heptodes, octodes, or triode hexodes.

Now that DC-only receivers have vanished from the market, it would be better to treat the AC/DC set as standard practice instead of adding a bare page to cover it; in which case the dangerous values of 0.1-1.0 mfd. for the earthing condenser would not be mentioned.

The author's experience of loud speakers must have been exceptionally fortunate when he is able to advise that they need not, in general, be suspected when the symptom is "rattling." Or, perhaps, the reviewer has been unfortunate.

The book is extremely commendable in emphasising the advantage of systematic methods in the location of faults and in presenting principles rather than mechanical analyses of particular cases. At the same time examples are given, not only in order to illustrate the principles, but sometimes also to show that faults are liable to occur which are apparent exceptions to the general rules.

Much information on the design of receivers and of test gear is included; and to make the volume as self-contained as possible even such simple matters as the difference between AC and DC are explained (but not, curiously enough, "parameters" and "regulation" in its technical sense). And while modern laboratory practice is described in Section II, the use of quite simple apparatus is assumed in Section I. The book is therefore addressed to amateur and servicemen as well as to the research or design engineer. M. G. S.

L'Oscillographe Cathodique, La Télévision Cathodique. By P. Hémardinquer. Pp. 239+x. 145 photographs and diagrams. Dunod, 92, Rue Bonaparte, Paris (6e). Price 50 fr.

ALTHOUGH this book covers the subject of the cathode ray oscillograph in general, as the title suggests it is mainly devoted to the application of cathode ray and allied electronic tubes to the problem of television. Chapters deal with the fundamental principles of the cathode ray tube, traced historically; its characteristics; the selection of types of tube for particular purposes, and the technique of operation; the principles of cathode ray television and early attempts to embody them; cathode ray systems at the transmitting end, including those of Zworykin, Castellani, and Farnsworth; reception systems; and finally a chapter on the use of the cathode ray oscillograph in laboratory work—investigation of voltage, frequency, waveform, characteristic curves, etc.

The advantages and limitations of the various systems are clearly described, including such recent inventions as Zworykin's electron multiplier. The Farnsworth camera is particularly well illustrated by photographs, diagrams, and a scale section. Unlike so many authors, M. Hémardinquer does not miss the main point when explaining the advantages of the iconoscope. Nor does he unduly favour the work of any particular country, firm, or individual. French television is, in fact, rather briefly treated; but a very interesting detailed description is given, with circuit diagram and schedule of components, of a vision receiver constructed by a French amateur, M. Chauvierre. It is designed to work on the Barthélemy system, and makes use of a miniature tube with a 3¾in. screen, viewed through a 6in. lens. This greatly simplifies the design, and the number of valves is as few as six, plus two rectifiers and the cathode ray tube. This number includes those used in both time bases. The wavelength covered is 6 to 8 metres, as is usual in this country.

The final chapter does not cover the applications of the oscillograph very fully, but it does give useful circuit diagrams and pictures of complete oscillograph assemblies.

This is a very satisfactory book, and can be usefully followed by anyone whose knowledge of French is, like the reviewer's, very slender.

Wireless Terms Defined. By "Decibel." Pp. 72, with numerous circuit diagrams and explanatory sketches. Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 2s. 6d.

As its title implies, this book is something more than a mere glossary or dictionary of technical terms. Many of the definitions are expanded into explanations running to a quarter-page or so, and the accompanying sketches, which average about two per page, help to make matters clear both to the non-technical user of a broadcast receiver and to the more technically minded readers of wireless literature. According to the preface, the work is addressed to both classes.

By clarity of expression, avoidance of redundancy and omission of anything akin to academic pedantry, the author has achieved a large measure of success from both points of view. Very rightly, the relevant fundamental electrical terms are included, but the field most thoroughly covered is that of broadcast reception, and here it is indeed difficult to find the unjustified omission of a term. Transmission is dealt with adequately, but certain television terms (e.g., raster) that have come into general use are not to be found. H. F. S.

The Practical Electrician's Pocketbook, 1937. Pp. 532. Numerous diagrams and illustrations. Published by Odham's Press, Ltd., Technical Book Department, 85, Long Acre, London, W.C.2. Price 2s. 10d. post free.

THIS extremely useful handbook containing data relative to all branches of electrical engineering is divided into seven sections, the headings of which will convey some idea of the very wide field which the book covers: (1) Principles and laws of electricity. (2) Generation and electrical machinery. (3) Transmission and Distribution. (4) Wiring Theory and Practice. (5) Power Applications of Electricity. (6) Light—Current Electricity. (7) Lighting, Heating and Domestic Uses. In addition there is a history of progress during 1936, and a tabulated list of the supply voltages of the United Kingdom, those which are time-frequency controlled being specially indicated. Wireless is dealt with under Section 6.

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Trouble on the Ice

I WONDER if any of you super-technical fellows can put me on to a good way of finding out what wavelength a certain transmitter is using. It's no use telling me to make a rough guess by looking at the dial setting of my receiver when it is coming in and then to measure it accurately with a wavemeter, for, as a matter of fact, I haven't yet heard it on any receiver. It is equally useless to tell me to approach the proprietors or operator of the transmitter with a request for information, for I've already tried that and have drawn a complete blank.

Perhaps before going any further it might be helpful to give you a few facts concerning my problem. A week or two ago I was basely induced, in spite of my protestations, to visit a certain skating rink in company of Mrs. Free Grid and several other females who have taken up this new skating craze as a method of combating Nature's just retribution in the matter of over-indulgence in the flesh-pots of Egypt—or, in other words, slimming or "preserving their youthful figures," as they euphemistically call it. Anyhow, whether you call it figure preservation, slimming or merely by the vulgar and honest name of fat reduction, it amounts to much the same thing.

From time to time during the evening the ice was cleared and a youthful Venus and Apollo took up their positions in order to show us how to waltz on skates.

Mixed up in hopeless confusion.

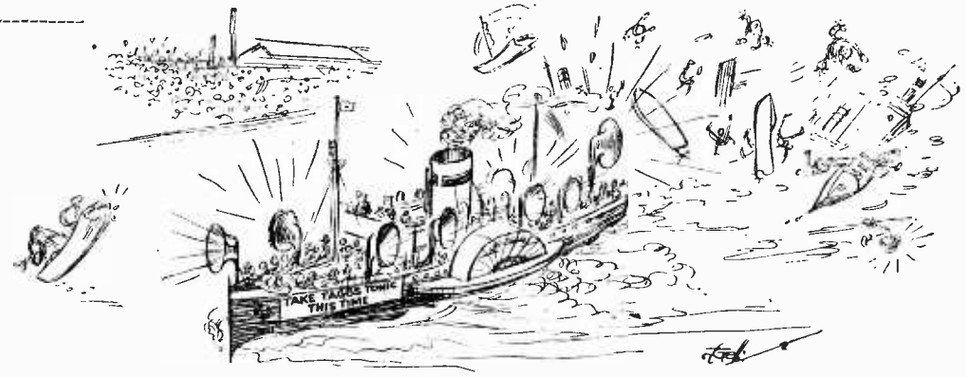
The aforementioned Apollo explained the various steps as he and his companion indulged in their Terpsichorean gyrations, his voice roaring out from loud speakers by which the arena was surrounded. I was frankly bored by the whole affair until it suddenly occurred to me to wonder how on earth his voice got to the loud speakers, for there appeared to be no tangible connection. I naturally thought of concealed microphones round the arena, but soon dismissed this as impossible owing to the distance. More careful observation revealed the fact that he was wearing a lapel microphone, and at once the solution occurred to me; he was obviously fitted somewhere about his person with a flea-power ultra-short wave transmitter.

Naturally, I immediately determined to set all my doubts at rest by making a personal investigation. No sooner did the resolve come into my mind than I put it into execution—or at least, attempted to do so—by taking a flying leap on to the ice. Unfortunately, however, I had forgotten that I was only a novice at this skating business and immediately my feet touched the ice I realised that my body was no longer under control. The momentum acquired by my leap kept me from falling, however, and carried me with a swift and sickening swoop towards the dancing instructor and his fair companion, and, although I gave a warning shout, the next moment my weight had caught him in the small of his back, and in the space of a split second all three of us were inextricably mixed up in hopeless confusion on the ice.

I did not, however, as many people might have done in my place, lose my presence of mind, but at once began to question the youth concerning the type of transmitter that he was using, together with all particulars concerning the wavelength, etc. Unfortunately, however, he proved very uncommunicative and descended to mere vulgar abuse. Since the incident mentioned I have spent several evenings at the rink-side with an ultra-short wave receiver endeavouring to locate the wavelength employed, but all to no avail. It is for this reason that I am appealing to you for help, and trust that you will not disappoint me.

A Boat Race Absurdity

SINCE the opening of the various Anglo-Continental stations with their sponsored programmes, we are all getting used to the pleasant rivalry which exists among our patent medicine vendors, and the efforts which they make in vying with one another for public favour. I think, however, that the latest stunt of one such firm, which has just been brought to my notice, is so absurd that in their own interests I hope they will spot this paragraph and decide to abandon it before they make themselves too ridiculous.



This floating monstrosity.

The great stunt is in connection with the broadcasting of the Boat Race, which is hard upon us once more. Everybody knows that the B.B.C. broadcasts a running commentary from a transmitter situated in a launch following the crews, and that this is picked up by a special receiver and retransmitted through the ordinary B.B.C. stations; I suppose that most people are also aware of the fact that loud speakers are provided for the benefit of the crowds which forgather at strategic points on the river bank. Briefly, the firm's idea is to provide a similar benefit for the crowd of boats which usually follows in the wake of the Umpire's launch, the smaller and hindmost ones of which are not really in a position to get a good view of the race. The method which it is proposed to adopt in order to remedy this defect is to equip a steam launch with a wireless receiver, a Gargantuan power amplifier and a collection of giant loud speakers; this floating monstrosity will proceed along the river at a respectful distance behind the Umpire's launch and blare out the running commentary.

I presume that it has not occurred to the firm concerned that all these small boats are usually equipped with ordinary portable receivers—many of them being of the lightweight headphone type like my own—and are thus able to get the running commentary themselves without disturbing their neighbours.

Boat Race Day will show whether my timely word of warning has had sufficient influence with the firm concerned to prevent their holding themselves up to public ridicule in this manner.

By Free Grid

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Broadcast Brevities

NEWS FROM PORTLAND PLACE

What Listeners Want

THE first phase of the B.B.C.'s enquiry into listeners' views on radio drama is now ended, and the experiment has been so successful that it is to be extended for a further three months.

A Comprehensive Survey

Three hundred and fifty listeners, selected by the B.B.C. officials in London, and in the Regions, from those who are known to be specially interested in drama broadcasts, were invited to listen with special care to twelve dramatic productions that were broadcast nationally during the four weeks ended on February 27th. At the end of each seven days the chosen band returned to Broadcasting House a questionnaire duly completed. The questionnaires came from an unemployed miner, an architect, a housewife, a country parson, a novelist, a professor of German, several blind people, a quarryman, a farmer, and representatives of many other callings.

They Like Thrillers

Some interesting analyses were obtained. Of 280 listeners who heard "The Merchant of Venice," 96 per cent. thought that Shakespeare was suitable for broadcasting. Eighty-seven per cent. were satisfied with the way in which the production was carried out. Reports on "Broadway" numbered 290. The play was enjoyed by sixty-three per cent., and seventy-eight replied that they liked hearing radio thrillers. The 283 reports on the play entitled "Wait For Me" produced eighty-seven per cent. appreciations. Of the 250 listeners to "Lepanto," a production based upon Chesterton's poem, sixty-nine per cent. enjoyed it, and of those who did not enjoy it, thirty-seven per cent. replied that they would like to hear further experiments of this kind. A regular staff is kept busy at Broadcasting House dealing with the issue of questionnaires and checking the returns.

Those Television Vans

RUMOURS that the television "O.B." vans will not be ready in time for the Coronation can be discounted. A definite delivery date has been fixed in the week preceding Coronation week, and, lest the pessimists should suggest that this gives little time for testing, it should be pointed out that the vans will be thoroughly tried out by the contractors before being handed over to the B.B.C.

Radio Link

Whether the "ultra short" wireless link will be used at once is doubtful. In the early days, with a co-axial cable covering a good deal of interesting territory in West London—and with a cable link between Broadcasting House and Alexandra Palace—it will be quite possible to dispense with a radio connection.

Television Rehearsals

GEORGE MORE O'FERRALL, who has produced television's "Picture Page" since the opening of the service, is now specialising in the presentation of drama. Already he has had a number of successful adaptations to his credit, including "Murder in the Cathedral," the Clemenceau play, "The Tiger," "Marigold," and, last but not least, "Jane Eyre" on Monday of last week. This drama, which resulted in a big postbag of congratulations, took four hours to rehearse.

Imaginary Cameras

The first part of the rehearsal took place in the Aldwych Theatre after the matinee on the preceding Saturday. The actors were at first somewhat astonished by the procedure, for in addition to real chalk marks and a moderate amount of genuine lighting Mr. O'Ferrall used four "imaginary" cameras. The positions of the "cameras" were carefully worked out, so that, when the production was translated to the studio on the Tuesday, the actors had only to observe the same timing and follow duplicated chalk marks in order to provide the desired result on the television screen.

Rehearsals in Odd Places

The ratio of rehearsal to transmission time is now approximately 4:1. At Alexandra Palace the ratio is nearer 3:1, but a great deal of rehearsal time is spent in theatres, in studios at Broadcasting House and even in private houses.

Very soon these haphazard methods may be abandoned. The Alexandra Palace theatre, now in use as a "property" shop, may shortly be used for preliminary rehearsals of all kinds, from dramatic excerpts to ballet and variety.

"Seeing" Across the Atlantic

THE wish was probably father to the thought in the stories current last week that London television had been seen in America. What really happened was that Mr. Gerald Cock, Director of Television, received a letter from a resident in New York which said, "For an hour yesterday (February 23rd) we got your video signal quite clearly and strongly." The reference was, of course, to reception of the *sound* of the vision signal.

Ethics of Advertising

SINCE the refusal of the B.B.C. to accept an alcoholic advertisement for its official publications, and the threat of the firm by whom the advertisement was offered to publish its correspondence with the Corporation, warm discussions have been held at Broadcasting House as to the ethics of its attitude.

Uncompromising "No"

The case for the proposers appears to be that, as the Corporation accepts all classes of medicinal advertisements, it is perfectly logical to suppose that the beverage which is said to be without equal should also be placed in the position of having listeners' attention called to its liquid virtues. The Corporation's case has never been stated, its refusal merely being unqualified; it can therefore be taken for granted that as this august body never has accepted such advertisements it does not intend to depart from precedent. This, then, is the Corporation's policy, and not, it would seem, the whim of any highly-placed individual.

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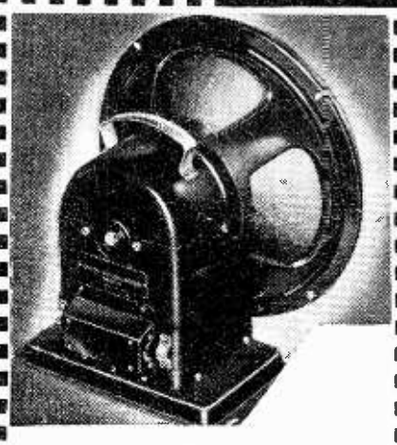

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Recent Inventions

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

CATHODE-RAY TUBES

ELECTROSTATIC focusing of the electron stream is combined with electro-magnetic means for deflecting it, provision being made to prevent any disturbance due to mutual interaction between the two controls. For this purpose, the accelerating electrode, forming part of the electron "lens" system, consists of a disc with a tubular extension pointing towards the fluorescent screen. It is set coaxial with, and spaced apart from, a second tubular electrode, which is nearer the cathode and is fitted with an internal diaphragm. The arrangement produces a sharp image on the screen, free from any "halo."

Radio Akt. D. S. Loewe. Convention date (Germany) March 3rd, 1934. No. 457757.

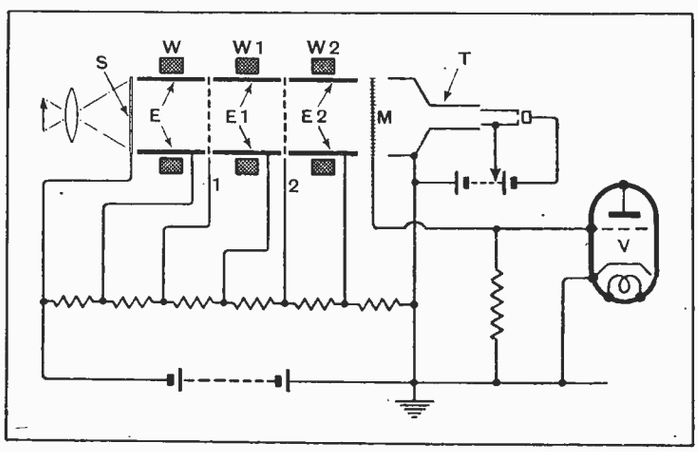
o o o o

ELECTRON-MULTIPLIERS

A PICTURE to be televised is focused upon a photo-electric transparent screen S, and the electrons so liberated are passed through a series of permeable grids 1, 2, where amplification takes place by secondary emission. The resulting stream is focused and controlled by magnetic windings W, W1, W2, and by electrostatic surfaces E, E1, E2.

The stream finally impacts upon a second photo-electric electrode M of the mosaic-cell type, where it forms an electric image, which is scanned by the electron stream from the "gun" part of a cathode-ray tube T. The arrangement is also suitable for micro-photography and for "seeing through fog."

H. G. Lubszynski and J. E. Keyston. Application date May 30th, 1935. No. 457493.



Electron multiplication arrangement applied to television transmitter.

TUNING CONTROL

WHEN tuning movements of considerable extent are necessary, a small motor is started up by a single sharp turn of the tuning-knob to drive the elements in one direction or the other. Fine tuning can be effected in the same way, or is performed independently by manual control. The motor may be of the single-phase squirrel-cage type, which is not self-starting.

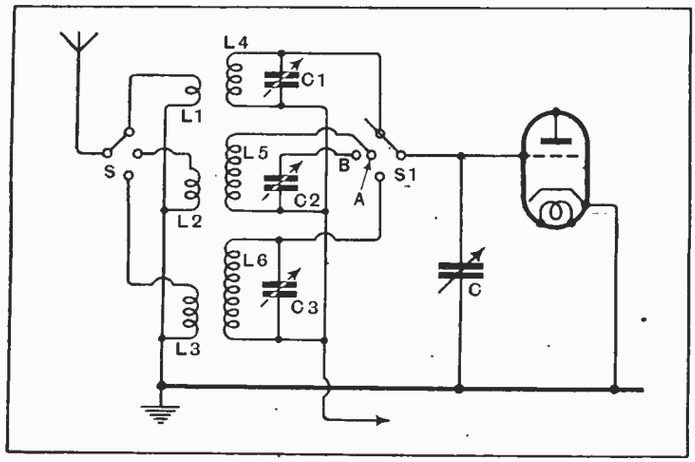
Preferably the indicator spindle passes through the centre of the loud speaker, the station and wavelength indications being printed on the inside edge of the cone.

W. J. Brown and E. C. Wadlow, Application date June 26th, 1935. No. 457207.

o o o o

SHORT-WAVE RECEIVERS

THE figure shows the switching arrangements for a short-wave set in which the coil that is, for the time being, out of use is prevented from acting as an absorption circuit. A switch S connects one or other of the coils L1, L2, L3 to the aerial, whilst a second switch completes the input circuit to the first valve through coils L4, L5, L6.



Tuning system to avoid resonance absorption.

The coil L4 is tuned by a preset condenser C1 and also by the main tuning condenser C. With the switch S1 in the position shown, the circuit L4, C1, C is in operation, and the short-wave coil L5 is open-circuited as regards the condenser C2, so that resonance "absorption" is prevented. When the switch S1 is moved to bridge the contacts A, B, the coil L5, preset condenser C2, and tuning condenser C form the input circuit to the valve for the highest range of frequencies. The third coil L6 is tuned to the medium-wave band. The merit of the arrangement lies in the means for breaking the connection between the terminals A and B.

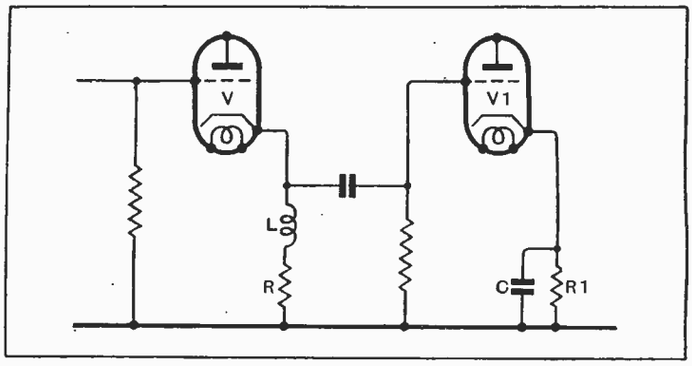
E. K. Cole, Ltd., and H. C. Rowe. Application date June 29th, 1935. No. 457398.

o o o o

FREQUENCY-COMPENSATING CIRCUITS

IN order to offset the natural falling-off in gain which occurs with rise in frequency it has been usual to insert compensating inductances in several or all of the stages of HF amplification. This, however, is open to the objection that the inductances tend to "resonate" with stray capacities and so give rise to distortion.

According to the invention, a frequency-compensating net-work L, R, is inserted in the cathode lead of one amplifier, so that it is effectively in both the anode and grid circuit of that valve, and also in the grid circuit of the succeeding valve. The resistance R may be 300 ohms in series with an inductance L of 30 microhenrys. The output impedance of the valve V is so low that the Miller effect may be neglected. In addition, the cathode lead of the valve V1 may include a resistance R1 of 300 ohms shunted by a condenser C of 500 mmfds.



Frequency compensation between stages of amplifying systems.

The arrangement is stated to give a constant-frequency gain of 10 decibels up to a frequency of 5 megacycles.

P. W. Willans; A. J. Brown; and Baird Television, Ltd. Application date June 7th, 1935. No. 457827.

o o o o

PIEZO-ELECTRIC CRYSTALS

A QUARTZ oscillator is cut from the mother crystal in planes which are substantially parallel with the electric axis and at an angle to the optical axis, so that it vibrates at a fundamental frequency which is independent of temperature-variation to within 5 cycles per million per degree of temperature. The crystal may be cut to vibrate either across its length or its thickness, and detailed directions are given as to the method of cutting in each case.

Marconi's Wireless Telegraph Co., Ltd. (communicated by S. A. Bokovoy and C. F. Baldwin). Application date May 31st, 1935. No. 457342.

o o o o

SCANNING SYSTEMS

LINE frequency impulses are obtained by frequency-multiplication from the framing impulses, the latter being based on the 60-cycle frequency of the supply mains. The first frequency-changer is a saturated iron-cored inductance, from which a 180-cycle component is filtered out and applied to a series of frequency-multipliers of the saturated-valve type. The final amplifier is biased so as to pass only positive peaks of constant amplitude. The arrangement is particularly suitable for interlaced scanning.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of A. W. Vance.) Convention date (U.S.A.) May 23rd, 1934. No. 457135.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of patents issued in U.S.A. is also included.

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The Wireless World

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

EDITORIAL COMMENT

Television Stagnation

The Finance Problem

WE have repeatedly stated in the past, at successive stages in the development of television, that there was little cause for any anxiety on the technical side. Having watched the progress which has been made the most sceptical observer must be satisfied that the technical achievement of television is satisfactory and that, even if no further improvements were made, it is, nevertheless, at the present moment of a sufficiently high standard to give general satisfaction to the public as a medium for the transmission of vision.

The anxiety which we have always felt on the financial side of television development still persists; the programme compilers at Alexandra Palace have made remarkable progress, and much of the material which they transmit is well worth looking at, but the standard is not high enough and, unless we have good programmes all the time instead of occasionally with a good deal of time filled in with indifferent efforts, public interest will not be maintained. There is, in addition, need for longer hours of transmission before the public becomes sufficiently enthusiastic for sets to be sold in large quantities.

Programmes Proportional to Funds

We assume that the B.B.C. television programme compilers are doing the best they can with the funds available to them, and if there is no prospect of more money for the television programmes it would seem that we shall have to go on with programme material at least no better than at present.

This problem of television finance was considered by the Television Committee which published its report and recommendations early in 1935. Of the various suggestions put forward by the Committee, the only one acceptable to the Government was that the cost should come out of the B.B.C.'s share of the ten-shilling licence, which share was increased on the recommendations of the Broadcasting Committee which, early in 1936, advised the Government as to the terms on which the B.B.C. Charter should be renewed.

The Advisory Committee

It would seem that since the Television Advisory Committee is still sitting, with the object of lending its aid on questions concerning the development of the service, it is to this Committee that we should look for suggestions offering a solution of the financial problem.

There are three questions which the Television Committee might be asked to consider.

Are the reports which circulate to the effect that the television programme compilers are short of funds well founded?

If so, then are the B.B.C. strangling television by adopting a policy of meanness towards this new branch of the service?

If the B.B.C. are supplying for television as much as their resources can afford, then what alternative solution for this problem of finance can be found?

The matter appears to be one which is primarily the responsibility of the Television Committee to investigate, and it is a matter of urgency, for it will take some time before a change of policy can have effect, and in the meantime the television programmes are not the best propaganda for the new service.

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American ASC Circuits

Selectivity Control by AVC System

ONE of the latest developments to be applied to broadcast reception is variable selectivity which is controlled, not manually, but automatically by the strength of the signal. In this article some methods of obtaining ASC are discussed by our American correspondent.

FOR several years now it has been realised that control of selectivity (and fidelity, unfortunately) must be provided on those receivers capable of reproducing frequencies above some 4,000 c/s to minimise the annoyance caused by whistles and sideband splash produced by transmitters broadcasting on channels adjacent to that of the "desired" station.

The first cure for this problem was the addition of a manual variable selectivity control to the higher priced "high-fidelity" receivers. Although such a control is quite satisfactory when operated by an intelligent individual who understands the problem, the public, in America, neither understands nor is sufficiently interested and patient to gain much benefit from its inclusion in a receiver, and it was found that it was generally left in the most selective position. The probable reason for this is that most individuals are more annoyed by the presence of a small amount of interference than by the loss of the high frequencies; the high-fidelity receiver thus often becomes a "fair to middlin'" receiver shortly after its installation in the average home.

The second disadvantage of the manual control is the ever-changing field strength of the adjacent-channel stations after dark. For instance, in New York, approximately 20 miles from 50 kw. WOR on 710 kc/s, 500 kw. WLW in Cincinnati, operating on 700 kc/s will vary in field strength from 1/100 of WOR's signal strength to an equal or slightly greater strength. Therefore no one degree of selectivity will be satisfactory for any length of time.

One of the earliest forms of automatic selectivity control was described in *The Wireless World* for October 4th, 1935, by R. I. Kinross, of the Gramophone Company. The system described involves the use of a three-circuit IF transformer, the tertiary winding of which is shunted by the AC resistance of a triode valve. The value of this resistance can be varied from 10,000 ohms on a weak signal to more than a megohm on strong local signals, giving selectivity curves which resemble those of an IF coupling unit having variable coupling.

Two months later (November 29th, 1935) several systems were discussed in an article in *The Wireless World* by B. D. Corbett. Several of these methods are very ingenious, and may yet prove themselves the most efficacious for the purpose. Mr. Corbett's solution of the fundamental problem of obtaining control voltage for the ASC system — regardless of the control element used—is very sound; and it is the writer's belief that no method of control by the *desired* signal can be completely successful.

Although much work has doubtless been done on this problem, most of it has been kept both dark and silent, so that the next development was presented before the I.R.E. 1936 autumn Convention, in Rochester, N.Y., by H. F. Mayer, of the General Electric Co., Schenectady, N.Y. This paper was unusually comprehensive, treating most of the possible methods of selectivity control by electronic methods, both experimentally and mathematically.

Mayer's paper points out that the control of Q (circuit efficiency) alone to effect large changes in selectivity is far from ideal, although frequently of value in connection with other methods. Another method discussed was the detuning, or staggering, of the several IF tuned circuits. This is accomplished by the use of a valve as a variable reactance, and normally requires two valves per stage, one across the secondary and the other across the primary.

This possibility of using a valve as a capacitive reactance has been thoroughly described in connection with the electronic control of oscillator frequency in several AFC systems. Figures 1 (a) and

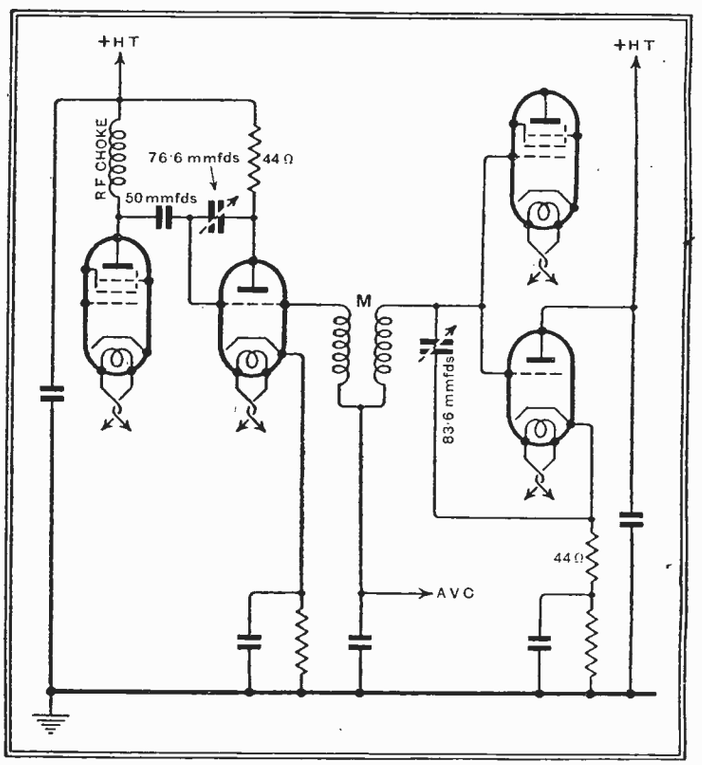

Fig. 2.—An ASC circuit which utilises two triodes to mistune the primary and secondary circuits in opposite directions.

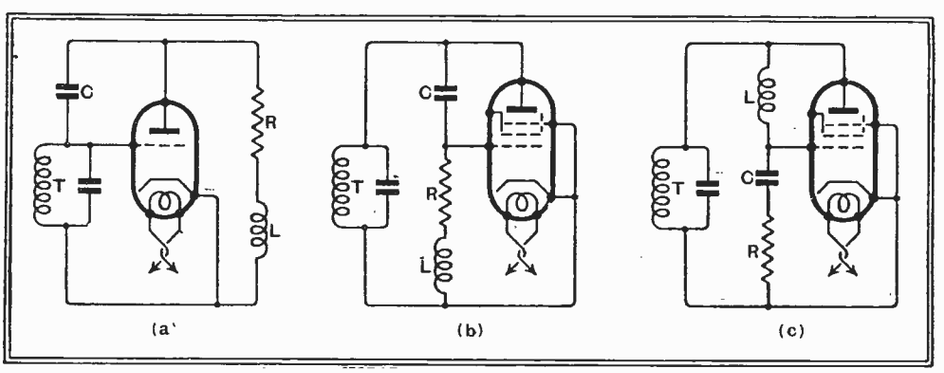

Fig. 1.—Three ways of connecting a valve so that it behaves as a variable reactance are shown here.

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American ASC Circuits—

(b) indicate two possibilities, and in both R is small compared to the reactance of C. L also is small, correcting the phase to as near 90 degrees as desired, and in many cases it may be omitted. In (a) the anode AC resistance of the valve does not matter, but in (b) it must be high. The electronic capacitance obtained by (a) or (b) is approximately gRC, where g is mutual conductance. In figure 1 (c) a lagging instead of leading current is drawn; R is small compared to the reactance of L, and C is the compensating reactance. In (b) the dynamic capacity is proportional to the mutual conductance, resulting in a lowering of the resonant frequency of the tuned circuit; while in (c) the frequency is raised with increasing mutual conductance of the control valve.

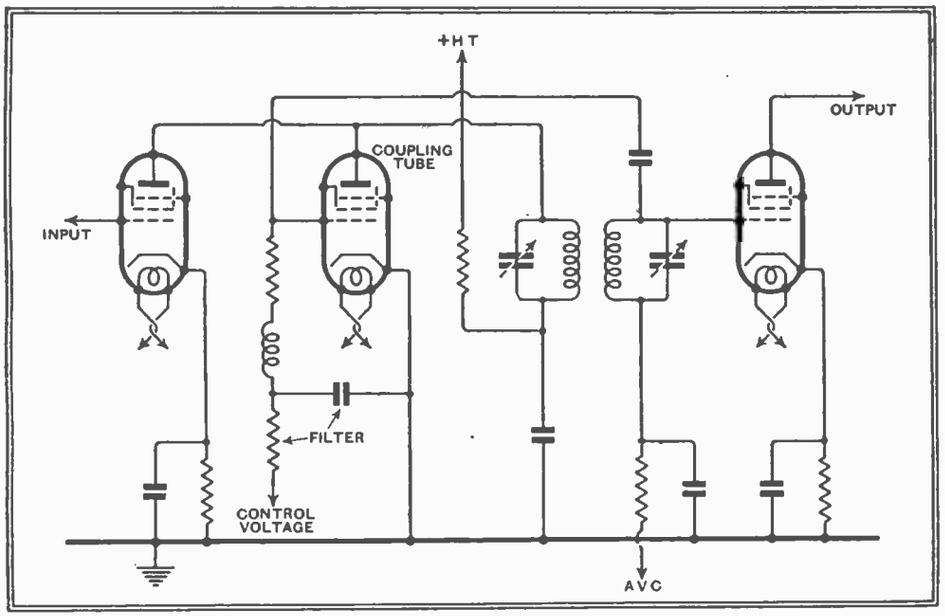

Fig. 3.—In this circuit an RF pentode varies the coupling between the two circuits of an IF transformer.

Staggered Tuning

When applying these circuits to a receiver the primaries of all controlled IF stages are detuned in one direction and the secondaries in the opposite direction. If circuit (b) is used across the primaries (the control reactance is capacitive) and circuit (c) across the secondaries (inductive control reactance), symmetrical detuning may be secured with only one control voltage. Otherwise, two oppositely directed voltages will be required. Also, alignment is made much more difficult with any other arrangement.

Mr. A. W. Barber, an American consulting engineer, has furnished more information on this system of band-width expansion by electronic detuning. Fig. 2 shows a circuit whereby 10 kc/s detuning is accomplished by the reception of a large signal. Across the IF transformer primary is connected the input capacity of a triode valve having an effective grid to anode capacity of 76.6 mmfd. which tunes this circuit to 456 kc/s. This capacity is secured by adding the necessary 70 mmfd. (roughly) to the internal inter-electrode capacity of the valve. As this valve may be assumed to have a mutual conductance of 1.0 mA/V, with a minimum bias determined by its cathode resistance, and as it has in its anode circuit a load resistance of 44 ohms, it will develop a gain of 0.044. Thus the anode to grid capacity will produce an effective input capacity of 1.044 times its nominal value, which with a static capacity of 76.6 mmfd. will give an effective input capacity of 80 mmfd. The IF transformer primary should be of the proper inductance to resonate at 456 kc/s with this tuning capacity. With sufficient negative grid voltage (derived from a strong signal via the AVC system) to bias this ASC valve to anode current cut-off, the gain will be zero, and the tuning capacity will therefore be the actual grid-anode capacity of 76.6 mmfd. which will tune its associated inductance to 466 kc/s, a change of 10 kc/s.

The secondary circuit of this IF coupling device is tuned by the effective input capacity of a triode valve similar to that used across the primary, but having a condenser connected between cathode and grid, and its load resistance in the cathode circuit. This secondary detuning valve has an effective input capacity less than the grid-cathode capacity at normal gain, as the phase of the current in its gain producing resistance is opposite to that of the primary control valve. With a total grid-cathode capacity (internal or interelectrode plus added external capacity) of 83.6 mmfd., the effective input capacity will be 80 mmfd. at maximum gain. However, when its gain is reduced to zero by a strong signal, the input capacity becomes 83.6 mmfd., detuning the secondary 10 kc/s below the initial no-signal value of 456 kc/s. The coupling between primary and secondary coils may be magnetic by an amount giving critical coupling.

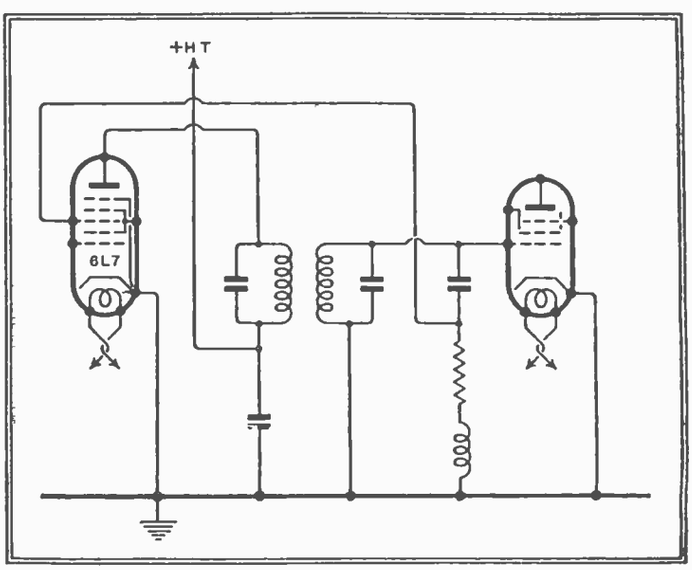

Fig. 4.—The simplest ASC circuit does not require any additional valve, for one IF valve is used to give control as well as amplification.

Variable Coupling

The last system to be discussed is one which has proved most useful—electronic variation of coupling. In this system, which is shown in Fig. 3, the number of auxiliary tubes is reduced to one per stage, while it becomes possible in certain variations to use the amplifying valve also as the control valve. Another advantage is that the coupling control valve may be used either to increase or decrease the effective coupling, depending on the polarity of the transformer. The network adopted is similar to that shown in Fig. 1 (b). With the coupling-control valve biased to cut-off, the transformer coupling is adjusted for the maximum desired selectivity. Then, as the grid of the coupling valve is made more positive, the selectivity curve broadens, finally becoming double peaked, just as though the two coils had been moved together physically. The gain decreases with band-width, just as in the better transformers with variable coupling. This helps the AVC system, as it assists in holding down strong local signals.

If one winding of the transformer in Fig. 3 is reversed, the coupling may be adjusted for the maximum desired band-width with its control valve biased to cut-off. In this case, a negative control voltage may be used, as the control valve is

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American ASC Circuits—

cut off on strong signals. As the signal strength decreases, the grid of the control valve becomes more positive with an increase in mutual conductance, which decreases the band-width while increasing gain. The circuit will oscillate if the mutual conductance of the control valve becomes too great, thus limiting its usefulness.

If a simple way to limit the gain of the feed-back valve could be worked out, it is possible that this circuit would become the most desirable of the group, because of the fact that the weak signal selectivity may be much greater than that warranted by the transformer Q. Also, the gain is increased beyond the normal value, and is maximum where most desired. This circuit is readily adaptable for use with a single amplifying-control valve as shown in Fig. 4, which is certainly a minimum, when three valves were considered necessary only a short time ago.

DISTANT RECEPTION NOTES

SINCE my last notes were written Radio Verdad, the alleged 50-kilowatt transmitter situated at Salamanca and operated by General Franco's people, has become more and more enterprising in the matter of grabbing wavelengths. It was at first heard on wavelengths below 300 metres, elbowing its way in where it could. Now it is reported on 304.3 metres, 368.6 metres, 420.8 metres and 491.8 metres, using sometimes one of these wavelengths, sometimes another.

A study of the wavelength lists shows that these channels are respectively those belonging to Genoa, Milan No. 1, Rome No. 1 and Florence. All of these, it will be noted, are Italian stations, and all the channels with one exception are Italian "exclusives." That of 304.3 metres is shared by Torun.

Recently the station has been on the air nightly at a little before eight o'clock and for some time after eleven o'clock. News is given in Spanish, and, I believe, sometimes in other languages as well.

When I have heard Radio Verdad it has usually come into action after the Italian station whose wavelength it is borrowing has announced an interval in its programme.

For this reason some have doubted whether Radio Verdad really exists, suggesting that the transmissions come actually from the Italian station which has announced a temporary closing down. I believe, though, that Radio Verdad is a genuine station at Salamanca. Its existence in that town is often referred to in Government newspapers.

Recently I mentioned that the Federal Communications Commission's response to those stations which had applied for leave to increase their output power to 500 kilowatts had been held up for a goodish time. I now hear from America that the Commission's report is ready. A very thorough investigation has been made and it is likely that something like a dozen stations will shortly receive provisional permission to carry out the desired increases in their power.

The allotment will most likely be made so that each of the big broadcasting chains has its fair share of high-powered stations. Thus among the probables for power increase are WGY and WHO of the National Broadcasting Company's Red Network, WJZ and KDKA of its Blue Network, WHAS of the Columbia Broadcasting System, and WOR of the Mutual Broadcasting System.

Some readers are probably a little hazy about the way in which the U.S.A. broadcasting systems are arranged. There are three mains systems, N.B.C., Columbia and Mutual, the first of these being divided into two networks, the Red and the Blue. In addition there are many smaller systems, such as Yankee, Inter-City and so on.

Each network has a number of "key" stations, from whose studios the greater part of the chain programmes is sent out. Of the members of any particular network the "basic" stations take all the sponsored programmes, filling in most or all of the rest of their time with locally produced items. "Optional" and certain other stations can be included in a sponsored broadcast when those who provide it desire this to be done.

Here are some of the best known U.S.A. stations in the networks to which they belong.

Columbia B.S.—WHAS, WBBM, WCAU, KMOK, WJR.

Mutual B.S.—WOR, WGN, WLW.

National B.C.—Red Network: WEAF, WGY, WTIC, WTAM, WMAQ. Blue Network: WJZ, KDKA, WBZ, WBAL, WLS.

Those who want the full lists will find them in the March issue of the American Radio News.

D. EXER.

CAR RADIO: AMERICA'S LATEST STYLE.—This versatile receiver, which operates either from the mains or a car battery, can be used either at home or in the car. A vibratory step-up generator supplies HT when the set is fed from a low-voltage source. The container is contoured to fit the cushions of the car.

SCOTT RECEIVERS

Arrangements for Manufacture in this Country

A LICENCE has been granted to Anson Radio, Ltd., a subsidiary company of Henry Anson, Ltd., for the manufacture of an English version of the Scott receiver. This will follow closely the American design, but will incorporate detail modifications which have been found desirable for the European market. In many of the complete instruments which are in course of preparation the Anson record-changer will be incorporated, and prices will range approximately from £150 to £550.

It has been decided to issue each receiver with a five years' unconditional guarantee covering all associated parts with the exception of valves. Sets will be under seal, and installation and servicing will be carried out entirely by the factory staff.

Showrooms have been acquired in Bond Street and will be furnished so that the performance of the instruments may be judged under conditions similar to those under which they will subsequently be used.

Television Programmes

Transmission times are from 3-4 and 9-10 daily.

Vision	Sound
45 Mc/s.	41.5 Mc/s.

FRIDAY, MARCH 26th.

3, Angus Morrison (piano) and the Television Orchestra. **3.20,** Friends from the Zoo. **3.35,** "Everyman": a masque.

9, Leon Goossens (oboe) and the Television Orchestra. **9.20,** Repetition of 3.20 and 3.35 programmes.

SATURDAY, MARCH 27th.

3, Boxing: a black and white demonstration. **3.15,** British Movietonews. **3.25,** In Your Garden: pruning roses. **3.40,** "The Court at Esterház."

9, Repetition of 3 programme. **9.15,** Gaumont-British News. **9.25,** Repetition of 3.25 and 3.40 programmes.

MONDAY, MARCH 29th.

3, O.B. from the Alexandra Palace fair ground. **3.15,** British Movietonews. **3.25,** Old-Time Music Hall.

9, Starlight. **9.10,** Gaumont-British News. **9.20,** Repetition of 3.25 programme. **9.55,** If technically possible, a view of the firework display at the Alexandra Palace.

TUESDAY, MARCH 30th.

3, Golfers in action—II. A. H. Padgham, open champion. **3.15,** Gaumont-British News. **3.25,** Ballroom dancing demonstrated by Alex Moore and Pat Kilpatrick. **3.40,** Film. **3.50,** Charlie Kunz at the piano.

9, Anthony Pini ('cello) and the Television Orchestra. **9.20,** British Movietonews. **9.30,** To the South Pole: programme commemorating the 25th anniversary of Captain Scott's death, with extracts from the film, "With Captain Scott to the South Pole."

WEDNESDAY, MARCH 31st.

3, The Southern Sisters in close harmony. **3.10,** Scott Gordon's Marionettes. **3.20,** British Movietonews. **3.30,** Forty-first Picture Page.

9, Lorna Tarbat (songs) with Joan Stevenson (piano). **9.10,** Repetition of 3.10 programme. **9.20,** Gaumont-British News. **9.30,** Forty-second Picture Page.

THURSDAY, APRIL 1st.

3, Scenes from Shakespeare. **3.15,** Masks through the Ages: first of series of four talks. **3.30,** Gaumont-British News. **3.40,** April the First: a crazy cabaret.

9, Scenes from Shakespeare. **9.15,** Repetition of 3.15 programme. **9.30,** British Movietonews. **9.40,** April the First: another crazy cabaret.

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The Deflection Amplifier

A RIVAL TO THE VALVE?

By E. P. RUDKIN

THE operation of the existing thermionic valve depends fundamentally on the intensity modulation of electronic discharge in a vacuum. While this system of obtaining amplification works satisfactorily in practice, it has numerous disadvantages such as lack of linearity of control characteristics, limited mutual conductance for a given internal impedance, and considerable interelectrode capacities. In addition, space-charge effects are troublesome in limiting anode current with given electrode potentials.

THE author states the case for a method of amplification differing fundamentally from that ordinarily carried out by means of the thermionic valve. The system that he describes depends for its operation on the deflection of a cathode beam, and not on the intensity control of a cathode-anode electron stream.

The purpose of this article is to describe a fundamentally different system of amplification which is largely free of these disadvantages. This system utilises the principle of position or deflection modulation of electron discharges or beams, and is essentially an arrangement wherein the voltages to be amplified are caused to control the position of an electron beam, which is directed against a collector plate or anode. The amplified voltages are developed across a load impedance connected to the anode. Furthermore, it is especially advantageous to combine deflection and intensity modulated amplification, the two processes being combined in the correct phase relationship. For instance, multiple amplification effects are obtained by using deflection control for direct amplification, and intensity control for the purpose of obtaining regeneration.

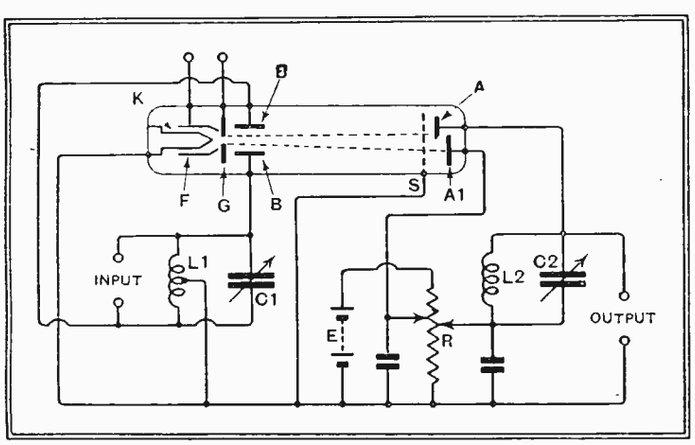


Fig. 1.—The simplest deflection valve circuit, as arranged for RF amplification.

The simplest type of deflection valve, shown diagrammatically in Fig. 1, comprises a cathode-ray tube arrangement. An electron beam, indicated by the dotted lines, is produced by means of a gun G, cathode K, and shield F. A fairly high voltage is applied to the gun, while an adjustable negative potential (say 0-20 volts) is impressed on the shield for focusing; the tube is of the gas-focused type. The shield aperture is rectangular in shape so that a beam of rectangular cross-section is produced; this beam is directed, as shown, against the edge of the target or collector plate A. The deflector plates B, designed to deflect the beam at right angles to the direction of propagation, are arranged on opposite sides of the beam adjacent to the gun. These plates are connected to opposite ends of the tube input circuit L1, C1, the centre point of L1 being connected to cathode, thus forming a push-pull circuit. A tuned output circuit L2, C2, is connected to the collector plate, which has a positive potential applied to it from the battery E and adjustable potentiometer R.

In operation, the input voltages are developed across the dynamic resistance of the tuned circuit L1, C1, and applied in phase reversal to the deflector plates B, so that the deflecting action of both plates is combined. This causes the position of the beam to vibrate or fluctuate in a direction at right angles to its direction of propagation, the frequency and amplitude of the movement corresponding to the input voltages. Now, the action of the electron beam in bombarding the collector A is to produce an "anode" current, the magnitude of which depends on the fraction of the beam cross-section impinging on, or overlapping, the plate. Hence it is clear that the fluctuation in position of the beam produced by the input voltages causes variations in plate current; these variations are, in effect, an amplified replica of the input voltages, and they produce corresponding voltages across the dynamic resistance of the tuned output circuit L2, C2.

The fundamental action of the deflection amplifier may perhaps be more clearly described by referring to Fig. 2, which illustrates the characteristic of the arrangement, and, in addition, shows the position of the beam corresponding to several values of deflector-plate voltage. In the characteristic shown in Fig. 2*a* the horizontal axis represents the voltage of one deflector plate (in this case the left-hand one), and the vertical axis represents the "anode" current. When a fairly large positive voltage represented by AO is applied to the left-hand deflector plate, the

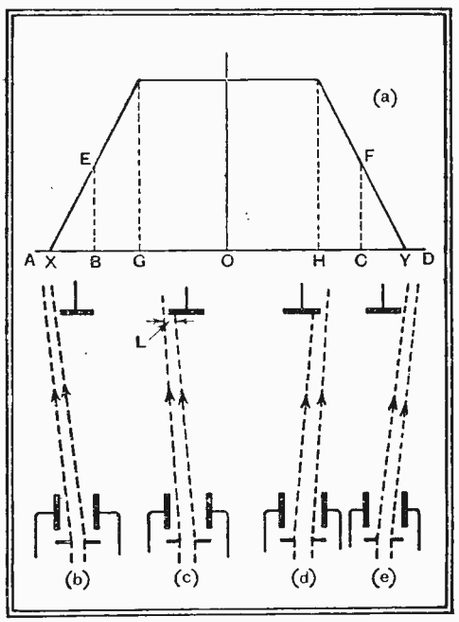


Fig. 2.—Illustrating the operation of the deflection valve.

position of the beam is such as to miss the collector entirely, as shown in Fig. 2*b*. Consequently, the collector-plate current is zero. If the voltage on the deflector plate be now reduced to OB (Fig. 2*a*), the beam takes up the position shown in Fig. 2*c*, and half its cross-section overlaps the plate. In this case the collector-plate current is equal to half the beam current, and is represented in the characteristic by the ordinate EB. As the voltage on the left-hand deflector plate is further reduced until it reaches a negative value numerically equal to the initial positive value, the beam passes over the surface of the collector plate and through the positions shown in Fig. 2*d* and *e* respectively. For values of deflector-plate voltage causing

www.americanradiohistory.com

The Deflection Amplifier—

the beam to impinge entirely on the collector, the characteristic is horizontal, but as soon as the beam reaches the edge of the plate the collector current commences to fall uniformly, as indicated by the sloping part of the characteristic, and passes through F until the current is again zero (Fig. 2*e*).

It will be seen that the sloping portions of the characteristic are linear, this being due to the fact that the angle through which the beam passes is small; for the sake of clearness this angle has been exaggerated in the drawings. The linearity of control characteristics exhibited by the deflection amplifier is a very pronounced advantage; it will amplify without distortion provided the operating point is correct and that the input voltage does not exceed the value represented by XG or HY in Fig. 2*a*. The correct initial operating point is clearly either E or F, either of which can be used by suitably adjusting deflector-plate bias. In the case of gas-focused tubes, bias should also be such as to avoid origin distortion. If the operating point be either X or Y, the arrangement acts as a distortionless anode-bend rectifier provided the input is limited so that the horizontal portion of the characteristic is not encroached upon.

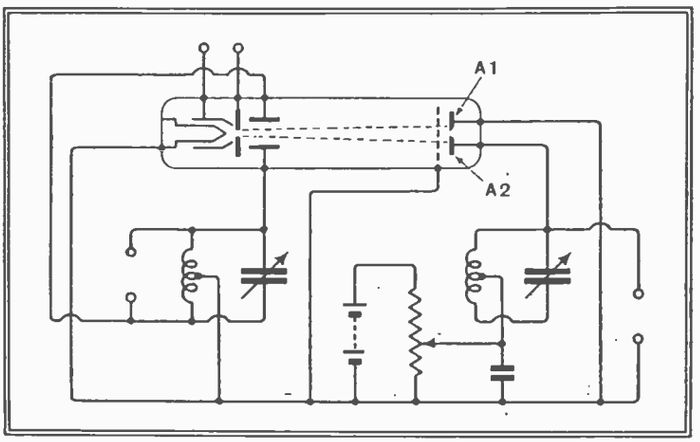


Fig. 3.—A double-anode tube working as a push-pull amplifier.

Factors Governing Amplification

The amplification obtainable from a deflection valve depends on the deflector plate-to-cathode impedance and on the effective mutual conductance, which corresponds to the slope of the characteristic. The mutual conductance depends on the deflection sensitivity, being, in fact, proportional thereto, and also on the shape of the beam. In order to obtain as large a value of mutual conductance as possible, it is necessary to focus the beam so that a maximum change in collector-plate current occurs for a given angular movement. This can be realised by focusing the beam to a wedge-shape, so that its depth in the plane of the collector and in the direction of its movement is as small as possible. This dimension is marked L in Fig. 2*c*, where it is exaggerated for the sake of clearness.

It is of interest to note that space-charge effects in a deflection amplifier, as shown in Fig. 1, are minimised by the action of the gun potential. Further, owing to the high velocity of the electrons bombarding the plate A, secondary emission is produced. As the direction of movement of the secondary electrons is governed by the charge existing at the surface at which they are liberated, it follows that, unless a large value of HT voltage be applied to the collector plate, a considerable proportion of the secondary electrons will be attracted towards the gun, and would, in effect, constitute a return-ray current. This would reduce the amplifying power of the system.

In order to eliminate this secondary emission effect so far as possible, it is necessary to screen the anode from the influence of the gun potential. This can be effected by the inclusion of an electrostatic screen or "suppressor" electrode placed between the gun and the deflector plate. This electrode is marked S in Fig. 1; it should consist of gauze of fairly wide mesh in order to minimise defocusing of the beam. The screen is connected electrically to the cathode. In order to reduce secondary emission effects still further, the collector should be constructed of a metal which is a poor emitter of secondary electrons.

Another point of considerable importance in the working of a deflection amplifier is that matters should be arranged so that the voltage applied to the collector plate does not reduce the deflection sensitivity. In order to ensure this, the direction of equi-potential lines existing in the region of the collector plate should be identical with the direction and movement of the beam; that is, at right angles to its direction of propagation. This condition is satisfied by applying a positive voltage to an auxiliary collector plate or anode A1, arranged immediately behind the main anode A (Fig. 1). This auxiliary anode is earthed with respect to signal-frequency currents through a condenser, and the voltage applied to it may be adjusted to the correct value by a second slider on the potentiometer R, so that the equi-potential lines of force are produced in the required direction. By these means it is possible to apply a medium potential to the collector plate, thereby increasing the beam current without adversely affecting the deflection sensitivity. Even with this precaution, however, it is undesirable to employ an excessive value of collector-plate potential, since this tends to constrain the beam to the surface of the plate and also to upset the focusing.

As an alternative to the use of a single collector plate or anode, two such plates may be worked in push-pull, with the advantage that an auxiliary collector plate becomes unnecessary. Fig. 3 shows this arrangement, the two anodes A1 and A2 being arranged adjacently and in the same plane. If positive and negative voltages be applied to the upper and lower deflector plates respectively, the beam moves upwards so that the current flowing in the A1 circuit increases and that flowing in the A2 circuit decreases correspondingly. Downward movement of the beam produces opposite changes, so that the whole arrangement constitutes an amplifier, the input and output electrodes of which work in phase reversal or push-pull. The width of the beam, and therefore the amplification of the system, is controllable by adjustment of the shield potential, which gives a "variable-mu" effect. The negative bias applied to the shield should not be reduced so far as to cause the beam to make contact with the deflector plate, since this would set up deflector-plate current and heavily damp the input circuit.

Short-wave Working

Provided this condition is observed, the damping thrown on the input circuit is small or zero. The internal impedance of the deflection amplifier is high, so that there is little damping on the tuned output circuit. The deflection valve should therefore be applicable to ultra-short wave amplification, since the dynamic resistances of the tuned circuit are not materially reduced by the valve. Another very pronounced advantage in ultra-short wave work is that the change in collector current corresponding to a change in deflector-plate voltage is practically instantaneous; regeneration effect can be satisfactorily obtained even with very high frequencies by direct back-coupling of the collector plate to the deflector plate, working in the same phase. Thus, by employing a sufficient value of back-coupling to produce self-oscillation, the deflector valve has application as a generator of ultra-high frequencies, and such an arrangement is shown in Fig. 4.

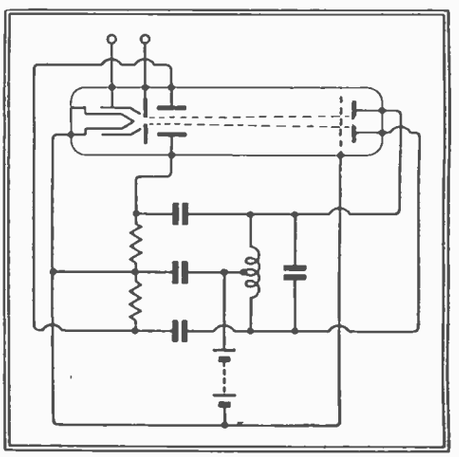


Fig. 4.—The deflection valve as a generator of oscillations.

www.americanradiohistory.com

The Deflection Amplifier—

It has been pointed out that considerable advantages attach to combining intensity and deflection amplification in the correct phase relationship, and that multiplied amplification effects can be secured by using deflection control for direct amplification, the amplified voltages being fed back to suitable electrodes so as to produce regeneration by intensity control. It is difficult, however, to apply intensity modulation satisfactorily to a gas-focused tube, since this is accompanied by defocusing; hence systems employing combined intensity and deflection control are confined to high-vacuum tubes, wherein focusing is effected by means of several guns arranged to form an electron "lens." An arrangement of this type is shown in Fig. 5.

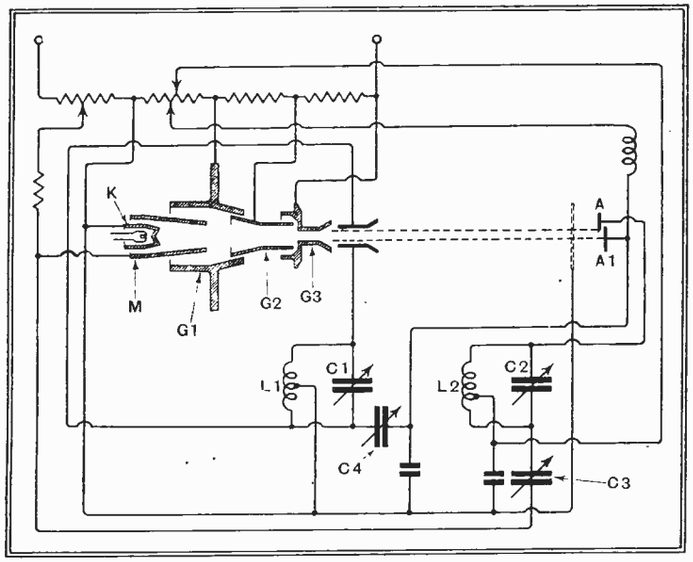


Fig. 5.—Another type of tube, with electron "lens" focusing, working in a circuit giving both deflection amplification and regeneration by intensity control.

In this arrangement focusing is effected by three specially arranged guns G1, G2, G3, of which G1 and G2 are electrodes tapered as shown and having rectangular cross-sections throughout. The third gun, G3, is also of rectangular cross-section, and is specially shaped to form the final section of the electron lens. The lower portion of this electrode overlaps the upper part of the second gun G2. Successively larger values of high-tension voltage are applied from a potential divider of G1, G2, and G3 respectively. The cathode K is indirectly heated, and between this and the first gun G1 is located the intensity modulated electrode M, which has a conical shape. The remainder of the electrodes comprise the main and auxiliary collector plates at the far end of the tube, the deflector plates, and the suppressor electrodes.

Deflection Amplification *plus* Reaction

In operation, deflection amplification takes place on the main anode, as described with reference to Fig. 1. The amplified voltages are developed across the tuned output circuit L2, C2, and a fraction of these voltages is reversed in phase by the action of the intermediate tapping on the inductance L2 and fed back to the intensity-modulated electrode M through the adjustable condenser C3. The voltages appearing at the electrode M are thus in the correct phase for reinforcing by intensity control the changes in plate current produced by deflection control. In addition, regeneration is obtained on the tuned output circuit. If C3 be sufficiently increased, self-oscillation of the system can be produced.

In addition to obtaining regeneration by intensity control, as described, it is also advantageous to incorporate deflection regeneration, since the two effects are substantially independent in adjustment. In Fig. 5 the auxiliary anode A1 is back-coupled in the correct phase through the adjustable condenser C4 to the input circuit, so that regeneration is obtained through the action of deflection control, and this may be adjusted independently of the intensity regeneration to enable still greater amplification to be obtained.

A reasonable value for the deflection sensitivity of an arrangement as in Fig. 3 is $\frac{1}{2}$ mm. per volt. Hence, if the width of the beam in the plane of the anode be adjusted by the potentials applied to the guns to a value of 0.005 cm., and the beam current be 400 microamperes, then the effective mutual conductance of the arrangement works out at 4 mA per volt. It is seen, however, that the grid swing is limited to 0.1 volt before the beam is discharging wholly through the deflector plate or output circuit. The mean internal resistance from plate to cathode would be high, however, and, assuming this to be of the order of $\frac{1}{2}$ megohm, then the amplification factor is 2,000. Furthermore, it is possible to increase this amplification by at least 100 times by regeneration, so the effective amplification factor reaches the value of 2×10^5. Hence, in any case, only very small inputs are needed to produce full output. The maximum output, incidentally, is determined by the value of the beam current, in this case 400 microamperes. This value, however, is very conservative, and it should be possible to obtain a discharge current of the order of 2 mA by suitably adjusting the voltages supplied without unduly affecting the deflection sensitivity; in this case the amplification is raised to 10^6, and the power-handling capacity is increased by five times.

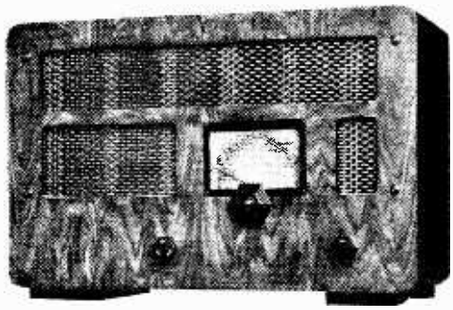
While it has not been possible to deal with all the possible types of deflection valves, sufficient has been said to indicate that, in its capacity as amplifier, rectifier, and generator, the deflection-control discharge tube may find as universal application as the thermionic valve, and may even supersede it. It is probable, however, that the first development will be in the direction of combined intensity and deflection control to the existing type of valve; later, the more advanced type of deflection valve may be expected to make its appearance.

New Marconiphone Models

THREE additions have recently been made to the current list of Marconiphone instruments. In the latest 557 table-model superheterodyne and its radiogramophone equivalent (Model 567) a new design of elliptical loud speaker has been adopted with a major axis of 10in. and progressive stiffening of the cone material towards the centre to ensure a good high-frequency response.

The tuning scale is of the rectangular type and special attention has been given to the clear calibration of the short-wave range. The waveband to which the set is tuned is indicated in a small aperture near the bottom of the scale. In the radiogramophone a squirrel cage induction type motor is employed, and the tuning scale is mounted on the front panel instead of under the lid as has been the practice in previous Marconiphone instruments.

The chassis used in both these models is a superheterodyne designed to work from AC mains, and the circuit comprises an RF pentode amplifier feeding a triode hexode frequency-changer which is coupled through an iron-cored transformer to the IF amplifier. This in turn is followed by a double-diode-triode second detector and a pentode output valve delivering three watts undistorted to the loud speaker. The waveranges are as follows: Short, 16.5-52 metres; Medium, 195-580 metres; Long, 725-2,000 metres; and the prices are: Model 557, 12 gns.; Model 567, 22 gns.



Marconiphone 314 battery receiver with automatic tone compensation.

The remaining set in the new series is a three-valve battery receiver, Model 314. The price, with full equipment including batteries, is 7½ guineas, and there are two waveranges (170-580 metres and 800-2,000 metres) with a full vision tuning scale incorporating station names.

An interesting feature of the circuit is the provision of automatic tone correction in the coupling between the detector and output pentode valve to compensate for change of quality resulting from the use of reaction. There is provision for the attachment of a gramophone pick-up for which an external volume control is necessary.

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UNBIASED

By FREE GRID

Micrometric Wavelengths

IN spite of the provision of free education, night schools and post-graduate courses at our great universities, the degree of ignorance that exists among the populace is truly astounding. A prominent figure in the scholastic world with whom I was discussing this matter the other day blamed it on to the B.B.C., whose well-known historical burlesques are accepted by the public with child-like faith at their face value.

In any case, whatever be the cause of this ignorance, there is no gainsaying the fact of its existence, and so I ought not, perhaps, to have been surprised at the astonishing display of it which appeared recently in the staid and respectable columns of a certain newspaper which usually prides itself on its accuracy. In the "radio corner" of the journal concerned, the question was raised as to what was the shortest wireless wavelength in commercial use.

The newspaper's radio correspondent rightly dismissed as absurd the suggestion that the place of honour was held by the ultra-short wave television transmissions from the Alexandra Palace, but having done this he dropped an equally heavy brick by stating that the 17 cm. wavelength used in the cross-Channel telephony service between Lympne and St. Inglevert was the shortest in actual use, although, he added, even shorter wavelengths of the

Strictly speaking, not wireless.

order of a few millimetres were the subject of laboratory experiment.

I am not, of course, attempting to deny that learned laboratricians may be engaged in researching into wavelengths of this order, but what I object to is the entirely misleading statement that 17 cm. is the shortest wavelength in actual commercial use. Wavelengths of the order of 10 *milli*millimetres have been used and are still being used, not only for telegraphy but for telephony also, although I am perfectly willing to admit that at present *telephony* on these wavelengths is still confined to the laboratory, there being, as far as I am aware, no commercial service on them at the moment.

To those who would retort that, strictly speaking, these wavelengths are not wireless ones, I would reply that in actual fact there are far less wires used in their propagation and reception than in the case of "ordinary" wavelengths. They are as fully entitled to the terms "wireless," "radio," "electro-magnetic," "etheric," or any similar appellation as are those ordinarily used by the B.B.C.

The Coronation Portable

I SUPPOSE that, like myself, a good many of you have made up your mind to see the Coronation Procession, and, again like myself, are far too heavily involved with ordinary domestic financial commitments to be able to spare the price of a seat among the bookmakers and other oppressors of poor people like you and me, who are to loll in lordly state and be provided with free beer and all the other amenities of life at our expense. For, after all, it is *our* money which provides the luxuries of life for the bookmakers.

However, as the Editor has just reminded me, this has nothing to do with wireless, although, if he were more familiar with the machinations of the tic-tac men he might revise his opinion. What I really wanted to talk to you about was the arrangements made for broadcasting the Coronation ceremony. For those who are going to listen-in at home everything in the garden will be lovely, as it will in the case of the plutocrats in the Grand stand who are to have wireless reproduction chucked in. The only people who will be left in the cold will, as usual, be myself and many thousands of my fellow-creatures who intend to stand on the kerb-side to see the procession.

It is true that there is some talk of providing loud speakers along the route so that we can hear the ceremony, but even if this idea is carried out—which I very greatly doubt—there will be many points where people will be just out of earshot of a loud speaker or, worse still, in a spot where there is bad fading due to interaction between the direct ray of the loud speaker and the indirect ray reflected from some building.

The only way to get over the difficulty will be for everybody to provide themselves with a small headphone portable, and I am at the moment actively engaged in designing one for you which will be as small and as light as possible. As it will be used within twenty miles of Brookmans Park such fripperies as HF stages and super-regeneration can, thank goodness, be dispensed with, thus greatly simplifying matters.

With regard to the question of portability, this is of paramount importance, and, in my opinion, in order to achieve this there is only one possible form of construction, and that is to build the whole outfit into one of the neat leather

A small headphone portable.

cases intended to contain the flat type of folding camera and to be slung over the shoulder with a leather strap. This leaves the hands completely free for messing about with binoculars, periscopes, light refreshments and other impedimenta without interrupting the programme.

I intend to put the whole of the works, batteries and all, into one of these cases. The self-contained frame aerial will be quite big enough to pick up Brookmans Park, but in order to increase the input and to get rid of any unwanted directional effects, I am arranging to connect the 'phone leads via a small fixed condenser to the aerial terminal, thus making them serve a double purpose. With regard to the 'phones, they will be of the super-miniature deaf-aid type which are hooked round the ear with a piece of wire. Thus they will easily pack away inside the set when not in use.

As a matter of fact, such a set will do far more than enable the Coronation ceremony to be heard, as it will while away the weary hours of waiting, for I understand that the B.B.C. is to start transmitting at a very early hour of the morning. Don't forget, however, to shove at least half a dozen spare ear-pieces in your pocket for the benefit of the unwise virgins and the other improvident type of people who haven't bothered about bringing a set of their own. The deaf-aid 'phones which I have mentioned are extremely pocketable, each ear-piece being not much larger than a cherry.

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Current Topics

A Petition to the B.B.C.

NOTTINGHAM, which has more wireless licences than any other town of its size in the country, has recently been promised that a *real* broadcasting studio will be established there by the B.B.C. This is not sufficient, however, to fulfil the desires of the townsfolk, and a petition is reported to be in course of preparation asking the B.B.C. to set up a television transmitter somewhere in the neighbourhood.

Educating the Broadcast Aspirant

NO fewer than 200 American centres of learning, such as the Universities, devote special attention to giving courses to those who intend to earn their living in the world of broadcasting. Apart from radio engineering courses, it is possible to learn everything about announcing, programme directing and continuity writing.

Wireless in Italian Schools

GREAT progress is being made in the introduction of broadcast lessons into Italian schools. The school wireless installations already completed make provision for teaching nearly two million children, and the work of equipping the remaining schools is being rapidly speeded up.

Causes of Receiver Breakdowns

AN illuminating survey has just been made by a group of American servicemen as to the most frequent causes of breakdowns in sets. Excluding valve faults, by-pass condensers head the list as being responsible for 29 per cent. of the trouble. Resistances come next with 22 per cent. Rather surprisingly, volume and tone controls cause only 14 per cent. of the breakdowns.

A Wireless Tax?

THERE are many rumours in the air at the present time concerning the possibility of a broadcasting tax being introduced in the Budget on April 20th. Some state that a tax will be imposed on sets, while others say that it will take the form of an increase in the cost of the wireless licence. Quite probably there is no truth in any of the rumours, but over in the U.S.A. things are in a far more advanced state. The authorities of Oklahoma City have decided that it is high time that a municipal luxury tax should be put on wireless sets.

Wireless and Weather

THE old canard that wireless is responsible for wet weather has raised its head once more as the result of the excessive rainfall experienced lately not only in this country but over most of the Northern Hemisphere. In answer to this the Abbé Moreux, who is director of Bourges Observatory, states that, so far as Western Europe is concerned, the climate has not changed appreciably for a thousand years. For several centuries past there have been alternating cycles of drought and excessive humidity, and the present wet weather is merely part of a humid cycle which began in 1935 and will not end until 1952.

German Interference in Uruguay

COMPLAINTS are being made in Montevideo that the German short-wave stations are causing interference with transmissions from the U.S.A. to which the Uruguayans prefer to listen. Uruguay is said to possess the distinction that the bulk of the wireless receivers which the inhabitants use are of the short-wave type. Apart from the desire to listen to American programmes, there is another thing which accounts for the large number of short-wave sets in use, and that is the fact that Spanish is the official language of the whole of South and Central America, with the exception of Brazil, and those who desire to listen to programmes in such places as Valparaiso and other distant cities are compelled to rely upon short waves.

TELEVISION AND THE CORONATION. Although there will be no television of the actual ceremony, hopes are entertained that parts of the procession may be transmitted. To be prepared for any decision a recently completed stand at Libertys, Regent Street, on the route has had installed a receiver at a convenient spot in rear of the seats.

CATHODE-RAY EQUIPMENT

NEXT week's issue will contain technical details of cathode-ray tubes, tube bases, and a number of special articles on their applications to television and other purposes.

Here Comes the Bride

LAST Saturday a wedding ceremony held at All Souls', Langham Place, which adjoins Broadcasting House, was recorded by Disc Recording, Ltd., of Richmond, Surrey. The speeches at the subsequent reception were also recorded. A complete mobile recording studio is now available for such functions, the total cost being 8s. 6d. for a 10-inch record and 10s. 6d. for a 12-inch one, plus 1s. 6d. per mile to cover the running costs of the van. The minimum charge is two guineas. A matrix can be prepared from which any number of gramophone records of the ordinary type can be pressed.

A Novel Defence

IN a recent case where the owner of a stationery shop was accused of an offence against the Danish Broadcasting Act by operating a receiving station without a licence, he pleaded justification on the grounds that the Post Office authorities were guilty of infringing another section of the same Act which forbids broadcast advertising. The Post Office authorities, said the defendant, by continually using the microphone to advertise their "greeting" telegrams, were undermining his business in birthday and similar cards. It was, he added, as a protest against this that he had refused to take out a licence. The magistrate was sufficiently impressed to inflict a relatively small penalty and give him leave to appeal to the High Court.

Radio Sightseers

IT is said that Radio City, New York, nowadays attracts a larger number of visitors than any other of the famous sights of the world. Even the Statue of Liberty and the Empire State Building, which have in their time each held the record, have been easily surpassed. Well over half a million people visited the City in 1936, and this year this number is likely to be greatly exceeded.

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Listeners' Guide for

Outstanding Broadcasts at Home and Abroad

AS is to be expected the programmes for Good Friday are of a rather subdued nature. At 10.55 a.m. a service from St. Nicholas' Church, Bristol, will be broadcast by both National and Regional transmitters, at which the Bishop of Bristol, the Rt. Rev. C. S. Woodward, will be the preacher. In the evening, at 6.30 (Nat.) the Archbishop of Canterbury will give the address during the service from St. Sepulchre's Church, Holborn. The music of Wagner's "Parsifal" will be relayed from the Queen's Hall in the National programme at 7.30. The B.B.C. Symphony Orchestra, the B.B.C. Singers and the Philharmonic Choir under the direction of Sir Henry J. Wood will be taking part, the soloists being Muriel Brunskill, Walter Widdop, Victor Harding, Norman Walker, Roy Henderson, and Foster Richardson. This broadcast ends at 10.15, when all B.B.C. transmitters will close down.

On Easter Sunday, services in the morning and in the evening come from cathedrals, the first being from Liverpool at 11 (Nat. and Reg.), and the second from Ripon at 7.55 (Nat.). On both occasions the Bishop of the respective diocese will give the address. The organ of Liverpool cathedral will also be heard in the afternoon, when Reginald Goss-Custard gives a programme of Easter music.

IN THE COURTYARD of Popoff's house, a scene during the stage production of Oscar Strauss' "The Chocolate Soldier" which listeners are to hear this week.

EASTER MONDAY

THREE sporting O.B.s come into Monday's National and Regional programmes. The first at 2.15, when John Snagge, in the launch *Magician*, gives a running commentary on the World Sculling Championship race to be rowed from Putney to Mortlake. This race should furnish excellent material for a running commentary. The contestants are usually evenly matched, and hence a ding-dong struggle results over the whole course. They are this year Eric Phelps, the champion, and Lou Barry.

At 3.30 Regional listeners will be switched over to the Brooklands Motor Track, where a commentary on the race for the Broadcast Trophy will be given. Then at 3.55 the switch will go over to Swansea, where the second half of the Rugger tussle between Swansea and the Barbarians on the St. Helen's ground will be commented upon.

ANOTHER HILTON PLAY

JAMES HILTON'S "Goodbye, Mr. Chips" and "Lost Horizon" were very excellent broadcasts, although of vastly different types. Listeners are now to hear another of his plays, "And Now Goodbye." This will be heard on Monday at 9 (Reg.) and Tuesday at 8 (Nat.). It has been adapted for radio by the author and Barbara Burnham. The story revolves around a harassed clergyman who makes his one excursion into romance. Listeners are warned that it does not result in a happy ending.

THE MAIL COACH

WHILE delving for material during the preparation of the G.P.O. broadcast, George Wright and Felix Felton amassed many intriguing facts and illustrations of the early mail-coach days when His Majesty's mails were carried over the most incredible roads by coach and horses. The outcome of this is that Felix Felton is presenting a feature programme called "The Mail Coach" on Friday at 5 (Nat.), incorporating much of the interesting material thus gathered.

Felix Felton will take his listeners for a ride with the mails, the last part being accomplished in the most modern mechanical mail coach which now distributes the mails with record-making speed and punctuality.

"JULIUS CÆSAR"

LISTENERS have not heard this favourite of Shakespeare's historical plays since 1933. Peter Cresswell has assembled a cast of great interest for the broadcast which he is producing on Sunday at 5.15 (Nat.). The part of Capurnia, for example, will be taken by Vera Lennox. It has long been one of her ambitions to play a Shakespearean character, and Peter Cresswell having given her a special voice test for a role so different from her usual light comedy interpretations, was quickly satisfied as to her fitness for the part. Julius Cæsar will be played by Henry Caine, whose resonant voice should add to the personifying of the great Roman.

"THE CHOCOLATE SOLDIER"

THIS amusing musical play was so deservedly popular when broadcast in 1935 that Gordon McConnell has decided to revive his radio edition on Tuesday and Thursday at 8.45 (Reg.) and 7.45 (Nat.) respectively. It was adapted by Mr. McConnell from Stanislaus Stange's English version of the libretto by Adolph Bernauer and Leopold Jackson. The story is a gay, satirical affair of the Ruritanian order. Betty Huntley Wright is returning from Paris to take the rôle of Mascha. Anne Ziegler returns from pantomime to play the microphone part of Nadina Popoff, daughter of Colonel Popoff, the latter being played by Dick Francis. Horace Percival, who figured in the play on the West End stage, will again create for radio the part of Bumerli, Lieutenant in the Serbian Army.

The story opens in Nadina's sleeping apartment in Popoff's house, which is situated in a small town near the Dragoman Pass, Bulgaria, in November, 1885, while the remainder of the play takes place in the courtyard of the house.

FLYING HIGH

THE second edition of this variety programme put over by the Flying Services comes to National listeners at 8 on Monday. Charles Brewer, the indefatigable Squadron Adjutant of "Flying High," has had a bright idea. He has in-

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the Week

GEORGES CARPENTIER photographed soon after the Great War. He will be the French guest pilot at the "Flying High" show on Monday.

vited Georges Carpentier to come as the French guest pilot to this show. Most of us know him best because of his fame as a boxer, but during the Great War he was a pilot of Escadrilles M.F.8 and M.F.55. He is now proprietor of a fashionable bar in the shadow of the Arc de Triomphe, Paris. The cast are all ex-members of the R.F.C., R.N.A.S. or R.A.F., and the audience will consist of members of the Flying Services associations.

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APRIL FOOLS' DAY

THE charm of April the First has for long been apparent only to the schoolboy on mischief bent; but time was when the day captured the heart and the head of merry England and of every country in the Western world.

It was while writing his programme for Shrove Tuesday that Felix Felton decided that the folk festivals held on April 1st would provide musically and dramatically a broadcast of considerable appeal. Working on this idea, he has collected a number of documents setting forth the history of the day. On Thursday at 8 (Nat.) he is to broadcast this programme of cameos depicting the mode and manner in which April the First was wont to be celebrated in the countries of Europe.

MUSIC

ON Easter Sunday John Barbirolli will conduct the Sunday Orchestral Concert at 9.5 (Reg.). This will be his first appearance with the B.B.C. since his return from America. The programme will include an Oboe Concerto which Mr. Barbirolli has arranged from original music by Pergolesi; this will be played by Leon Goossens.

In commemoration of the 250th anniversary of Lully's death, his "Acis and Galatea" will be broadcast at 8 (Nat.) on Monday by the London Symphony Orchestra, under the direction of Constant Lambert. This broadcast is the central feature of this week's Special Recitals which are devoted to the music of Lully.

At the Royal Philharmonic Society's concert, which will be broadcast on Thursday at 8.15 (Reg.), Sir Thomas Beecham will conduct a new work by Ralph Vaughan Williams, specially written for the Coronation, entitled "Flourish for a Coronation."

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OPERA

THERE is a scarcity of this type of programme during the coming week. Perhaps the outstanding transmission of Good Friday, which brings works of a religious trend, is the 6-11 programme from Berlin (Funkstunde), it being a relay of the State Opera performance of Wagner's "Parsifal." This opera is regarded by everybody, whether Wagner lovers or otherwise, as the great composer's outstanding work. It is infinitely more suited to the atmosphere of a church than that of the Opera House. It was for this reason that Wagner would not agree to the performance of "Parsifal" away from Bayreuth. The music of this opera will be heard in the National programme on the same day from 7.30-10.15, relayed from the Queen's Hall.

To fit the day, Breslau, too, broadcasts an opera of a religious character at 5.15. It will be "Palestrina"—described by Pfitzner, its composer, as a musical legend—which deals with the mystic side of Church history of the mid-sixteenth century. Bucharest gives us the pleasure of a public performance, its 6.35 programme being a relay from the Royal Opera. Massenet's three-act "Werther," fills the bill on this occasion. This performance will be well worth hearing, and will be within reach of most receivers, as it is also taken by the powerful national transmitter Radio-Romania (Brasov).

Milan 1 has the most important transmission of this type in the Saturday programmes, with a relay at 8 from La Scala, Milan, of Puccini's much-debated "Girl of the Golden West." At its première in New York before the War American critics complained that Puccini failed to get the Wild West atmosphere, his music being much too civilised.

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PASSION MUSIC

FEATURING all the leading Swedish talent in the realm of classical music, Bach's St. Matthew Passion will be broadcast in full on Good Friday at 6.30 from the Engelbrekts Church, Stockholm, by all Swedish stations. The part of Our Lord will be sung by Sigurd Björling, of the famous family of operatic stars, which can boast three brothers who rank high in the world of soloists.

Bach's St. John Passion will be heard on Good Friday from Strasbourg at 4.30, relayed from St. Guillaume's Church, and again at 8.45 from Radio-Paris, sung by the Rauget choir.

THE AUDITOR.

HIGHLIGHTS OF THE WEEK

FRIDAY, MARCH 26th.

Nat., 5, Mail Coach: feature programme. 6.30, The Archbishop of Canterbury. 7.30, "Parsifal."
Reg., 7.30, Dorothy Hogben's Singers and Players. 8.45, B.B.C. Military Band.
Abroad.
Vienna, 8.10, "Stabat Mater" (Haydn) by the Hofmusikkapelle.

SATURDAY, MARCH 27th.

Nat., 5.15, Lou Preager and his Band. 8, Music Hall. 9.55, The Theatre Orchestra and Frank Titterton.
Reg., 3.15, Saturday Contrasts: Fish Netting and Women's Hockey. 4, Lauri Wylie's "Wireless Puppets." 8.55, Acts II and III of "The Travelling Companion."
Abroad.
Leipzig, 7.10, "Love and Money": potpourri of opéra-comique music.

SUNDAY, MARCH 28th.

Nat., 4.30, Popular Swiss Songs from Geneva. 5.15, Julius Caesar.
Reg., 5, "The Table Under the Tree." ¶Hero and Heroine: duets from famous operas. 9.5, Sunday Orchestral Concert.
Abroad.
Strasbourg, 8.15, Folk Music Soirée, including the folk songs of Lorraine.

MONDAY, MARCH 29th.

Nat., 2.15, Commentary on Sculling Championship. ¶The Music Shop—13. 8, "Flying High."
Reg., 3.30, Relay from Brooklands. 3.55, Swansea *v.* Barbarians: Rugger match at Swansea. 6.30, "Poland greets the Spring": relay from Warsaw. 7.30, Pianoforte recital by Mark Hambourg. 9, "And Now Goodbye."
Abroad.
Hamburg, 7, "Lehár in a Thousand Moods": orchestral programme.

TUESDAY, MARCH 30th.

Nat., 7.30, Van Phillips and his two Orchestras. 8, "And Now Goodbye."
Reg., 6.40, From the London Theatre. 8.45, "The Chocolate Soldier."
Abroad.
Deutschlandsender, 7.10, "Memories of the Ball," concert of old dance music.

WEDNESDAY, March 31st.

Nat., 5.15, Billy Cotton and his Band. 8, The B.B.C. Symphony Orchestra at Usher Hall, Edinburgh.
Reg., 7.30, Pianoforte recital; Eileen Joyce. ¶Variety from the Grand Theatre, Doncaster. 8.45, Stock Exchange Male Voice Choir.
Abroad.
Strasbourg, 8.30, Symphony Concert from the Théâtre des Champs-Elysées, Paris.

THURSDAY, APRIL 1st.

Nat., 5.15, B.B.C. Dance Orchestra. ¶Organ Recital: Günther Ramin. 7.45, "The Chocolate Soldier."
Reg., 6, The Folkestone Municipal Orchestra. 8, April Fools' Day. 8.15, The Royal Philharmonic Society's Concert.
Abroad.
Kalundborg, 7, The Young Musicians Society's Concert from the Odd Fellows Palace.

"... here comes Charlie Kunz." This wizard of the piano will be heard in Music Hall and seen by viewers on Tuesday. This week's Music Hall bill also includes Elsie and Doris Waters; the Western Brothers; Clapham and Dwyer; and Alexander and Mose.

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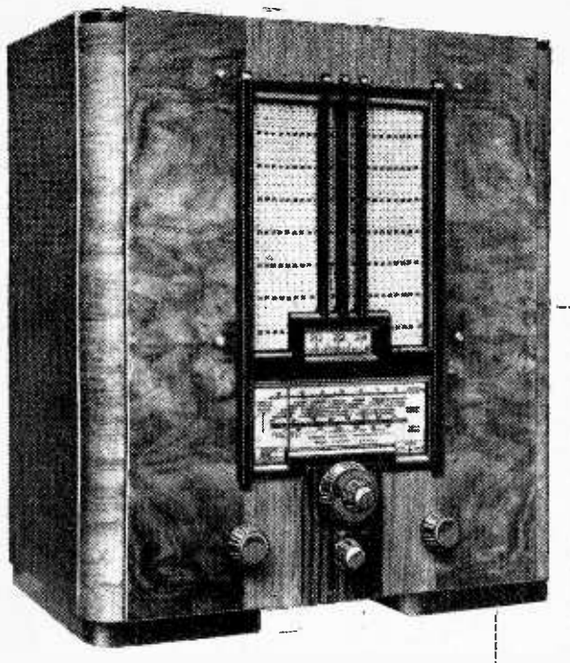


Ferranti MODEL 1237B

GOOD QUALITY AND SENSITIVITY IN AN ECONOMICAL BATTERY RECEIVER

FEATURES.—*Type.*—*Table model battery superheterodyne with three wavebands.* ***Waveranges.***—*(1) 19-51 metres. (2) 200-550 metres. (3) 900-2,000 metres.* ***Circuit.***—*Heptode frequency-changer—var.-mu pentode IF amplifier — double-diode-triode second detector — QPP output valve.* ***Controls.***—*(1) Tuning (two-speed). (2) Volume and on-off switch. (3) Wave-range. (4) Tone.* ***Price.*** *12½ guineas.* ***Makers.*** *— Ferranti Ltd., Moston, Manchester, 10*

IN the new series of battery receivers recently introduced by Ferranti, Ltd., names as a means of identification have been dropped in favour of numbers. These are not arbitrary figures, however, but give approximate details concerning each receiver. Reading from right to left, the letter indicates the type of supply, the next two figures the year of manufacture and the first two figures give an approximate idea of the price.

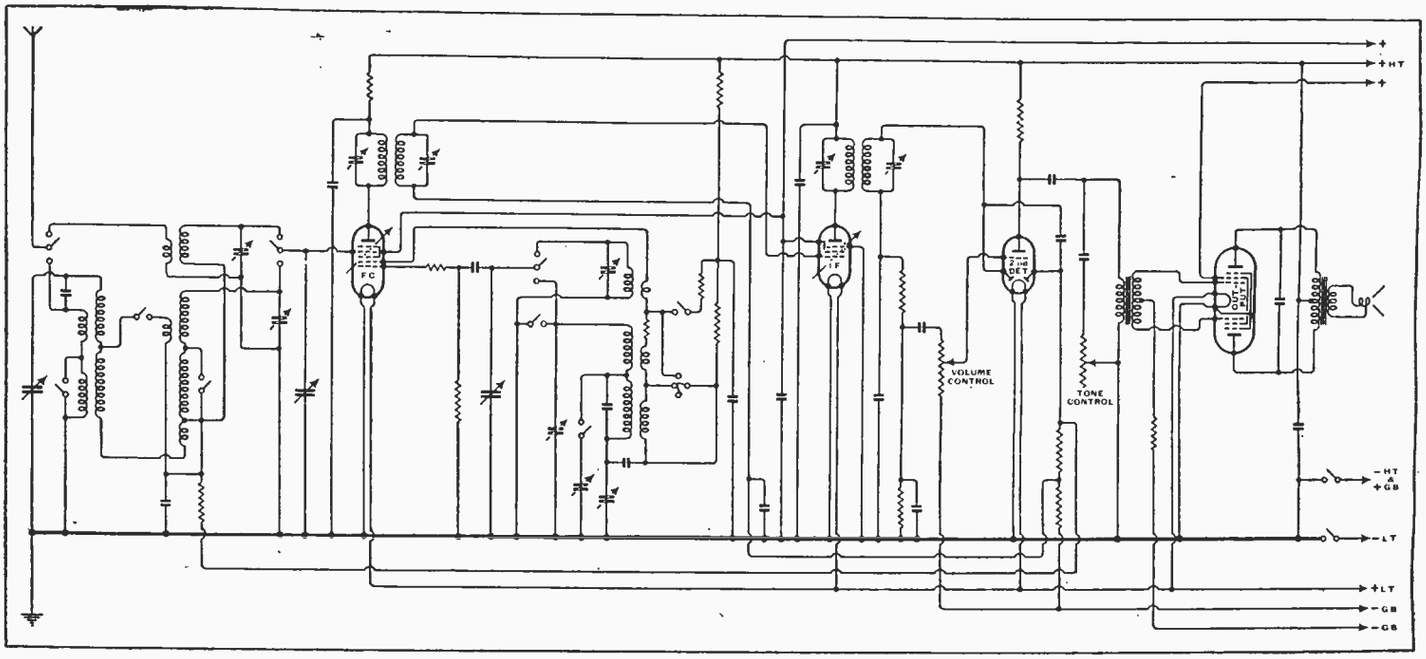
The Model 1237B is a three-waveband superheterodyne receiver. The chassis is the same as that of the Model 1137B, but a veneered wood cabinet is provided instead of a moulded bakelite case, and there is better accommodation for batteries. These are supported on a shelf which can be easily withdrawn to facilitate the insertion or removal of valves.

There are four valves in the circuit, which comprises a heptode frequency-changer, variable-mu pentode IF amplifier, double-diode-triode second detector and double pentode push-pull output valve. The aerial tuning arrangements are similar to those which have been used in previous Ferranti sets and consist of an inductively coupled band-pass filter for medium and long waves and a separate single tuned circuit for the short-wave range. Full AVC bias is supplied to the heptode frequency-changer and a reduction of about a third is made in the control bias supplied to the IF amplifier. The connections of the second detector are interesting for the fact that AVC delay is provided from a tapping on the grid bias battery. A parallel-fed transformer couples the amplified AF output from the second detector to the QPP output valve and the high-note response is controlled by a resistance-capacity shunt across the primary of this transformer.

The chassis is compact and can be removed from the cabinet without disturbing any soldering connections, as the leads to the loud speaker, which include an earth for the frame, are provided with plugs and sockets. There are only two terminals at the back of the set for the aerial and earth as there is no provision for a gramophone pick-up or for an external loud speaker.

The tuning scale, which is of the well-known Ferranti type with subsidiary pointers showing the settings of the various control knobs, is illuminated by a pilot lamp connected across the LT supply. This serves also to illuminate the "Magnascopic" dial which provides a scale length equivalent to approximately six feet and is a great help in tuning on short waves. To some extent, also, it makes up for the absence of a tuning indicator. The moulded frame surrounding the tuning scale differs from that of other models in this series in that it has a rectangular step immediately above the tuning knob. While this may improve the set from the decorative point of view, it is open to criticism, as the lowest line in the list of long-wave stations is obscured unless one leans forward to look down behind the obstruction.

However, the fact that space is given to this minor criticism may be taken as an indication that there is nothing seriously amiss with the more fundamental attri-



From a technical point of view the circuit provides most of the features of modern mains-operated superheterodynes.

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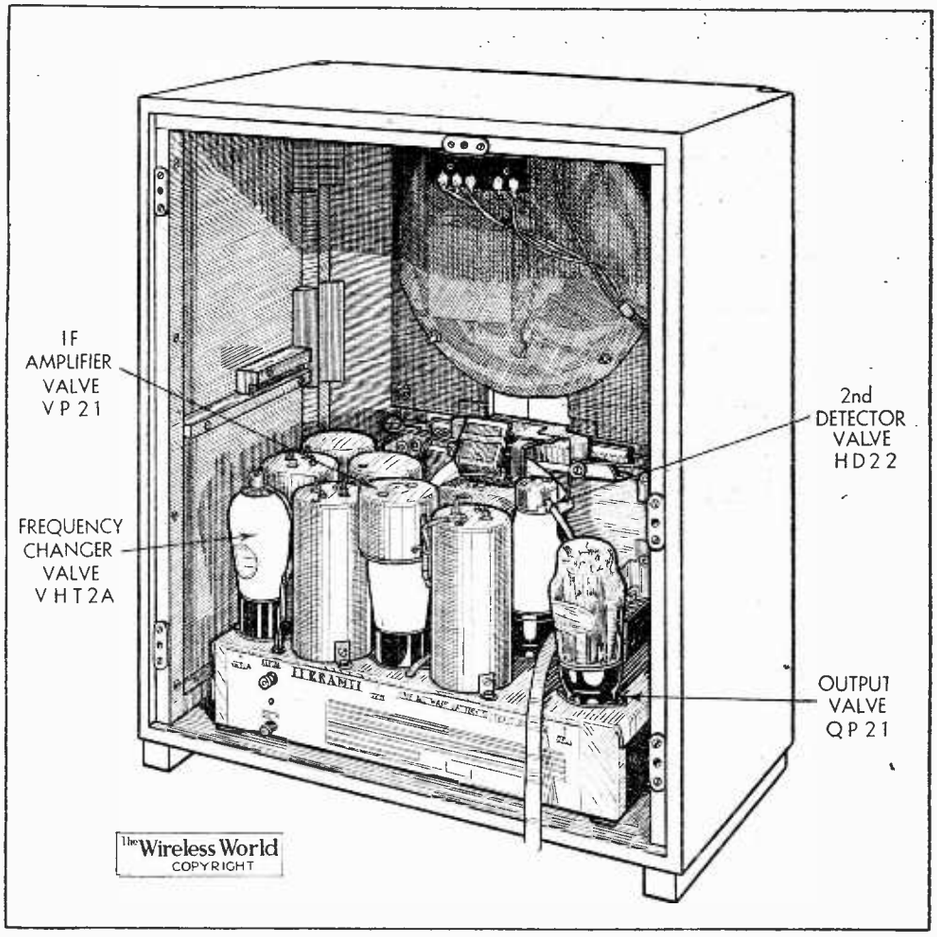
Ferranti—

butes of the set. The range on medium waves, for instance, is equal to that of any of the more efficient four-valve superheterodynes operated from AC mains and provides a selection of upwards of fifteen or twenty Continental programmes during the hours of daylight. The long-wave performance in no way suffers by comparison with the standard set by the medium waveband, and on both ranges selectivity is well up to the performance of the receiver in other respects. Only one channel is lost on either side of the Brookmans Park transmitters when using the set in Central London, and on the long-wave range the Deutschlandsender, which provides excellent volume, could be cleared of all but the last trace of sideband interference by making use of the tone control. Feeble self-generated whistles are fairly widely distributed throughout the long-wave range, but are not a source of serious inconvenience. On the medium-wave band there was one fairly prominent second channel whistle which would occur at just above 450 metres in the case of a set working in the London area.

Short-wave Performance

While the double tuning points which must be expected without a tuned RF stage give, perhaps, an optimistic first impression of the number of stations receivable on the short-wave band, there is no doubt that the performance of the Model 1237B on this range is one of real merit. Although the set goes down only as far as 19 metres, Schenectady, W2XAD, is a regular performer and was received with excellent volume and quality for several afternoons in succession during the periods of the tests. Transatlantic reception is, however, by no means the only justification for the inclusion of a short-wave band, but it may be taken that reliable reception of American stations indicates that all the other fare available will be re-received with good measure. This proved to be the case, and those who are unable to work their sets from the mains need have no fear of being at a disadvantage by comparison with known and tried all-wave mains receivers.

Neither will the performance suffer by comparison with mains receivers on the score of quality, provided that the volume is limited to the equivalent of a power expenditure of a little over 1 watt. A permanent magnet loud speaker provides an extraordinary full body of tone with excellent bass response, and its upper register is free from resonances which might put a restriction on the full use of the available power of the set. Here the only restriction is the power-handling capacity of the output valve and caution must be exercised in the use of the volume control, as in nearly every case the over-all magnification of the set is sufficient to load the output grids beyond the valve's normal rating. Not only will this result in poor quality, but will unnecessarily drain the HT battery. A meter in the negative HT lead showed that momentary currents of the order of 25 or 30 mA could be obtained by deliberate mishandling of this control. The ear is the best guide in these matters, and with the volume control set just below the point at which distortion begins to appear it was found that the average total HT consumption for the set was about 8.5 mA. with occasional excursions to 12 or 15 mA. Between stations the standing HT current was 7 mA., which was reduced to 6.5 mA. in the presence of an unmodulated carrier of average strength. These figures were taken with the maker's recommended battery voltages (150 max.). The measured LT battery consumption with a fully charged accumulator was 0.88 amp., including the pilot lamp.



Interior of Ferranti Model 1237B receiver with battery shelf removed.

Club News

Southall Radio Society

Headquarters : Southall Library, Osterley Park Road, Southall.
Meetings : Tuesdays at 8.15 p.m.
Hon. Sec. : Mr. H. F. Reeve, 26, Green Drive, Southall.

Attendance figures at the Society's lectures are showing a steady increase, and at a recent talk given by a representative of Lissen, Ltd., there were over 100 present. The lecture was followed by a demonstration of several all-wave receivers.

International Short-Wave Club (Brighton Chapter)

Headquarters : 100, Cromwell Road, Hove.
Hon. Sec. : Mr. John C. Bennett, 205, Braeside Avenue, Brighton, 6.

Mr. D. W. Atkinson, one of the Club's short-wave experts, recently gave a lecture and a demonstration on a four-valve S.W. set. This Chapter has been promised the use of transmitting and receiving apparatus, and negotiations are in progress for a television demonstration.

Arrangements are being made under the auspices of the Chapter for a party of overseas members of the International Short-Wave Club to visit Broadcasting House on May 13th. As the number will be strictly limited those overseas members who are coming to London for the Coronation, and desire to join the party should make immediate application to the Secretary of the Brighton Chapter, stating their name and address, address in London and date of arrival.

Croydon Radio Society

Headquarters : St. Peter's Hall, Ledbury Road, South Croydon.
Meetings : Tuesdays at 8 p.m.
Hon. Pub. Sec. : Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

The Society recently joined forces with the Short-Wave Radio and Television Society of Thornton Heath to listen to a talk on "High-grade Servicing Equipment," by Mr. T. S. Cawthorne, of the Weston Electrical Instrument Co., Ltd. The lecturer dealt with the use of the radio analyser and oscillator. With this apparatus, he explained, it was possible to undertake all the various measurements which the amateur was likely to require. On a subsequent date an interesting lecture on orchestration was given by "Amphion" the well-known music critic.

Halifax Experimental Radio Society

Hon. Sec. : Mr. J. B. Bedford, Oak House, Triangle, near Halifax, Yorks.

During the past two weeks members have been receiving lectures by Mr. F. Ambler, late instructor in wireless theory, and operator at the Scarborough Naval Wireless School. He commenced by describing the electron theory and the principles of alternating current and then passed on to high-frequency work.

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Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Volume Expansion

I HAVE read with interest the contributions to your journal on the subject of volume expansion, and feel that a short account of my own system might be of interest.

In Fig. 1 the basic system is shown. Alternating potentials, in phase opposition, are tapped off by means of VR1 and VR2, the outputs being combined. In practice VR1 is varied while VR2 is preset.

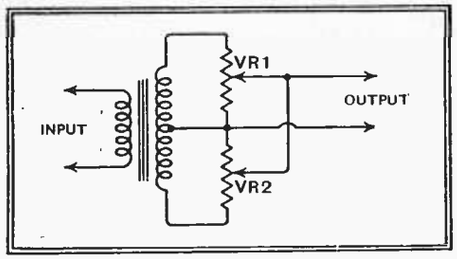

Fig. 1 (above) The fundamental volume expansion circuit, and
Fig. 2 (right) The practical circuit in which one potentiometer is replaced by the AC resistance of a valve.

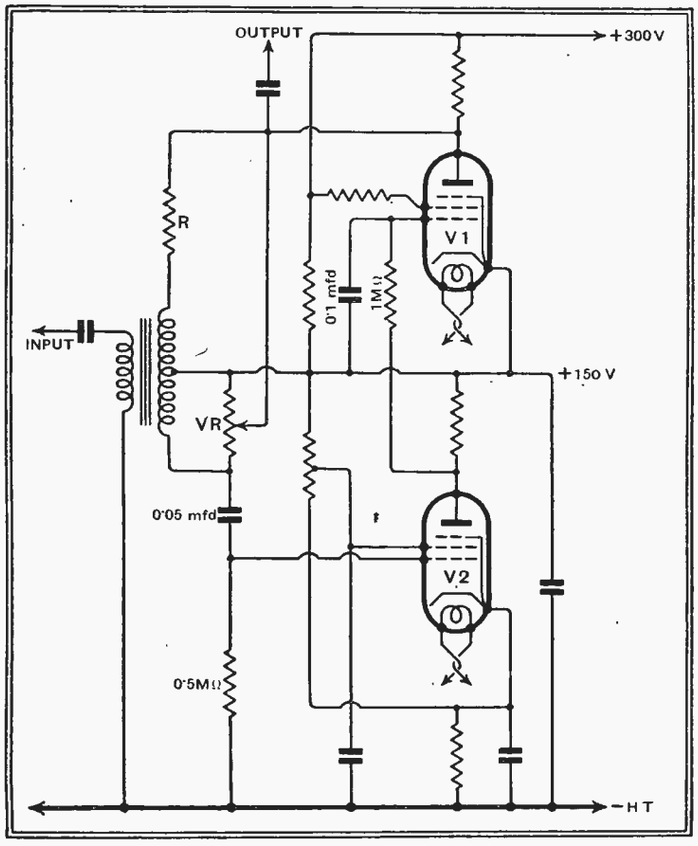

Fig. 2 shows the practical arrangement. VR1 (Fig. 1) is formed by R and the anode impedance of V1, the latter being controlled by the signal input by means of V2, acting as an anode bend rectifier. The potentiometer VR is adjusted to cancel out residual output from VR1 when the input tends to zero.

It is therefore unnecessary for V1 to be operated with so low an anode voltage as to bring operation off the straight portion of its characteristic.

Herein lies the main feature of the system, as comparatively large inputs may be handled without distortion. The degree of expansion possible is great and can be adjusted by means of VR. It will be seen that complete extinction of small sound *can* be achieved if desired.

Bromsgrove. LAURENCE J. SNELL.

Horn-loaded Moving-coil Loud Speakers

I REGRET that, owing to my absence from London on a demonstration tour, my reply to Mr. Barden's letter has been delayed.

First, I would point out that, although his figures for flare diameter are correct, the formula he quotes gives results twice as great. Actually, as he works out, a flare diameter of half a wavelength is satisfactory, and it is even possible to take some liberties with this figure.

When discussing the Tractrix horn, Mr. Barden states that for a given mouth diameter the Tractrix horn is longer than the exponential horn (this being a disadvantage), but admits that the cut-off may be lower. These two remarks rather cancel one another. Actually, if he were to ignore formulæ, and compared a Tractrix horn with an exponential horn of corresponding *measured* performance, he would find the Tractrix to be the shorter.

I quite agree that a horn capable of going down to 40 (why not 30 while we are about it?) is hopelessly impractical for average domestic use. Unfortunately, the alternative ways of getting *aperiodic* reproduction at such low frequencies are even less practical. (I will revert to this aspect later.)

Mr. Barden disagrees with a statement attributed to me, "that a baffle affects the loading at high frequencies only." What I did say was that "with baffle speakers, the loading is a maximum at high frequencies," which is a very different thing.

Considering a diaphragm as a non-resonant piston, and vibrating with a velocity of 1 cm./sec., the air will exert a pressure (or suction) opposing the motion equal to approx. 42 dynes/sq. cm., provided that no appreciable portion of the air can escape the action of the piston by flowing sideways. At high frequencies, where the air has no time to escape, the load on the diaphragm is, therefore, equal to 42 dynes/sq. cm. per cm./sec. velocity (on each side of the diaphragm). Incidentally, at these high frequencies a beam is formed, and also the baffle does nothing useful.

As the frequency is reduced, however, more and more of the air is able to escape sideways unless a horn is used, and consequently the back pressure on the piston drops more and more (and with it the loading), the exact amount depending, among other things, upon the shape of the space into which the air spreads. In the case of a plane baffle, this shape is a hemisphere for each side of the diaphragm.

It will be noted that, except for its effect on the shape of the space into which the air can flow, the baffle is powerless to prevent the sideways spread of the air and the consequent reduction in air loading on the diaphragm.

If the back of the diaphragm is connected, say, by a pipe to some point very far away, and the baffle is removed, then the air can spread into substantially a full sphere, and the loading is halved. If, however, the back of the diaphragm is exposed, things are much worse, as the work pressure, already reduced, collapses owing to neutralisation from the opposite face of the diaphragm. It will be seen, therefore, that the object of the baffle is (*a*) to prevent the complete collapse of work pressure on the diaphragm, and (*b*) to limit to a hemisphere the shape of the space into which the air can escape.

A properly designed horn, down to its cut-off frequency, permits only such a small spread that no appreciable loss of loading takes place. There is, consequently, no difficulty in obtaining aperiodic working. To see why this should be difficult with a baffle, let us get down to figures.

Taking a diaphragm of 500 sq. cms. (about 10in. dia.), the loading at 500 cycles would average out at about 11 to 15 dynes/sq. cm. (at a velocity of 1 cm./sec.).

At 50 cycles, however, vibrating at the same velocity (and therefore generating the same back EMF in its speech coil), the average loading would be about 1/60th to 1/70th of the above. Consequently, the energy output would be similarly reduced. If the same energy is required at 50 cycles, the velocity (and consequent back EMF) would have to be increased about 8 times. Since even then the work current is still about $\frac{1}{8}$th of its previous value, it will be seen that the equivalent work resistance is about 60 times higher, a factor which does not help to maintain a uniform load on the power valve.

This, however, is not the only disadvantage of such a high velocity. Such a high velocity also involves a considerable store of kinetic energy in the moving parts, and if

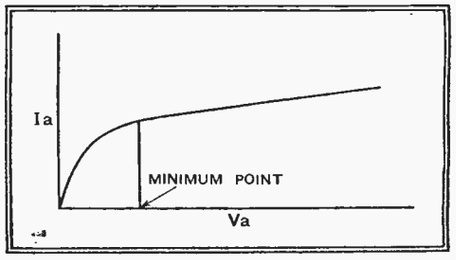

Fig. 3. In operation, the volume expander functions over a linear part of the valve characteristic.

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the diaphragm in the case we have been discussing weighs 20 gms., then the kinetic energy stored when it is vibrating is about equal to that radiated during 120 milliseconds at that amplitude; this obviously makes aperiodic working impossible.

In the case of horn loading, the velocity does not rise as above, consequently the work resistance remains constant, the stored kinetic energy is negligible at low frequencies, and its demodulating effect is avoided entirely.

Mr. Barden is wrong in assuming that a baffle speaker offers a more uniform load than that possible with a small horn and bass chamber in combination. In the case of a baffle speaker, variations of 100 to 1 in the work resistance are normal, and fundamentally unavoidable. In practice, the static impedances are generally large enough to mask the extreme changes and to prevent the total impedance from varying in quite such an alarming manner. The impedance curve when using a small horn and bass chamber in combination, while not so smooth as the baffle impedance curve, does, however, remain within limits which lie much closer together.

Referring to the formula for efficiency which I gave in the advertisement, he is quite right in drawing attention to the fact that it is dynamic resistance and not impedance which matters. The point was, however, carefully considered at the time of drafting the advertisement. Owing to the fact that a later section of the advertisement dealt with impedance as distinct from resistance, and as the impedance necessarily includes its resistive component, I felt justified in using the comprehensive word throughout rather than resistance at one point and impedance at the next. Such a step would have involved the need for additional words to explain the change, and Mr. Barden—who is no doubt familiar with the technique of drafting an advertisement—will, I hope, appreciate my point of view. In any case I did cover the fact that the formula was not quite accurate by saying "Roughly speaking . . ."

Finally, Mr. Barden's methods of making a 5ft. baffle behave like a 10ft. one, by using walls and floor, literally "fills me with delight" It is based on precisely the same considerations which led me to use the walls of the room for cutting down horn and bass chamber size when developing our corner horn. The method has even a greater advantage than merely reducing baffle size. The walls and floor of the room prevent the escape of the air over a hemisphere and restrict it to one-eighth of a sphere. This immediately quadruples the loading at low frequencies, and is a step towards horn working; on that ground it has my full approval.

I would point out, however, that the sound distribution from the arrangement might leave much to be desired, and feel that further development on the lines of our domestic horn would help materially in overcoming this defect.

Apologising that this letter has become so long,

For Voigt Patents, Ltd.
P. G. A. H. VOIGT,
London, S.E.26. Director.

Beat Oscillators

IN his letter on the subject of Beat Oscillators in the February 26th issue, Mr. P. K. Turner states that, in order to minimise waveform distortion, either the "mixer" must be square-law, not linear, or one of the two beating currents must be much larger than the other.

This is quite true if, instead of "mixer," the word "detector" is substituted, but I do not see how this applies to the triode-hexode.

If the triode-hexode is a "true modulator and approximately linear," then it follows that the mutual conductance of the grid G_3 bears an approximately linear relation to the potential of the grid G_1. If, therefore, the potential of G_1 is $(A+a\cos pt)$, and the potential of G_3 is $(B+b\cos qt)$, the anode current change will be proportional to

$$(A+a\cos pt)(B+b\cos qt)$$
$$=AB+Ab\cos qt+Ba\cos pt+ab\cos pt\cos qt.$$

The last term, which is the one containing the sum and difference frequencies, is exactly the same as would be obtained from a square-law detector, and is mathematically identical with

$$\frac{ab}{2}[\cos(p+q)t+\cos(p-q)t]$$

This appears to be true whatever the relative magnitudes of a and b, provided that neither a nor b is large enough to invalidate the assumption of linearity in the triode-hexode.

I suppose there is a fallacy in my argument. Will some kind reader please enlighten me? E. E. DAY.

Widnes, Lancs.

Television Range

RECEPTION of television broadcasts from Alexandra Palace is being enjoyed at my address in this town, situated in a main thoroughfare.

The distance from the transmitter is about 70 miles and a further difficulty is the need for employment of a converter as the supply mains are DC.

In spite of these disadvantages the picture received is quite good, it being possible easily to see even small detail of the subject.

Some difficulty is experienced in retaining line synchronism when certain makes of cars pass (there is an almost constant stream of traffic within 30 yards of the aerial), but the frame gives practically no trouble.

Employment of a filter and treating noise as "no signal" level has effected some improvement of line synchronism, and further alterations now being carried out will, it is hoped, result in a further improvement in this direction.

The aerial, a vertical half-wave with reflector, is about 58 ft. high and the feeder a Belling Lee low impedance line. The receiver consists of an Acorn RF stage; Acorn RF pentode as mixer; Acorn triode as oscillator; followed by four stages of IF amplification (Mullard TSP 4's); diode detector.

Doubtless, removed from proximity to the main street and using controlled AC mains supply better results would be achieved.

It is hoped this information will show that the B.B.C. estimate of the service area is conservative, and that with suitable apparatus good reception may be enjoyed at much greater distances. S. WEST.

Ipswich.

WIRELESS TERMS EXPLAINED

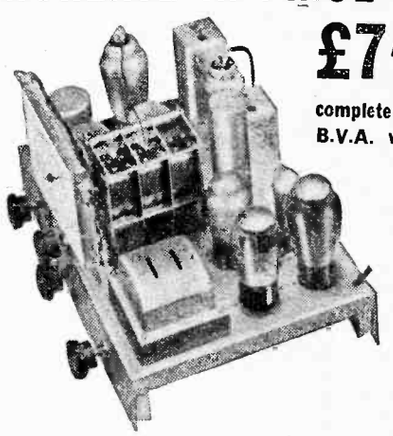
THE title of "Decibel's" new book, published by Pitman's, is as above, and not "Wireless Terms Defined," as stated in our review last week. As was implied in the review, the word "explained" correctly defines the scope of the book, in which many technical definitions are expanded into explanations covering a quarter-page or so.

McCARTHY

IMPORTANT
to Wireless World readers

Due to its great popularity with "Wireless World" readers, we have hitherto been able (despite successive improvements in construction, design, and performance) to continue to offer the McCarthy 6-valve all-wave superheterodyne chassis at its original price of £7—undoubtedly the finest value in all-wave receivers of such a performance and specification that can be offered to-day. We have now, however, to announce an

INCREASE IN PRICE TO £7/7
complete with 6 B.V.A. valves.



Brief Specification: 8 stage, all-wave band-pass superheterodyne, 7 tuned circuits employing iron-cored coils. Triode-hexode frequency changer. Double diode detector provides D.A.V.C. Separate L.F. stage. 3½ watt pentode output. Variable tone control. Switch connects gramophone pick-up terminals. Illuminated "Airplane" dial. Wave ranges: 16.5-50, 200-550, 800-2,000 metres. A.C. or A.C./D.C. types for all usual voltages.

for 7 days only
SPECIAL OFFER
to Wireless World readers

Though we are now selling at the increased price of 7 guineas, in order to avoid disappointing the many readers of the "Wireless World" who may be considering the purchase of this chassis, we are prepared to accept all orders received on or before Friday, April 2nd (whether for cash, or on hire purchase terms) at the original price of £7.

All McCarthy receivers supplied complete with valves, knobs, pilot lamps, leads, mains cable and plug. 12 months' guarantee.

Deferred terms on application, or through London Radio Supply Co., 11, Oat Lane, E.C.2.

Cash with order on 7 days' approval. Also write for illustrated catalogue of complete range of all McCarthy receivers.

McCARTHY RADIO LTD.
44a, Westbourne Grove, London, W.2
Telephone: Bayswater 3201/2.

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Broadcast Brevities

NEWS FROM PORTLAND PLACE

When Mike Works Overtime

IN keeping the Droitwich, Regional and Midland transmitters open until 3.30 a.m. on the night of March 16th-17th, in order to provide an emergency service of warning to dwellers in the Fen district against the danger of floods, the B.B.C. did not, as many listeners appear to think, create a new record. The General Election of May, 1929, still holds pride of place, for results were broadcast up to 4 a.m., and on that occasion the Director-General, Sir John Reith, created a personal record in remaining at the microphone for hours on end so that he could himself announce the results as they were received.

The Great Midland Mystery

TALKING of coincidences, shall we include the following story in that category, or can it worthily be classed as a mystery with a simple explanation?

One night a listener tuned-in to Midland, and at 7.30 p.m. heard a certain French record. An hour later (mark the time) he decided to change the accumulator, and therefore switched off the current, leaving the tuning on Midland's wavelength. The operation of changing the accumulator being finished, he switched the set on again and, to his amazement, heard, so he said, the record of an hour earlier. To add to the mystery, the announcer presently informed listeners that the next part of the programme would follow at 7.30.

Sounds from the Past?

On the face of it, the uninitiated might suppose that, owing to some supernatural phenomenon, a broadcast of the past had been brought back on the ether—an omen of the time when, by magical means, listeners will hear again the voices of Cleopatra and of Henry the Eighth, which, some would believe, are still ringing down the grooves of Time. What actually happened was that, owing to the short running of a programme at 8.20, Part 2 of a record of Mozart's Concerto for Harpsichord and Orchestra was put in to fill the gap until 8.30. Part 1 of the same Concerto had been broadcast between 7 and 7.30 by a different announcer. The only slip that occurred was due to the announcer at the later hour stating that the next part of the programme would follow at 7.30, when he meant 8.30. Simple, my dear Watson.

East Anglia's Demands

ALWAYS on the eve of the seaside concert party season the voice of East Anglia is heard in the land appealing for an opportunity of broadcasting various concert parties which favour resorts on the East Coast with their talent. Further, a strong plea is usually heard for a Regional transmitter of East Anglia's very own.

Where the Cost of O.B.s is Greatest

As regards O.B.s, the overhead costs involved are a serious consideration. The expense of lines from East Anglia, especially towards the North, would be shared by fewer broadcasts than is the case with localities in some other parts of the country, and the technical difficulties are thereby increased. A considerable number of visits must be paid by engineers and members of the programme staff to places from which an outside broadcast is contemplated, and as these officials are always working against time the tendency is generally to accept the most accessible places for outside broadcasts. In spite of this, Harry Pepper, B.B.C. producer, will not overlook the claims of places like Clacton and Felixstowe when he comes to make his summer tour in search of suitable O.B.s.

When it comes to a question of a Regional transmitter, it may be said that there are certain areas in various parts of the country, of which East Anglia is one, where there is at present no entirely reliable service of a Regional type of programme, although programmes from several of the Regional transmitters can be received when conditions are favourable.

Sharing of Wavelengths

For some time past the B.B.C. has had in mind the desirability of improving the Regional service in East Anglia, but international restrictions on the use of wavelengths have prevented immediate action. The Corporation is, however, at present carrying out a number of tests to ascertain the best conditions for the sharing of one wavelength between two or more stations, and the future development of the service will be governed by the results achieved.

No Deception

THE B.B.C. has been criticised for using recordings without informing listeners that they were not listening to the real thing. One day, perhaps, the critics will level the same criticism in regard to tricks with the television camera. So far, however, it can be said truthfully that there has been little or no "hanky panky" of this kind at Alexandra Palace; indeed, the producers have been notably restrained in the use of a new toy which offers scope for deceiving the eye to a far greater extent than any sound record could mislead the ear.

HOW AMERICA DOES IT. This reproduction of an untouched posed portrait taken in New York of the reception of the N.B.C. 441-line, 60-frame transmission illustrates how television technique has progressed in America.

Single Camera Difficulties

One harmless piece of deception was resorted to in that early O.B. from the Alexandra Palace bowling club last year. It was necessary to show close-ups of the bowlers and, almost simultaneously, of the bowls as they reached the opposite end of the green. Unfortunately, only one camera could be used, and if this had been rushed backwards and forwards the results would have been bewildering to the viewer and there would have been extreme difficulty in getting each shot in focus.

So Simple

Since the object of the broadcast was not to show actual match play, but simply to demonstrate how the game is played, it was decided to keep the camera at one end of the green, "panning" over a small angle. A slight turn to the left showed the bowl as it left the bowler's hand; then, panning to the right, the camera depicted what appeared to be the same bowl nearing its mark. Actually it was another bowl proceeding from another hand.

Televising Cricket

Single-camera technique will again be necessary in the broadcast on April 3rd from the Alexandra Palace Indoor Cricket Club, but this time there will be no deception. The camera will be situated between two parallel pitches. One shot will show batsmen at the nets, and the other, taken at a slightly different angle, bowlers in action.

A Transatlantic Record

PEOPLE at Alexandra Palace last week smiled incredulously as they listened to a record, just received from New York, of a variety programme transmitted from the Baird studio on January 30th last. Picked up by ultra-short waves which had ricocheted no one knows how many times from one heavenly layer to another, the voices of Paddy Brown, discuse, Van Dyck, cartoonist, and Jasmine Bligh, announcer, were reproduced so faithfully that the recording might almost have been carried out at Maida Vale.

It was interesting to note that, just before the final spotlight announcement, even the whirr of the scanning disk could be heard.

Incidentally, American rebroadcasts of reception from Alexandra Palace are now being picked up at Tatsfield.

Television engineers are now waiting to hear that the vision signals have been resolved into a picture. Present opinion is that the signals are too chopped up in their passage through the upper layers to give either a good "sync" or a workable scanning sequence.

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SIMPLE MODULATED OSCILLATOR

Economical Single-Valve Test Set

By D. W. HEIGHTMAN

THE writer recently had occasion to build a portable ultra-short wave transmitter, operating from batteries, which would emit a modulated RF signal. It was desirable that only one simple triode valve should be used so that the apparatus would be as compact as possible and battery consumption could be kept low.

After some experiment it was found that with a suitable circuit arrangement the single valve would oscillate quite satisfactorily at an audio frequency and a radio frequency simultaneously. The actual circuit used was that in Fig. 1, and it will be seen that this is extremely simple and requires a minimum of components.

L1 C1, of course, provide the high frequency oscillatory circuit, and their values depend on the frequency it is desired to use, as also do the values of C2 (regeneration condenser) and C3 (RF by-pass). L2 L3, which may conveniently be a 1 : 1 ratio AF transformer, form the anode and grid inductances of the low frequency circuit.

Modulation Circuit

The modulation frequency can be controlled by varying C4 which tunes L3. This frequency also depends on the value of the RF by-pass condenser C3 which is in effect in parallel with L2. A variable resistance across L2 or L3 will control, to some extent, the modulation percentage.

There is, of course, no need to use the particular RF circuit shown in Fig. 1 as

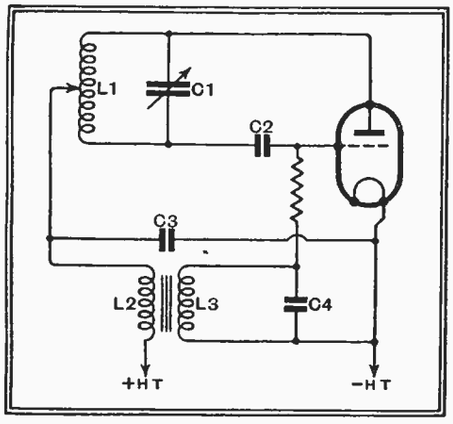


Fig. 1. Circuit of the modulated RF oscillator.

the method of modulation can be applied to any of the conventional oscillatory circuits.

Since the circuit operated so well as a modulated short-wave oscillator it was decided to make up a modulated test oscillator, operating on the usual broadcast frequencies, which would be suitable for ganging up receivers and for general test work. For this the circuit of Fig. 2 was used and very satisfactory results were obtained with the additional advantage of a very compact lay-out. The output from

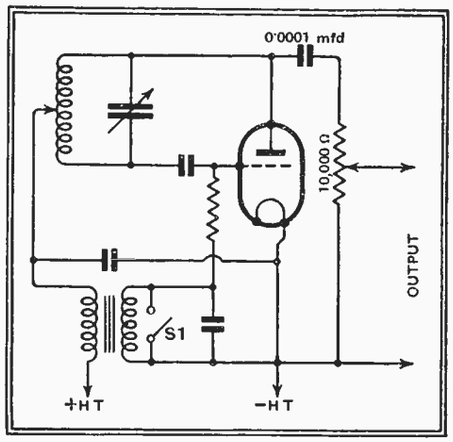


Fig. 2. The addition of a few simple components will convert the circuit of Fig. 1 into a useful testing oscillator.

the RF oscillator is controlled by the 10,000 ohms potentiometer while the switch S1 cuts out the modulation when not required.

The Radio Industry

HOLIDAY & HEMMERDINGER, Holmer Works, Dolefield, Bridge Street, Manchester, 3, have added to their range of service accessories a cellulose cement, suitable for loud speaker repairs, made up in bottles with screw stoppers incorporating a brush. A special "thinner" is also available and the prices of the standard sizes of cement and thinner (approx. 20 c.c.) are 1s. 6d. and 1s. respectively. Postage 9d. in each case.

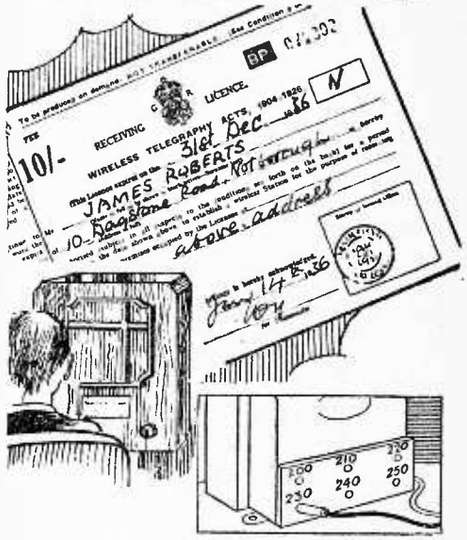
◇ ◇ ◇ ◇

A brochure containing much useful information on plastic mouldings, including mechanical and electrical characteristics of moulding materials and hints for designers, has just been issued by H. E. Ashdown, Ltd., Eccleston, St. Helens, Lancs. Copies will be sent to readers who care to apply.

◇ ◇ ◇ ◇

We learn from America that the entire supply of the Supreme Instruments Corporation's manual (recently referred to in these notes) is now exhausted. However, it is hoped that it will eventually be possible to send copies to all readers who have already applied for them. Mr. J. Toubkin, Faraday House, Todd Street, Manchester, 3, has now been appointed sole distributor for Great Britain, and any correspondence relating to the Corporation's productions should be addressed to him.

They SHOULDN'T DO IT— BUT THEY DO!



ROBERTS' licence has expired—we'll call it carelessness. Roberts is that kind, he is the man who changes over transformer tappings - leaves valves out, switches on .... and then blames the set maker, but it's his own carelessness, or ignorance, that has let the SURGE VOLTS through causing havoc amongst components. There's no need to run such risks, T.C.C. Wet Electrolytics prevent high switching-on surge voltages reaching components. They provide a positive safety barrier, obviating breakdown, inconvenience and costly replacements. Fit T.C.C. 'Wets' and be sure.

FOUR TYPICAL TYPES

Type	Capacity	Continuous Working Volts
802	16 mfds.	440 volts Peak
602	8 mfds.	440 volts Peak
805	8 mfds.	500 volts Peak
809	32 mfds.	320 volts Peak

Special types are available to meet the stringent conditions found in A.C./D.C. Receivers. Write for full details.

T.C.C.

VOLTAGE REGULATING WET ELECTROLYTICS

THE TELEGRAPH CONDENSER CO., LTD., WALES FARM ROAD, NORTH ACTON, W.3.

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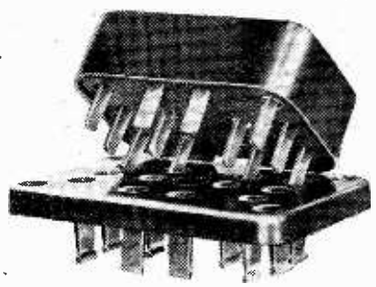
New Apparatus Reviewed

RECENT PRODUCTS OF THE MANUFACTURERS

BULGIN HIGH-VOLTAGE CONNECTORS

A NEW plug and socket designed especially for the high voltages used in television receivers has been introduced by A. F. Bulgin and Co., Ltd., Abbey Road, Barking, Essex. It is made of moulded bakelite, and special care has been taken to ensure adequate insulation, and when the plug part is inserted into its socket all metal parts external to the front of the chassis are completely protected.



New Bulgin 12-pin high-voltage television plug and socket.

Flat pins are used and the socket part is fitted with hairpin-shaped flat springs, and a perfectly satisfactory contact is made at all points.

These new television connectors are available in 6- and 12-pin models, the former being suitable for maximum potentials between pins of 5,000 volts, while in the case of the 12-pin type, owing to the necessary closer spacing, 2,500 volts is the maximum rated working voltage. All connectors are, however, tested at 7,500 volts.

The high-voltage plug costs 5s. 9d. in either 6- or 12-pin types, and appropriate socket parts for chassis mounting cost 1s. 9d. each.

NIVEX TIME SWITCH

MANY listeners must have experienced the disappointment of having decided to listen to a particular item in the radio programme, forget the passage of time and realise too late that the broadcast has finished. A device that will obviate such

Nivex radio programme time-switch.

disappointments is now obtainable from the Nivex Instrument and Gauge Co., 3-11, Pine Street, London, E.C.1. It is a delay time-switch and is operated by clock mechanism.

The switch can be set to come into operation after a lapse of time of from about 10 minutes to 11 hours.

The specimen sent in for test is made to fit a 5-amp. wall socket and has outlet sockets for the mains plug of the radio set. It is interposed between the set and the mains point.

Tests made show that the switch operates correctly after the delay period chosen. The dial measures 1⅞in. in diameter and is marked 0-11, with each hour sub-divided into ¼-hour periods. Though it is possible to set the dial to the nearest 5 minutes with care and good judgment, it would be wisest to deduct 10 minutes or so from the delay period required to ensure that the set is switched on in ample time for the desired item in the programme.

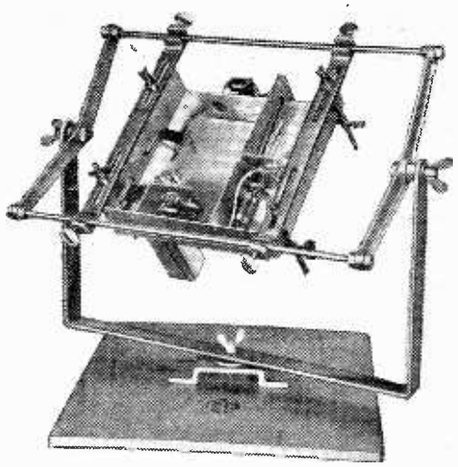
The Nivex time-switch can be obtained with a lamp adaptor fitting or with the mains pins on the top for alternative types of mains supply points. It costs 19s. 6d.

There are, of course, many uses for a time-switch other than in connection with a radio set, and its various applications are described in the instructional leaflet accompanying each switch.

PYE CHASSIS CRADLE

WHEN building or servicing a receiver, means of supporting the chassis to give access to the underside has to be improvised, but supporting blocks have an unfortunate habit of slipping out of position at most inconvenient moments.

A useful accessory to the workshop that



Chassis cradle made by Pye.

obviates the need for improvised fixtures of this kind has been introduced by Pye Radio, Ltd., Cambridge, and though intended primarily for holding Pye chassis the required fittings for accommodating any radio chassis are included. It is known as the Pye Chassis Cradle, and consists of a stout baseboard 18in.×18in., on which is assembled a U-shaped member supporting a cradle which has adjustable transverse bars to which the chassis is secured by clamps.

When mounted, the chassis can be swung round or turned over and fixed at a convenient angle for easy access to all parts.

It is strongly made and will accommodate chassis up to 18½in. long×13½in. wide, and the price is 30s.

We have had one of these cradles for examination, and can confidently recommend it as being a very useful adjunct to the workshop equipment.

RANDOM RADIATIONS

By "DIALLIST"

Let's be Consistent

IN certain ways some of our set makers seem to be bent on confusing the ordinary man's ideas about wireless. Some time ago, for instance, one firm brought out a set with 4 waveranges, covering about 1,000-2,000, 200-600, 35-80, and 15-45 metres. These were labelled Long, Medium, Short and Ultra-short. Now I have just come across the "book of the words" of a set of another make which describes it as covering Long, Medium and Ultra-short waves, the "ultra-shorts" in question being 16-50 metres. And there's yet a third receiver whose ranges of roughly 900-1,000, 180-550, 40-90, and 16-45 metres are listed as Long, Medium, Intermediate and Short. There's quite enough muddle and confusion about wireless terms already without our adding to it gratuitously in this way. Surely the accepted classification is: Ultra-short waves, below 10 metres; short waves, 10-100 metres; medium waves, 100-1,000 metres; long waves, 1,000 metres upwards. If there are two short waveranges they might be called the Upper and Lower. Set manufacturers might well get together on this point and agree on a common nomenclature.

Books of the Words

And while I am in the mood for patting set-makers on their united backs . . . with a knobkerry—may I mention once more those instruction booklets or leaflets or folders that are sent along with sets? It falls to my lot to try out a heap of sets during the year, and as each comes along one naturally wants to get it into working order, properly fixed up, with the minimum waste of time and trouble. Some instruction booklets are first-rate. You read them through and all is plain sailing. Others—and these are far too common—are just the reverse. They are so vague or so prolix or so inaccurate that it's hard work to discover what they're driving at. Often, too, the illustrations are small, indistinct and even inaccurate. I write, perhaps, with a little exasperation since I have just been struggling with a set whose book of the words (a) makes no reference to a mysterious terminal at the back of the chassis (which looks as if it ought to have some important use), (b) gives me a picture of the said chassis which is about as much like it as a portrait of Sir John Reith is like Mr. Baldwin, and (c) bids me check carefully the positions of the valves with the aid (?) of a sketch in which one valve of a particular type might just as well be in front of as behind another.

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The Aeroplane Dial

WHAT is known for some quaint reason as the aeroplane dial is becoming very popular. I don't wonder, because in its best form it is neat and pretty easy to read. But it isn't always in its best form. I'm using a set at the moment whose aeroplane dial makes my fingers itch for the coke hammer. To begin with, it is rather deeply inset in the surrounding escutcheon, which means that heavy shadows are thrown across it (it is in a battery set and is not illuminated, save when I use an electric torch in self-defence); next it is covered by a kind of giant watch glass with a pronounced convex curve, which catches the light very awkwardly at various points; thirdly, it has station names writ small in black on a khaki background and, though I have at any rate one perfectly good eye, they are the very dickens to read; fourthly, it has a pointer about as thick as a poker, and I needn't tell you what that means. If only dial designers could bring themselves to bear in mind that the user wants to be able to *read* the wretched thing, possibly in rather a poor light, what a lot of trouble they would save us!

Feminine Broadcasters

THE B.B.C.'s recent conference at Leeds wasn't at all kind to the feminine broadcaster. Dr. G. E. Myers, of Manchester University, said that the microphone didn't suffer the female voice too gladly. There was a sameness about it (the voice, not the microphone) that became irritating. Arose Miss Phyllis Bentley, doughty champion of woman's rights, to get a word in edgewise, or to get a spate of edgy words in somehow, who laid the blame on the engineers, on the ground that they would shut out the feminine voice simply because they found its proper transmission beyond them technically. The engineers, poor chaps, are not of course to blame, and, hard though it be to say it, I'm afraid that Eve herself is at fault. In this country (though not always in others) she seems to develop when before the microphone a flat, toneless, way of speaking which . . . well, *vide* Dr. Myers' remarks above.

Dance Music That's Different

IT'S interesting to find how many people now use the German stations for their dance music. Devotees of hot jazz, swing, and so on (I've never yet met a swing enthusiast who could tell me what swing was, by the way) are not attracted by the strains of the Fatherland's dance bands; others, though, who like the rhythm of the music but detest the deliberate introduction of discordant noises and the whining bleat of the crooner, turn nightly to Berlin or Hamburg or Stuttgart. Though dance tunes are occasionally given from these stations in their more jungly form, they are usually played melodiously by orchestras with a real sense of music and of rhythm. Crooners do not exist in Germany; very rightly they are "strengstens verboten." When the refrains are vocalised, they are sung by men or women with good voices, whose adenoids and tonsils and things have been properly attended to. If you haven't yet realised how different German dance music is and what a pleasant change it makes from the swamp stuff, let me recommend an hour or so with some of their best-received stations every now and then.

Nuff Said

THIS is, or at any rate I hope it is, the paragraph to end all paragraphs on the great U.S.A. relay controversy. If you remember, I suggested originally that, whatever the B.B.C. might have to say about it officially, transmissions far stronger than those normally coming from W2XAD or other American short-wave broadcasting stations were to be picked up from across the Atlantic at times when relays were in progress. Though there were those who hastened to tell me that I spake as a fool, dozens of readers have kindly confirmed my own observations. The latest communication received comes from a Finningley reader, who heard (as I did) the recent "Hill Billy" relay both from London and direct on the short waves. Beyond "any possible, probable shadow of doubt" it was transmitted (?from Rocky Point) via the transatlantic telephone service, though whether the B.B.C. received it that way or not I can't say. I switched over several times quickly from London to short-wave direct reception and my impression was that the latter gave distinctly the better results with a receiving set whose A.V.C. arrangements are particularly good.

Crystal Sets for India

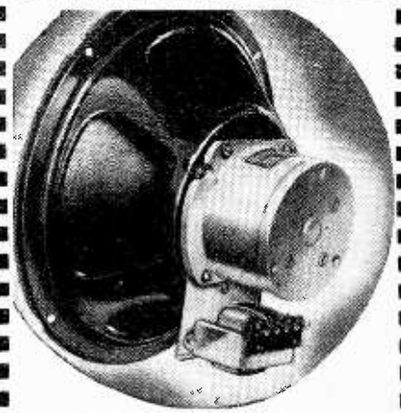
BACK from his long stay in India, where he has been helping to put the engineering side of the India Broadcasting Company on a firm basis, Mr. H. L. Kirke gave some interesting information at a recent R.M.A. luncheon. Most of what he said was eminently sound, though I can't agree with some of his statements. He told his audience that of India's 350,000,000 inhabitants (the actual figure is a good deal higher) 90 per cent. were villagers who could not afford sets. It's true that the valve set would be beyond most of them; it would be also too expensive for a large proportion of those who live in the towns. But what about the crystal set? Any number of villages are within the "crystal area" of the 20-kilowatt transmitters built or building under the new scheme. As for the towns, Bombay and Calcutta have populations of over a million, and specially designed crystal sets (a special design of a very simple kind is required) should sell like hot cakes. Won't any manufacturer try for this market?

K.B. Battery Receivers

A THREE-VALVE "straight" circuit with pentodes in the RF and output stages forms the basis of the new K.B.620, which is designed for reception of wavelengths between 18.5 and 52 metres as well as the medium- and long-wave bands. The waverange switch is incorporated with the tuning control and a "local-distance" switch is provided. The set, with its 8in. PM moving-coil loud speaker, is housed in a horizontal-type cabinet, and the price, including batteries, is eight guineas.

In the K.B.610 battery superheterodyne an octode frequency-changer is followed by a pentode IF amplifier, double-diode-triode second detector and pentode output valve. Combined variable selectivity and tone control is provided and the sloping rectangular "Alphadex" tuning dial has station names arranged in alphabetical groups. The short-wave range in this case is from 16.5 to 50 metres. The price, complete with batteries, is 11 guineas.

POINTS OF IMPORTANCE in the Rola G.12



TO THE LISTENER

The Rola G.12 is a 12in. diameter speaker that is definitely unsurpassed for impressive volume and faithful reproduction. It is the speaker par excellence for every connoisseur of radio reception. Ask your dealer to demonstrate to-day.

TO THE DEALER

For the "quality" market no speaker is so certain to give universal satisfaction as the Rola G.12. It is emphatically a unit which builds business and ensures repeat orders.

TO THE MANUFACTURER

All manufacturers using G.12's this season have found it necessary to increase production on the sets in which these units are installed. It is these particular models which have the largest sales increase. Let us give you full particulars.

G.12 P.M. (as illustrated) with Transformer	£5 5 0
G.12 P.M. less Transformer	£4 16 0
G.12 D.C. Complete with Transformer, Mounting Stand, Handle and Base	£5 5 0
G.12 D.C. with Mounting Stand, Handle and Base, but without Transformer	£4 16 0
G.12 D.C. Stripped, but with Transformer	£4 4 0
G.12 D.C. Stripped and without Transformer	£3 15 0

(When ordering please state Field Resistance and Impedance of Transformer required.)

For Public Address work both the P.M. and Energised Models can be supplied with a 15 ohm Voice Coil at an additional charge of 3/-.

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Recent Inventions

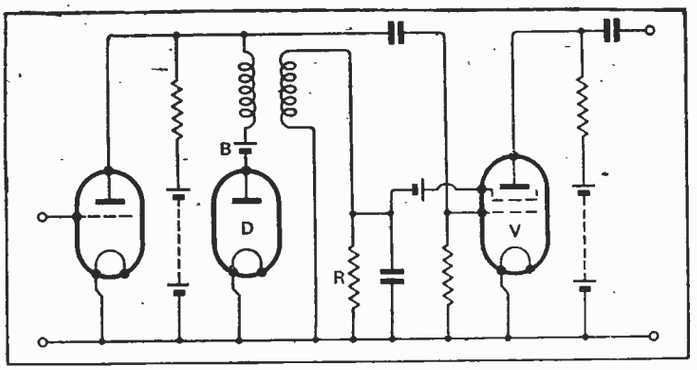
The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of patents issued in U.S.A. is also included.

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

PREVENTING TELEVISION "INTERFERENCE"

IN a cathode-ray television receiver overmodulation of the electron stream, due to the impact of atmospheric or other disturbances, produces bright "flashes" on the picture which not only distract the eye but may also damage the fluorescent screen. In order to prevent this, means are provided to limit the total signal voltage to a "safe" or desired maximum.

As shown in the Figure a diode D, suitably biased by a battery B, is interposed in the chain of amplifiers. When the combined signal and "interference" voltage becomes excessive the diode passes a current which induces a compensating voltage in a resistance R. This is used to reduce the effective amplification of the amplifier V, and so prevents the undesired disturbance from increasing the intensity of the electron stream as it passes through the cathode-ray tube on its way to the fluorescent screen.



Method of preventing excessive modulating signals reaching cathode-ray tubes in television receivers

A. G. D. West and Baird Television, Ltd. Application date June 5th, 1935. No. 457800.

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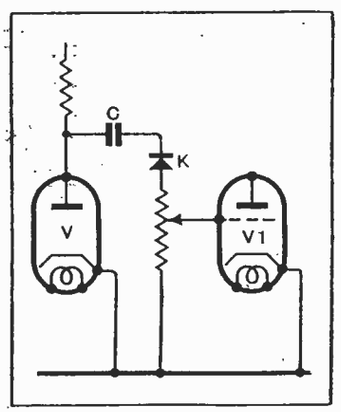
TELEVISION RECEIVERS

IN receiving television it is necessary to separate the picture signals from the synchronising impulses which are transmitted at the same time. The figure shows how a rectifier contact K of the copper-oxide type is used to facilitate the separation of the two types of signal.



Using copper-oxide rectifier in separating picture signals from sync impulses.

Synchronising impulses, mixed with picture signals, are fed from a valve V through a condenser C and the rectifier K to the grid of the amplifier V1. The "sense" of the picture signals is such that they tend to throw the grid of the amplifier V1 positive, and, since this valve is already biased to run into grid current, they produce practically no effect on the output from that valve. On the other hand the "sense" of the synchronising impulses being such as to drive the grid of the amplifier V1 negative, they give rise to amplified changes in the plate currents. The rectifier K is connected so as to present a high impedance to the first-mentioned set of signals, and a low impedance to the synchronising impulses, thereby assisting in the process of separation.

E. D. McConnell and Baird Television, Ltd. Application date June 6th, 1935. No. 457812.

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SIGNALLING SYSTEMS

TWO valves are reciprocally coupled together, i.e., with the anode of one connected to the grid of the other, and vice versa, and are used to generate oscillations in what may be called a "flip-flop" fashion. That is to say the time constants of the coupling circuits are such that the combination possesses two states of equilibrium. When one state has lasted for a certain time it passes practically instantaneously to the second state. A glow-discharge lamp inserted in each of the reciprocal coupling-links ensures the swift change-over. The arrangement is convenient for preventing "key click" noises when applying Morse signals to two overlapping beams of radiation, as used in aircraft navigation and the like. It is also suitable for controlling "automatic" traffic lights.

Marconi's Wireless Telegraph Co., Ltd., and N. H. Clough. Application date May 31st, 1935. No. 457771.

TELEVISION SYSTEMS

AT the transmitting end it is usual to amplify the picture signals and the synchronising impulses separately, before combining them for radiation. It is possible that certain of the picture signals, having the same "sign" as the synchronising impulses, may thus acquire sufficient amplitude to cause "false" synchronising effects at the receiving end.

To prevent this a gas-filled discharge valve is inserted in shunt with the grid of the last picture-amplifier so that it acts as a limiter to prevent any signal from exceeding a certain "safe" amplitude. The output from the last amplifier is also rectified and used to bias one or more of the preceding amplifiers so that the regulation necessary when changing-over from, say, a "high-light" to a "low-light" film is effected automatically.

Radio Akt. D. S. Loewe. Convention date (Germany) April 6th, 1934. No. 457879.

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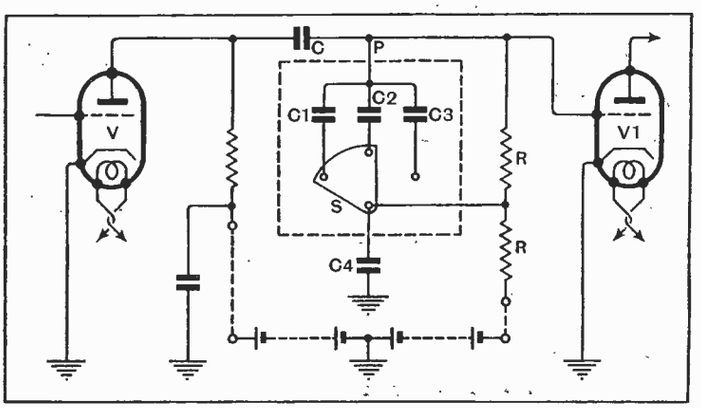
TONE CONTROL

A TONE control circuit is specially designed to avoid the production of "clicks" when adjustment is made from one position to another. As shown, a bank of condensers C1, C2, C3 is arranged between the coupling-condenser C from the valve V and the grid-leak resistance R of the valve V1. The three condensers are connected on one side to a common point P, and on the other side through the switch-sector S to a tapping on the resistance R. A condenser C4 is inserted between the switch and earth.



Tone control circuit evolved for silent operation during adjustment.

In each of its positions the switch bridges two of the condensers. Since the grid of the valve V1 does not normally draw current no unidirectional voltage is developed across the resistance R, and the condensers C1, C2, C3 do not, therefore, charge or discharge as the switch sector is moved from one position to the other. Further, no clicks can be developed from the plate circuit of the valve V since it is isolated from the tone-control device by the condenser C. The resistance R and condenser C4 also serve as a filter for the grid-bias supply.

J. Y. Johnson (communicated by Philco Radio and Television Corpn., of U.S.A.). Application date May 25th, 1935. No. 457452.

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AVC.

IN ordinary systems of AVC the speed at which the "gain" of the receiver falls off, for a given input signal, is the same as the speed at which it rises when the signal is removed. This is desirable when receiving a modulated wave, but in the case of "interrupted" CW it has the objectionable effect of inserting "blocks" of noise between the signal dots and dashes.

In order to cause the control to operate quickly to increase gain, and slowly to decrease it, the biasing voltage is applied through a time-lag circuit comprising a dry-contact rectifier and shunt condenser. The combination has an asymmetric resistance, which, when a "dash" commences, holds the output volume substantially constant for, say, the ensuing "dash" interval, without admitting any background "noise" in between.

Kolster-Brandes, Ltd., and L. W. Reinken. Application date June 1st, 1935. No. 457614.

REMOTE TUNING CONTROL

A MOTOR-CAR set is tuned through a cable from a circular casing, which contains a variable condenser and a lamp for illuminating the wavelength scale. The lid of the casing is transparent, and is rotated to turn the spindle of the tuning condenser. This simultaneously moves the lamp so that it throws the shadow of an indicator needle on to a translucent scale mounted near the under-surface of the lid. A switch on the side of the casing brings a second condenser into circuit to change the waveband setting. A volume-control knob is also fitted so as to protrude through one side of the casing. The whole arrangement is designed to facilitate single-handed manipulation.

E. K. Cole, Ltd., and R. I. Cowley. Application date August 14th, 1935. No. 457217.

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