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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.

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EDITORIAL COMMENT

"Better Reception"

A Word to New Readers

WITH this issue we present a booklet entitled "Better Reception," in which has been collected a large amount of information covering all the more important aspects of the subject. Although much of the material in this booklet will, it is hoped, be of value to those who have been readers of this journal for some time, the articles have been written primarily for the benefit of newcomers, and particularly for those who are beginning to take a serious interest in the technical side of wireless reception.

Introducing Ourselves

To describe this booklet as an introduction to *The Wireless World* would perhaps be an exaggeration. The subject of broadcast reception (which is but one of the aspects of radio to be covered in our pages) is too diverse and complex for even an introduction to it to be compressed into 32 pages. Thus, although we cannot with truth print on the last page of the booklet the classical formula, "New readers start from here," we can at least hope that the articles in "Better Reception" will help such readers towards an appreciation of the matter regularly appearing in the pages of the journal.

The time seems opportune for a word about the scope of *The Wireless World*. New readers sometimes find that some of our articles require a good deal of study. That is because we concern ourselves mainly with the technique of wireless, and our regular readers have shown most clearly that they regard that as our proper sphere. But every effort is made to treat the subject as simply and clearly as possible; mathematical articles are comparatively few and even when recourse must be had to mathematics to illustrate a principle the author's conclusions are given for the benefit of those who cannot follow his arguments. Many of our subjects must be dealt with on a quantitative basis if the articles are to be of any value to the serious wireless worker, and it is our aim to cover every interest within our sphere.

Kilocycles Only

An Air Ministry Change

ACCORDING to a "Notice to Airmen" recently issued, the Air Ministry has decided that "As and from March 1st, 1939, the waves used in radio signalling will be designated by their frequency in kilocycles per second or megacycles per second, and not by their length in metres, in all communications exchanged between United Kingdom aircraft and United Kingdom aeronautical stations."

Custom Dies Hard

This change, though it will probably cause some minor initial difficulties among those who have for long been accustomed to think in terms of wavelength, is likely to be eventually beneficial and is certainly, as befits anything connected with air transport, in keeping with present international tendencies. The habit of thinking in frequencies is rapidly displacing the wavelength convention, which now has little justification except in connection with such things as resonant aerials and Lecher wires.

The Modern Receiver Stage

IN this series of articles the action of the modern receiver will be treated in detail stage by stage, especial attention being paid to the effects of any changes which can be made to a circuit. Not only will one or more particular circuits be discussed, therefore, but it will become clear why the arrangement adopted is the best for that receiver.

Part 1.—GENERAL BALANCE AND PERFORMANCE

ALL good design is very largely a matter of compromise between conflicting factors, and not all of these factors are technical; some are economic, others are æsthetic. When considering the design of a receiver certain standards of performance can be laid down, and provided that they are not mutually conflicting they can be realised in practice. The æsthetic standards, such as the shape and colour of the cabinet, and the arrangement of the controls, can also be met.

When cost is important, as it usually is, another factor is introduced and one which profoundly modifies the technical design of the receiver. It may often happen that it is impossible to obtain the required performance at the price which is laid down, and then something must be sacrificed.

If the question of a definite price limit is ignored, however, and price only enters in so far as it must be kept at a minimum for the performance demanded, no two receivers are likely to be the same. Ideally, different designers setting out to produce receivers of the same performance for manufacture in the same factory would produce identical designs.

In practice, different designs result very largely because factory conditions are different. One firm, for instance, may have exceptional facilities for the cheap production of mains transformers and can afford to fit a larger transformer than another. As a result, its designer is likely to choose a triode, or even a push-pull, output stage, and will not economise in current consumption. Another firm to whom mains transformers are more expensive will reduce their cost by cutting the current to a minimum; a pentode output valve will be used. In hundreds of different ways small variations between the products of different designers will creep in.

In the case of the amateur the considerations are rather different, and his choice of design depends more on what components he has on hand rather than on the total cost of the parts. If he has a good mains unit with an output of, say, 500 volts at 100 mA, he will naturally prefer to use it with a single 25-watt triode output valve instead of buying a new transformer of, perhaps, 400 volts at 125 mA and using two push-pull 12-watt triodes. Technically, the latter course is the more perfect and it is little, if any, more costly if all parts are bought new. It would be much more expensive, however, if it entailed the loss of material on hand.

In addition to questions of cost, the same standard of performance does not please everyone. In commercially produced receivers a rough balance is preserved between the main attributes of sensitivity, selectivity and quality. The higher the price of a receiver the better

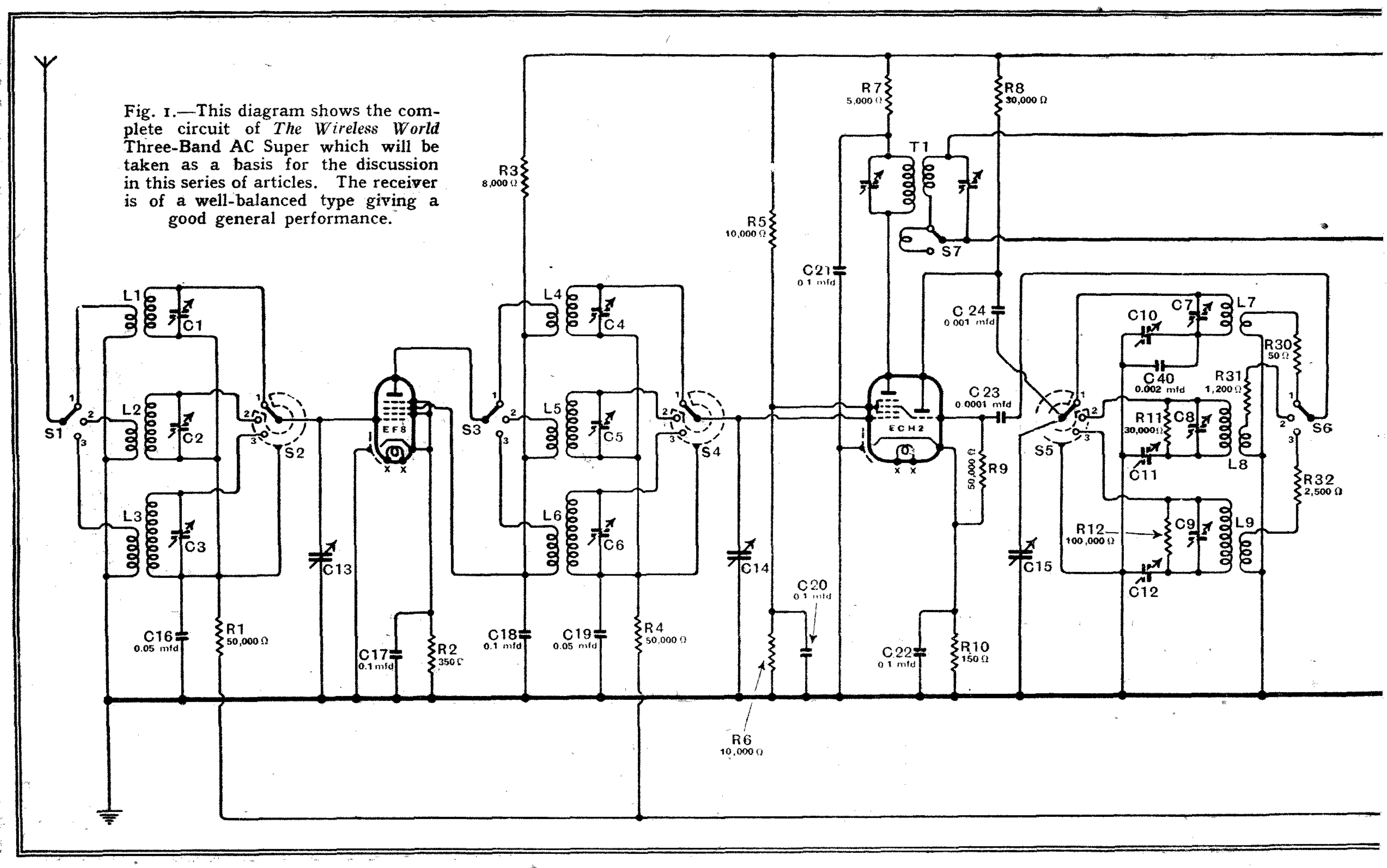


Fig. 1.—This diagram shows the complete circuit of *The Wireless World* Three-Band AC Super which will be taken as a basis for the discussion in this series of articles. The receiver is of a well-balanced type giving a good general performance.

by Stage

it is likely to be in all three. A balanced performance such as this best meets the average requirements, and most people consequently rightly choose such sets.

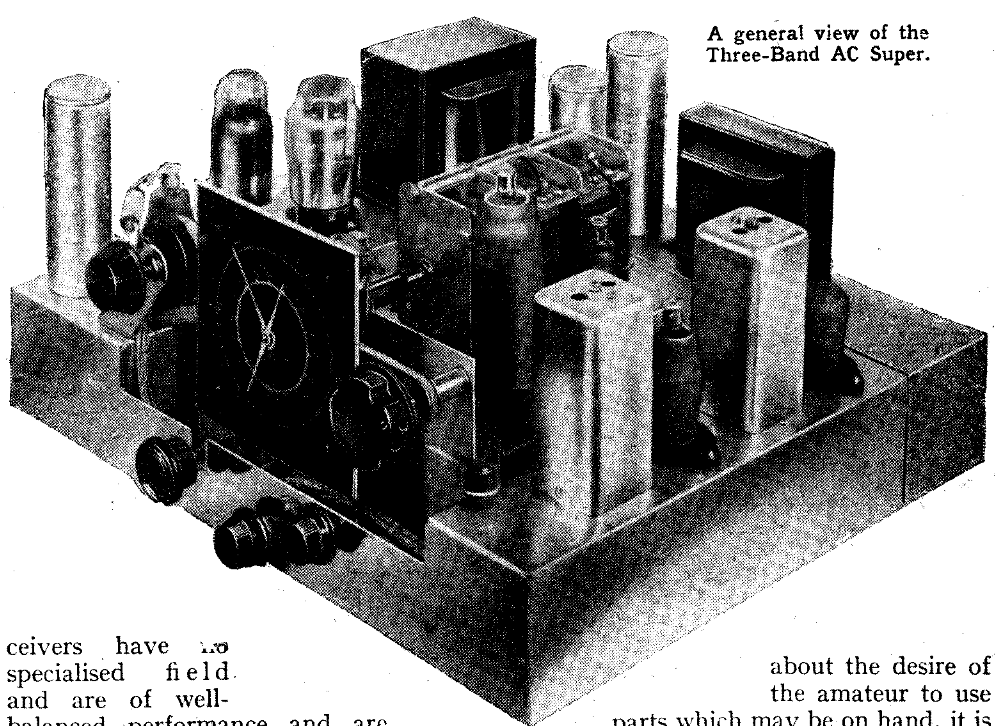
This general balance does not suit all, however. The listener at extreme distances requires higher sensitivity and selectivity than the average and can tolerate a lower standard of quality. At his distance he probably cannot get first-class quality in any case.

Another listener lives only a few miles from a broadcasting station and listens to no other. It is a waste of money for him to pay for sensitivity and selectivity when he wants quality of reproduction above all.

Between these extremes there are all grades of requirements, and it is here that the amateur comes into his own, for he can build a receiver of just the kind he needs. Moreover, if his requirements change in time, he can alter his set suitably.

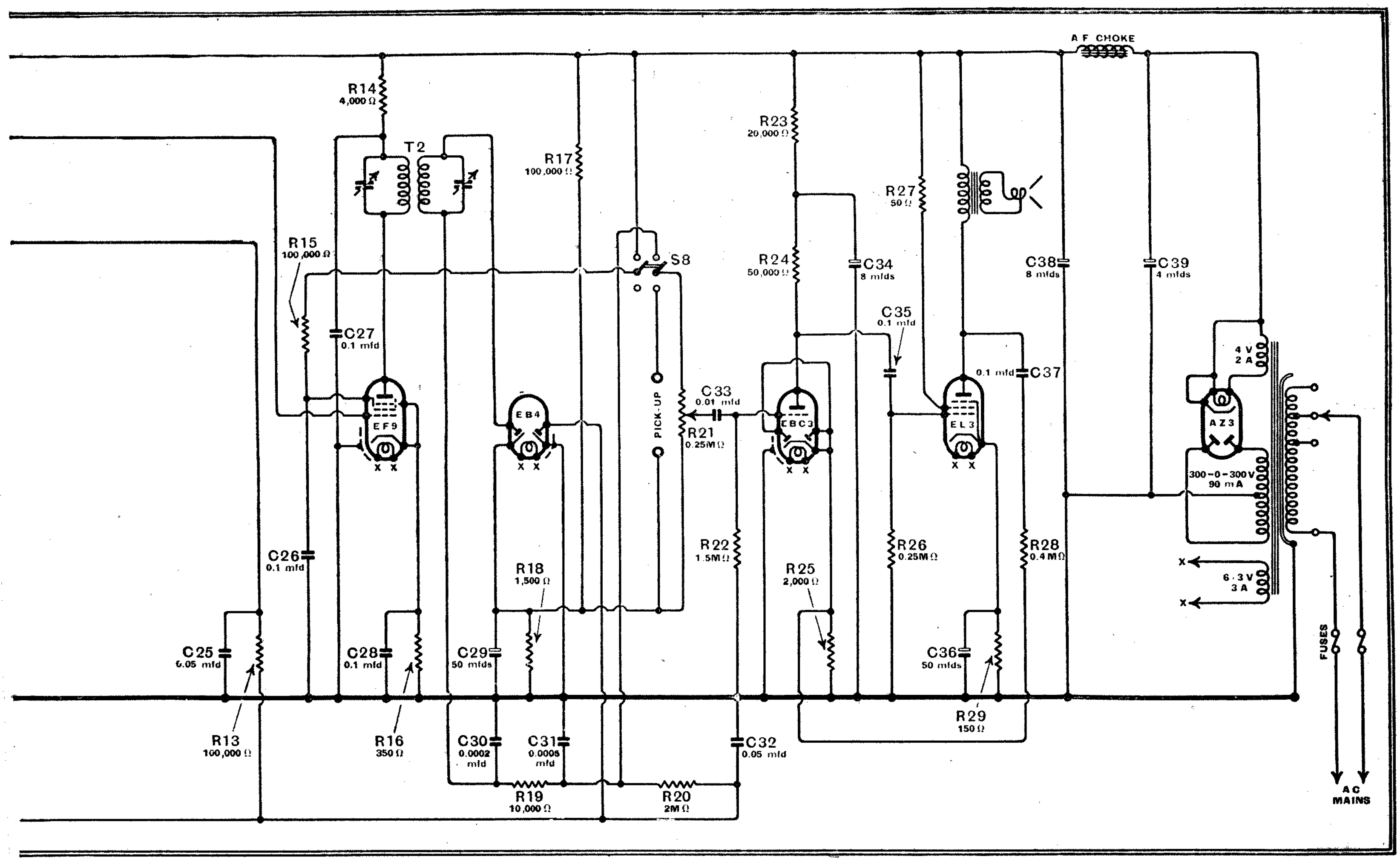
Modifying Designs

From time to time details of receivers designed in *The Wireless World* Laboratory are published, and these sets represent all classes. In addition to meeting many somewhat specialised requirements, they also illustrate in practical form new developments in technique. Other receivers have no specialised field and are of well-balanced performance and are illustrative of current practice. In all *Wireless World* receivers, however, the question of quality of reproduction is kept well to the fore in design. When a compromise between quality and some other factor is inevitable the choice lies in favour of quality unless this would be *seriously* detrimental to the other attributes.


A general view of the Three-Band AC Super.

Bearing in mind the earlier remarks about the desire of the amateur to use parts which may be on hand, it is not expected that everyone building a receiver will adhere exactly to the specification. Quite a lot of latitude is often permissible and more than minor changes can be made if they are carried out properly.

It is just here that the difficulty arises. It requires a good deal of knowledge to know just what alterations it is possible to make safely; sometimes, in fact, it is not



The Modern Receiver Stage by Stage—
possible to predict whether a change will be satisfactory. It must be settled by trial.

The beginner cannot be advised to make any changes either in components, layout, or wiring, for he lacks the knowledge and experience necessary to predict the effect of changes. The expert can do as he likes, for if his changes are unsatisfactory, as they are bound to be sometimes, he can trace and remedy the trouble for himself.

Between these extremes are many who can carry out modifications of varying degrees of complexity with success. Now, the introduction of any alteration to the design of a receiver necessitates some familiarity with circuit theory, and the bigger the alteration the greater must be knowledge.

To change any part of a design, the amateur must be in some degree a prophet. He wishes, let us say, to improve the automatic volume control. There are perhaps half a dozen different ways of doing so, and he must consider each carefully and judge how each will affect the performance in other respects.

One system may introduce distortion on strong signals, another on signals of a particular strength, while still another may mute the receiver on very weak signals. One may be simple and straightforward, while another may be complex and critical in adjustment.

Since perfection is rarely to be found, whichever method he chooses will have some drawback, and it is up to him to choose the one with the least disadvantages from his point of view. Having done this, he has to consider it in relation to the whole receiver with a view to minimising its drawbacks.

Now, this cannot be done without a good working knowledge of what goes on in a receiver, and in this series of articles it is proposed to discuss in detail every part of a typical modern set. It is best to start with a well-balanced receiver rather than with a specialised type, and we shall accordingly consider *The Wireless World* Three-Band AC Super.[1]

It will be remembered that this receiver is a superheterodyne with one short waveband, in addition to the medium and long wavebands. It has one RF stage, frequency-changer, one IF stage, diode detector and AVC system, triode AF amplifier and pentode output valve. Negative feed-back is used, and there is variable selectivity.

The receiver is sensitive and selective, and gives good-quality reproduction. It is not superlative in any one of its qualities, for if it were it would probably be deficient in others, but it has a very well-balanced performance. It is, then, a particularly good set to take for our purposes, since it will be relatively easy to show how an alteration which effects an improvement in one attribute is likely to spoil the performance in other ways.

The complete circuit diagram of this receiver is repeated in Fig. 1 for ease in reference. At first it may seem complex, but this is more apparent than real, and is caused largely by the switching. In succeeding articles we shall analyse it step by step, and the complexity will disappear.

[1] *The Wireless World*, December 22nd and 29th, 1938.

The Three-Band AC Super

Before doing so, however, a few words about the general arrangement may be advisable. The receiver is a superheterodyne because it is easier to secure high selectivity with it than with a straight set. Because it is a superheterodyne, a frequency-changer is necessary.

Now, there is a very broad optimum signal level at which a frequency-changer should operate. If the signal is too strong, distortion and whistles are likely, while if it is too small, background noise becomes serious. The amount of amplification needed before the frequency-changer, therefore, depends upon the strength of the signal to be received.

With strong signals no amplification is necessary, but with weak ones quite high gain is desirable. Experience shows that one RF stage is sufficient.

The amount of IF amplification needed depends on the frequency-changer output and upon the detector input required. If the detector is to be operated at a high level then two stages may be necessary, but with the usual moderate input a single high-gain stage suffices.

The type of detector, its normal input level, and to some degree the IF circuits, depend upon the AVC arrangements. The inter-relations are actually quite complex, and will be dealt with later in this series.

Turning now to the AF circuits, the output valve is chosen to give the necessary output with the required freedom from distortion. The choice between triode and pentode is dictated largely by their relative efficiency, the standard of quality required, and the sensitivity obtainable.

The gain and type of intermediate AF stage is not, however, chosen to bring the normal detector output up to the level required by the output stage. It is chosen to suit the output of an average gramophone pick-up, because this is less than the detector output.

This at once raises a point which well illustrates the necessity for care in making alterations. If one has a receiver in which no provision is made for the use of a pick-up, one is tempted to connect it to the first AF valve, and the changes for this are usually very simple indeed. It may easily happen, however, that the receiver has its detector designed to operate at an unusually high-signal level, and the audio-frequency gain will be correspondingly low. It will then be impossible to obtain adequate volume from the pick-up. Another AF stage may have to be introduced, and this is obviously much more complicated.

It is not usually difficult, however, to judge whether a modification such as this will be satisfactory or not. It is easy to form a rough estimate of the AF stage gain; but trouble is likely if an alteration is made without thinking about it beforehand.

PROBLEM CORNER—9

Test Your Powers of Deduction

HENRY FARRAD, though an invalid and therefore unable to investigate wireless problems on the spot, has so developed his powers of deduction that he can generally diagnose receiver faults successfully from the most unpromising data. Here is a comparatively easy problem from his postbag.

2, Tanner Road,
Shillingsworth.

My dear Farrad,

We still have the all-wave set I got over two years ago, and the reason you haven't heard much about it is that it has been behaving itself very well. What little spots of bother there have been I have been able to tackle myself, having had plenty of practice on its predecessor! After the first enthusiasm wore off I didn't do much with the short waves, but it has been used pretty regularly for the usual handful of good medium- and long-wave stations. Then just lately, having heard that there is so much news in English from different foreign stations, I though I would hear some of it. But I couldn't get a single thing below 27 metres, not even morse. Yet on 31 metres I heard several foreign stations quite well. Of course, I thought at first the batteries were down, but even when a new HT was put in and the LT freshly charged it wasn't much better, except that I got an American and one or two others on about 25 metres. But not a whisper of anything below that. As reception was quite good on other wavebands, my previous experience warned me to look at the waveband switch for dirty contacts, but after the twisting to and fro I gave the knob when turning to the short waves after such a long lapse it had proved to be truly self-cleaning. So now I am stuck, and hope you will help once again; for, although I can tackle most things in an old straight set, I am still not quite clear about superhets.

Yours ever,
Bob.

For Henry Farrad's solution turn to page 206.

Radio Trouble-Shooters Handbook. By Alfred A. Ghirardi. Pp. 518. Published by Radio and Technical Publishing Co., 45, Astor Place, New York City, U.S.A. Price $3.

THIS book should be of great value to those engaged in servicing American receivers, since it contains an enormous amount of information. Some 270 pages are given to a list of the common troubles encountered in 3,313 models of various makes.

There are lists of the different intermediate frequencies used and data on car radio sets. The wiring diagrams of 90 American cars are given and there are details for the elimination of ignition interference with different models.

Designing an Individual Receiver

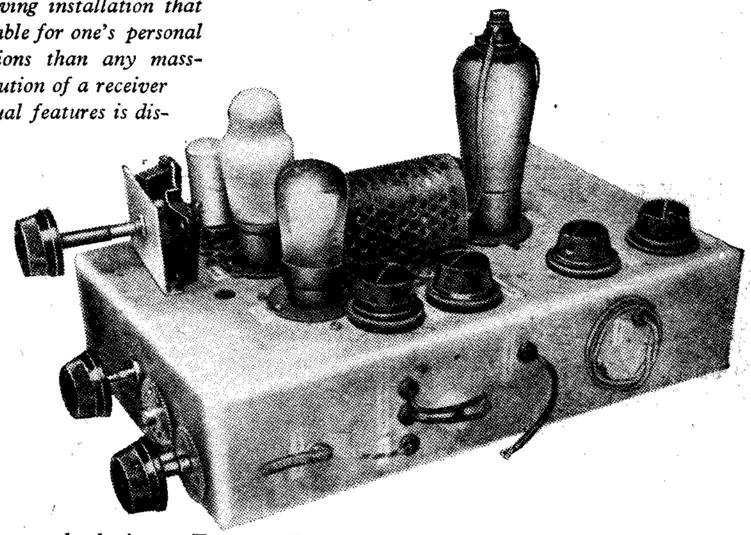
EVOLVING A SET TO SATISFY SPECIAL REQUIREMENTS

By R. H. WALLACE

NOT the least of the advantages of being a wireless amateur is that one can design and build a receiving installation that is likely to be more suitable for one's personal tastes and local conditions than any mass-produced set. The evolution of a receiver embodying several unusual features is discussed step by step in this article and its sequel.

THE chief differences between the design of a production receiver and that of an individual one arise from the respective quantities to be made. This naturally leads to a variation in technique, and to quite different solutions of the same problems. The commercial designer has the advantages of mass production, and can, therefore, call for components to his own specification, for resistances of non-standard values, or a variable condenser of special type, and so on. He can naturally rely on paying much less than the home constructor for those parts which he cannot himself manufacture, and if a standard article does not exactly suit his purpose, can arrange with the maker to supply it in a more convenient form. On the debit side, he is constantly working against cost figures, and must introduce many features which he would not otherwise choose in order to compete with his rivals.

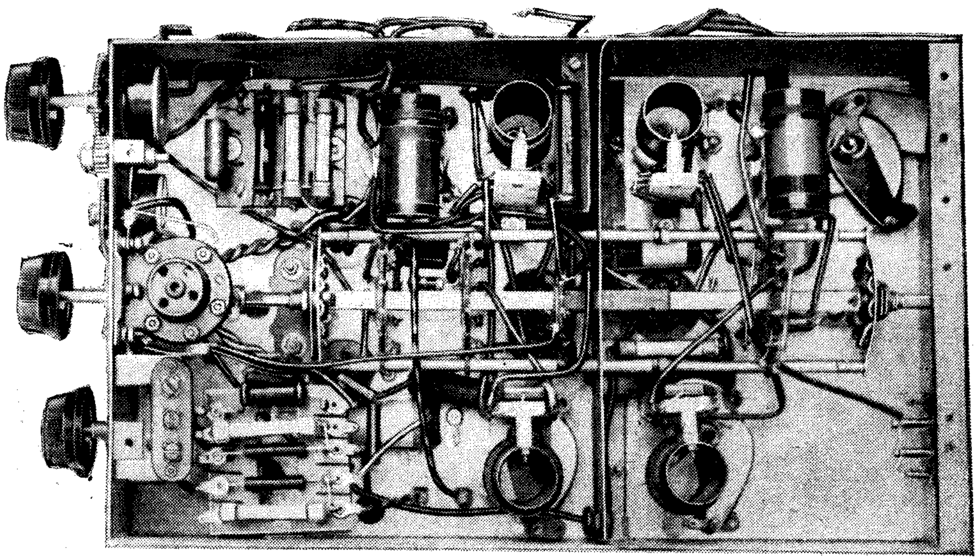
The home constructor has the advantage on his side of being able to incorporate the very latest developments even if these become known while the design is in preparation; he knows just what he requires, and if he personally does not think some feature desirable can omit it with consequent saving in cost. He is also able to alter the response of the set to suit the conditions of the listening room, thus simplifying the tone-control section. In addition to these points, he is able to choose the cabinet and the power sections so that he can rebuild from time to time and keep up to date.



Top view of the pre-tuned chassis ; the connections at the side for the superhet unit are shown ; note the use of rubber grommets where these connections emerge. The felt discs visible under the tuning knobs of the variable condensers are to prevent any movement of these through vibration. Photo was taken before the fitting of the low-pass filter and a temporary condenser filter is shown.

Some readers may argue that the complete design of a set is a very long and troublesome business, and that they have not the ability or the time to perform the necessary calculations. For these there are the designs published from time to time in *The Wireless World*, and amongst these are to be found circuits for most cases. There is, however, another use for these published sets, and that is as a short cut for the individual designer in the matter of calculations; the knowledge that a certain circuit and arrangement has worked satisfactorily is a good indication that a choice of somewhat similar components will give a comparable performance.

A design for a diode load circuit might be wanted, for instance. Well, a search of back numbers will probably reveal a similar set, and the values may be taken from this in much less time than it would take to calculate them. It should not be thought that the indiscriminate use of details of circuits will always be successful; care is needed, of course, especially to see that the receiver does not become unstable, but a great deal of time may be saved by judicious borrowing.



Underside of the pre-tuned unit ; note the two panels carrying, respectively, the diode and the phase-changer components ; also the small panel mounting for the 200-ohm resistor in the cathode of the RF pentode, and that for the voltage dropping resistance fitted near the dividing screen. The 8-mfd. condenser for detector decoupling is under the AF output terminal strip at the front of the chassis.

Clarifying One's Ideas

The first step in any design should be to set out on paper the specification; by this is meant the orderly setting forth of those features which are considered essential or merely desirable so that it may be clear just what will be needed to give effect to them. This is a step which should on no account be omitted as much valuable time may be wasted at later stages of the design if the end is not clearly in sight. It may be needful to relinquish some of the desirable points if they cause undue difficulty, but any temptation to jettison those set down as essential would obviously have to be resisted.

The question of future alterations ought to be borne in mind, and if opportunity occurs where the use of a slightly dearer component will leave a substantial margin of performance, then it would be better to choose it; the time may come when this may save much more than the difference. Similar remarks apply to the provision of extra positions on switches and the choice of a cabinet of ample size so that

Designing an Individual Receiver—
there is room for any needed extensions.

Consideration of further steps in the design and the manner in which use may be made of published circuits to save time and better guarantee the eventual performance can best be described by dealing with an actual example. The design worked out in the following example was for the writer's own set, which started out as a local-station quality receiver with a moderate output, and which it was desired to rebuild as a more ambitious model with less restriction on the stations obtainable. It proved possible to do this and provide all the desired features at no greater cost than would have been involved in buying a good table model, and with the incorporation of many extra points, plus a vastly better quality of reproduction, than the alternative course would have provided.

Basis of the Design

The specification had first to be decided upon. After some thought and a scrutiny of the various features included in the better class of set the following was sketched out and used as the basis of the design:—

SPECIFICATION.

Essential Features:—High-quality local reception. Reliable daylight reception of Regional stations. Provision for gramophone reproduction. Simplicity of operation. Provision of switching for extension lines.

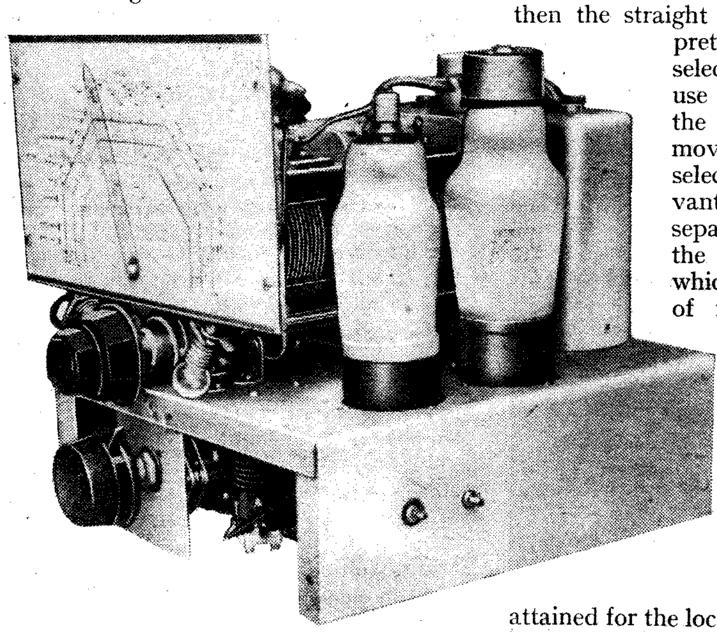
Desirable Features:—Permanent tuning of local stations. Foreign and short-wave reception. Low noise level. Use of existing cabinet, speaker and power packs. Suitable tone control for gramophone and radio.

The next step was to decide on the circuit arrangement and the nature and amount of amplification required. Several possibilities were considered, as the desired performance could be obtained in different ways. The high-quality local reception could be provided by a simple RF tuner and grid detector, suitably designed, or by the use of really wide-band variable selectivity. It is clear that point two in the specification could only readily be met by the inclusion of a superhet with AVC, and if this were used then the provision of short-wave reception would not be costly.

The reliable daylight reception of the Regional stations would necessitate so much amplification that the worth-while foreign ones would be receivable at good strength, since few of these are any weaker than some of the home transmitters at the minimum of a "fade." If short-wave stations were to be satisfactory, then it was clear that there would have to be two bands at least in order to provide easy operation and not-too-critical tuning. There was the alternative of band spreading, but this was considered by the writer to be rather complicated for uninstructed users, and was therefore ruled out; even the use of two bands involved the choice of a good slow-motion drive to make tuning simple and the duplication of a given setting easy.

If short waves were to be allowed for, then the IF was at once settled at about 465 kc/s. There was then the question of whether one or two stages would be needed; with two stages the sideband cutting would have been drastic enough to make the provision of a good deal of tone control, or the use of variable selectivity, needful even for the average distant station, while with one stage at this frequency the cutting would not be serious on any but the locals. The problem therefore resolved itself into a choice between two alternatives; a superhet with variable selectivity, giving a band width of at least 20 kc/s, and with the detector designed accordingly, or a more ordinary superhet, plus some form of "straight" tuner for the local stations.

If the dual construction were chosen, then the straight section could easily be pretuned and operated by a selector switch, while the use of only one IF stage in the other section would remove the need for variable selectivity there. Other advantages of the adoption of separate tuners would be the much greater ease with which the required standard of reproduction could be attained for the locals and the greater overall reliability achieved by the use of two units.



Top of superhet unit; the aerial terminal is the one showing on the right; the lower knob is for wavechange and the upper for tuning; one of the bulbs illuminating the switch indicator is visible between the two knobs.

The commercial designer, faced with the same problem, would quite likely choose the variable selectivity superhet. As in the first place it lends itself more easily to manufacturing methods of to-day, and is therefore cheaper, since the factory can readily make allowances in the overall response to correct for sideband cutting in the tuned circuits, whereas the amateur has often not the necessary facilities for accurate measurement of the amount of compensation required. Also, the use of the more complicated IF transformers is not much more costly for the manufacturer, and a great deal less so than the provision of extra valves with the bigger cabinet needed to house them. The writer found that the advantages attaching to the use of two units did, in his case, far outweigh the disadvantages, and decided on that course. He also considered that it would be as cheap to buy ready made the necessary tuner unit, as this would save time and avoid the need for much ganging.

Choosing the Superhet Unit

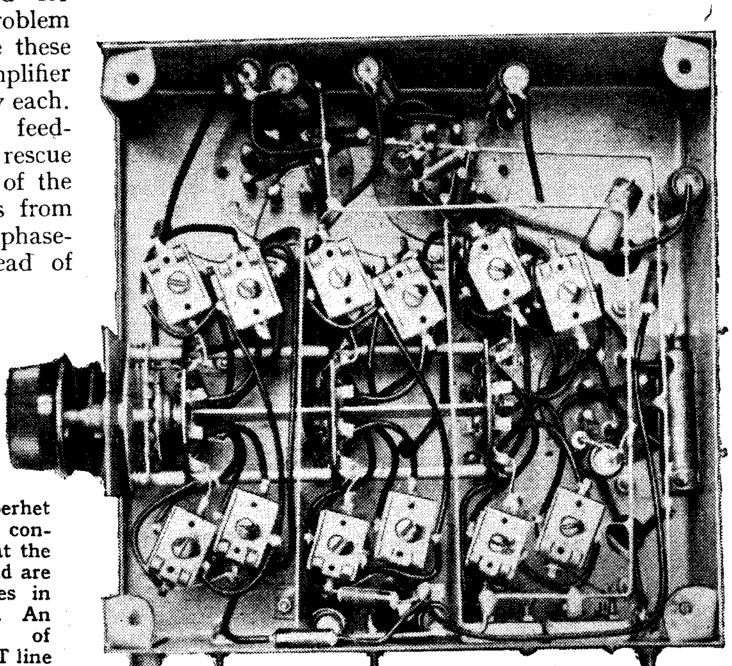
The type of tuner had now to be settled; the required performance, in regard to sensitivity, could actually be obtained without the use of any RF pre-amplifier. But as one of the desirable features was a low noise level, it was clear that this would be more readily attained by the use of one stage tuned to signal frequency. This was accordingly decided upon. Since short-wave reception was to be included, the best valve for the frequency-changer was thought to be a triode-hexode and the IF was fixed at 465 kc/s. There would then be no need for tone correction to compensate for the moderate sideband cutting in this section.

As regards the AF amplifier, the specification of good-quality reception with the speaker available (an efficient type of baffle-mounted moving-coil) called for about 5 watts undistorted output, since the set was to be used in a room of moderate size. A push-pull amplifier is easier to design for really good reproduction, and no better design for the output required could be wanted than the *Wireless World* Push-Pull Quality Amplifier. When modified for the higher rating of the PX4 valves now permissible, this gives an undistorted output of 7 to 8 watts. Since the existing power pack could deliver 400 volts at 120 mA, this could comfortably feed the amplifier provided that the tuned stages were fed from some other source. Happily, a pack with an output of 250 volts at 60 mA was available, and the use of two separate sources of supply made the securing of stability easier, besides permitting the use of condensers of lower voltage rating in the tuner units. In order to save some expense the modified version of the amplifier given in connection with the Pretuned Receiver was used, the two valves in each stage being biased by common resistors without decoupling condensers.

Since the chosen amplifier required a split-phase input, the necessary feeder unit had to be allowed for and it had to function on both the straight and superhet sections. The question here was how to reconcile the differing outputs of the two units. An examination of the Pretuned Receiver above mentioned showed that the work of phase-splitting and detection could be combined in a single triode as long as the tuning coils and condensers

Designing an Individual Receiver—
were not earthed, and that the output of a similar type of tuner, with one RF stage, would then be adequate. This obviated the need for a trial to see if more amplification were needed for the local stations, whereas had this design not been available it would have been necessary to try out the circuit and find if this were in fact the case. As it was, there was no doubt that the output would be approximately of the desired value.

The AF output of the superhet diode would clearly have to be much greater than that of the straight section on account of the need for AVC, and the problem was how to reconcile these two so that the amplifier was equally loaded by each. The use of negative feed-back came to the rescue here. If the output of the diode was fed across from grid to earth of the phase-reversing valve instead of from grid to cathode as with the straight tuner, then the feed-back taking place in the cathode coupling resistance would limit the gain to under two (measuring the latter across the whole output). A gain of this value would compare suitably with that on the other tuner, which may be reckoned as about ten times as great.



Underside of the superhet tuner; the padding condensers are mounted at the left side of the unit and are adjusted through holes in the side of the chassis. An additional condenser of 0.1 mfd. across the HT line was found necessary to secure stability.

It was therefore decided to follow the design of the *Wireless World* Pretuned Receiver fairly closely so far as the general arrangement went, though it was evident that the switching would have to be quite different in order to provide for the use of the other unit and to effect the appropriate alterations for the detector stage. The tuning coils to be used were of the compact solenoid type originally produced for plug-in use in short-wave sets and mounted on ceramic bases. They were selected as they were small and wound separately for the long and medium wavebands. Such coils made for easier switching and greater efficiency, and it would then be possible to make signals from the three local stations of equal volume by shunting the tuned circuits with resistances. Provision was to be made for the reception of both the long- and medium-wave National transmitters because the "Little Nationals" are silent during part of the day.

The performance noted in the case of the *Wireless World* design made it almost certain that no reaction would be needed, save possibly in the case of the North National. With this in mind, and also the efficiency of the switching, it was decided to use three separate coils in each stage, two for the medium waves, by which means the tuning condensers could be connected permanently across the coils, and all the switch had to do was to transfer the grid leak to the right point.

Stability should not be any difficulty in the straight tuner, as the band width of the circuits would be great and the stray capacity small. The superhet diode would have to be included in this chassis, however, and it would be necessary to allow adequate screening of this and the output from the unit. The location of the components associated with the diode in this assembly made the switch leads short and permitted the separate mounting of the tuner unit on rubber, as is usual nowadays. The diode circuit of the *Wireless World* Four-Band Super-Six was followed closely, the only alteration being the use of an extra resistance for the diode load in order to divert the DC component from the volume control, thus avoiding risk of noisy operation. This has the effect of making the AC load less than the DC load and somewhat reducing the modulation depth that the detector can handle without distortion; but the difference is slight, and in this case only affects the distant stations.

A small problem was raised by the differing power requirements of the two units; the "straight" section would take about 10 mA, while the other would consume at least 30 mA. Further, if the RF valve of the straight unit were switched off for gramophone reproduction, the consumption would be still less. Something had to be done to reconcile these or there might have been trouble with the power unit. The difference on radio between the two units was equalised by choosing a rather smaller value than usual for the potentiometer of the RF valve of the local unit, and thus bringing its consumption up to that of the other. The rest of the problem was solved by fitting a turntable lamp; this was needed anyway, and might just as well help. A low-consumption lamp of the 200- to 230-volt 7-watt type would take about 30 mA and provide ample illumination, while acting at the same time as a load equaliser.

(*To be concluded.*)

Television Programmes

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

An hour's special film transmission intended for demonstration purposes will be given from 11 a.m. till 12 noon each week-day. The National or Regional programme will be radiated on 41.5 Mc/s from approximately 7.45 to 9 p.m. every day.

THURSDAY, MARCH 2nd.

3, "The Fletcher Case," a "telecrime" by Mileson Horton. **3.20,** Gaumont-British News. **3.30,** 221st edition of Picture Page.

9, Cabaret, including Charles Harrison and Walsh and Barker. **9.30,** British Movietonews. **9.40,** 222nd edition of Picture Page. **10.10,** News.

FRIDAY, MARCH 3rd.

3, The Ambrose Octet. **3.25,** British Movietonews. **3.35,** "The King of Spain's Daughter," a play by Teresa Deevy.

9, Catherine Lacey and Percy Marmont in "The Unquiet Spirit," by Jean-Jacques Bernard; music by Sibelius. **10.15,** News.

SATURDAY, MARCH 4th.

2.55, Rugger O.B. from Twickenham: Royal Navy v. The Army. **3.40,** Cartoon Film. **3.45,** Gaumont-British News. **3.50-4.30,** Rugger O.B. continued.

9, Jack Jackson and his Band. **9.25,** Cartoon Film. **9.30,** British Movietonews. **9.40,** O.B. from the Empress Hall, Earls Court. Viewers will see exhibition skating by Daphne Walker, and the last period of the match, Earls Court Rangers v. Harringay Racers. **10.5,** "Condemned to be Shot," a play in the first person by R. E. J. Brooke. **10.25,** News.

SUNDAY, MARCH 5th.

3, Ballet: "The Selfish Giant"; choreography by Joy Newton, music by Eric Coates. **3.15,** Film. **3.25,** Cartoons, by Patrick Bellew. **3.45,** Ballet: "Strauss Tänze."

8.50, News. **9.5-10.40,** Lilli Palmer and Cecil Parker in "Little Ladyship," a comedy by Ian Hay from the Strand Theatre.

MONDAY, MARCH 6th.

3, "In the Barber's Chair," the first of a new series featuring Charles Heslop. **3.10,** Cartoon Film. **3.15,** Pamela Norris, pianoforte. **3.25,** Gaumont-British News. **3.35,** Henry Oscar in Bernard Shaw's play "The Dark Lady of the Sonnets."

9, "Harlem in Mayfair," a coloured cabaret including Adelaide Hall. **9.30,** O.B. from the Empress Hall, Earls Court, of N.S.C. Boxing. **10,** Guest Night. **10.30,** News.

TUESDAY, MARCH 7th.

3-4.15, "The Unquiet Spirit" (as on Friday at 9 p.m.).

9, News Map, 12:—Refugees. **9.20,** Cartoon Film. **9.25,** Wyndham Goldie as Prince Charles Edward Stuart in "Count Albany," a historic invention by Donald Carswell. **10.5,** Gaumont-British News. **10.15,** Edward Cooper in songs at the piano. **10.25,** "In the Barber's Chair," (as on Monday at 3 p.m.). **10.35,** News.

WEDNESDAY, MARCH 8th.

3, Big Bill Campbell in "Western Cabaret." **3.50,** Gaumont-British News.

9, Ernest Milton plays his original part in "Rope," the thriller by Patrick Hamilton. **10.35,** News.

The People's Set

By
WOLF E. FELIX

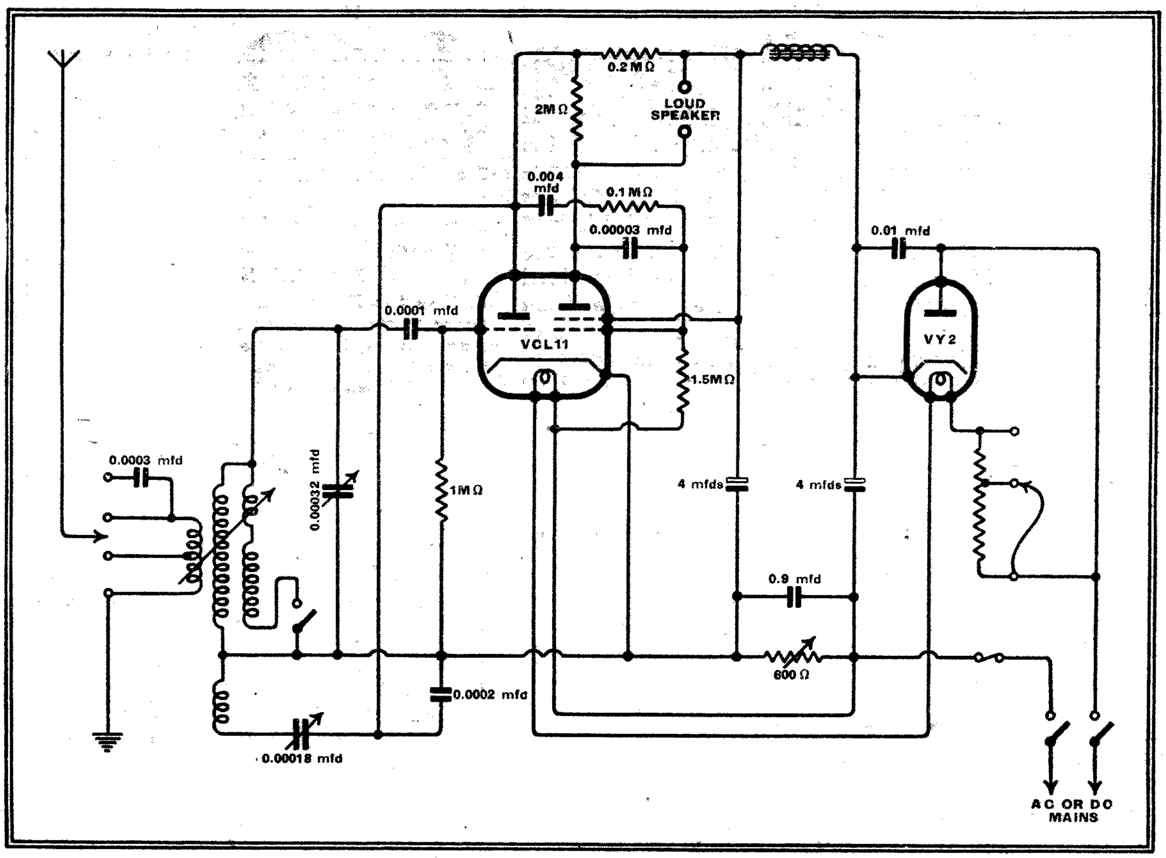
CO-OPERATIVE RECEIVER PRODUCTION IN GERMANY

THERE are still many misconceptions as to how the German "Volksempfänger" came into being, and still more on the effect of its introduction on receiver design and on the broadcast industry. This authoritative article by a German contributor explains the reasons for its success, and also surveys the co-operative receiver plan after some five years of trial.

CO-OPERATIVE production of radio sets is probably not a question of immediate practical interest in England. As one of the successful solutions to the problem of effective price reduction—or increase of sales possibilities—the German People's Set scheme should, however, command attention, the more so as comparatively little has so far been published about the details, and widely differing opinions seem to prevail as to the success, both with the manufacturer and the public. It may, therefore, be worth while to give an authentic account of the situation as it appears after five years of practical experience.

Co-operative methods are, as a general rule, resorted to only where individual effort has failed, or may be expected to do so. The co-operative scheme under which the German People's Receiver and its various followers were produced was no exception to the rule. The idea originated because in 1933 the prices of receivers in Germany were absolutely and relatively too high. Absolutely, because the lack of sets within the purchasing power of the masses was limiting sales, especially in the rural areas. Relatively, because German prices were considerably in excess of world prices. It should be remembered that 1930 saw the beginning of the great price drop in U.S.A., and that the British and Dutch radio industries had effected drastic reductions of receiver prices by 1932, the downward tendency apparently continuing. Prices in Germany, however, had remained practically unchanged throughout this period, protected by an effective price agreement among manufacturers. As the Hitler Government looked upon radio not only as one of the commodities that should be within the purchasing power of the poorer as well as the richer classes, but also as an important means of conveying propaganda, plans were immediately considered for a drastic reduction in set and valve prices. The methods successfully applied in U.S.A. and, to a lesser extent, in England, could not, for a variety of reasons, be used in Germany at that time. The ruling consideration in those days was to find occupation for six and a half million unemployed. Price-reduction by labour-saving, therefore, appeared to be out of the question—and the American method evidently consisted mainly in cutting down labour by installing highly specialised machinery. It was also thought dangerous to interfere with normal production and distribution, as nobody could foresee the effect of drastic price reductions on existing stocks and on merchandise in course of production—not to speak of the difficulty of bringing about any appreciable price drop without reducing the labour component. The way out of this conundrum was the design of an entirely new type of receiver, with the simplest specification compatible with the purpose in view and definitely less ambitious than anything else on the market. Such a set, if sufficiently cheap—say, about half the price of the nearest type of proprietary set—would, it was argued, create an additional market without disturbing the sales of normal sets.

The next question was as to who should manufacture this set. While the idea of erecting a special factory for the purpose (as realised later on for the People's Car) was doubtless also discussed, it was soon dropped for the much simpler scheme of manufacture on a co-operative basis, all existing receiver factories, to the number of 28, having a share in the production corresponding to their share in the total set market of the season before. It was only necessary to co-ordinate the production in such a way as to ensure punctual delivery of the quantities agreed upon by the industry and identical appearance, as well as performance, of sets independent of the manufacturer. The latter point demanded a detailed specification and a neutral institution where parts and assembled sets could be



Circuit diagram of the cheapest People's Set, Model DKE, an AC/DC receiver with a double triode-tetrode valve acting as detector and output.

The People's Set—

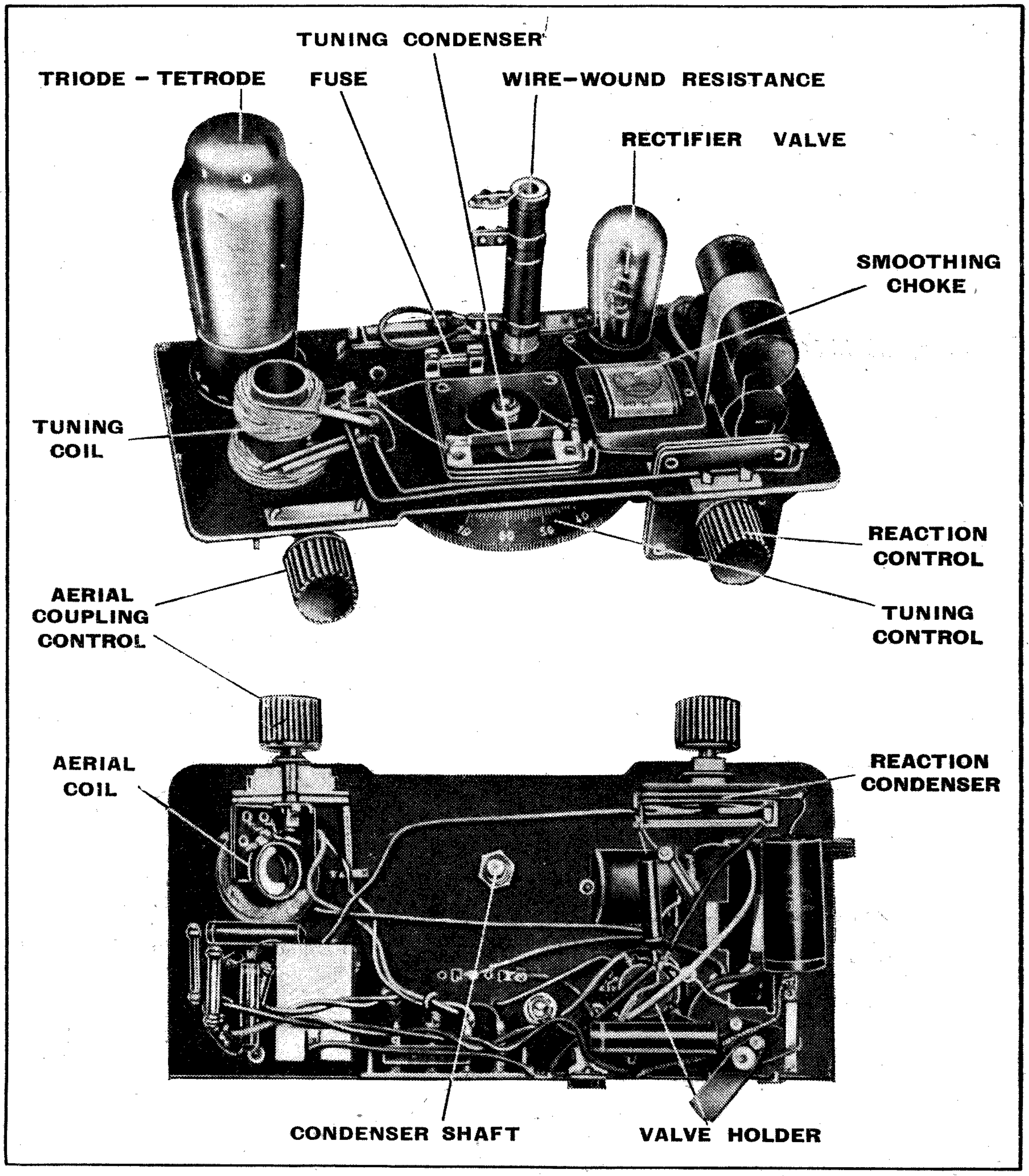
tested. The former could well be left to the existing organisation of the industry—the Radio Manufacturers' Economic Association or W.D.R.I.—membership having been made compulsory under the new regime.

Such, then, was the plan in outline. Its reception by the industry was mixed—as might be expected of a plan so novel and daring. It was feared in industrial circles that the People's Set might monopolise part of the existing market at prices ruinous to the industry. Evidently the entire plan stood or fell with the possibility of creating a completely new market without sapping the existing one. As a matter of fact, the apprehensions of manufacturers were later proved to be unfounded. Not only was the entire volume of People's Set sales—totalling about 3 millions in 5 years—an addition to the otherwise stable figure of proprietary receiver sales—about 1 million a year—but it so happened that the People's Set, in spite of its extremely and, at first sight, impossibly low price, was a first-class money-maker, saving several tottering small firms from the hands of the receiver. The solution of the enigma was in the magic word "mass-production." It is only natural that manufacturers gradually learnt how to save a penny here and another there until prices that once appeared disastrous were found to hold an ample margin of profit. A year and a half ago the price for the (slightly improved) first model was reduced by about 15 per cent. without a murmur from the industry. This season—the popularity of the first model having gradually declined after 5 years of production with but a slight change in valve equipment—a new small People's Set was introduced at not quite half the price of the original model, with about the same performance, and there is nobody who doubts that it will be a sound business proposition. Mass-production on a scale to warrant similar prices would have been almost impossible for individual manufacturers without official backing and help of propaganda and with the need to fight their competitors into the bargain.

The cutting-down of distribution costs played an important part in reducing the price of the German People's Sets, while the Telefunken licence—equivalent to the Marconi licence in England—was dropped. Moreover, Telefunken designed special valves for these sets and sold them to manufacturers at practically cost price (at the time, apparently counting on a safe profit in the long run).

The design of the People's Set has nothing unusual. It was, in fact, the work of a small committee of engineers of leading radio firms, under the auspices of the manufacturers' association, as in all subsequent cases of co-operative models. This body agreed on the circuit, built three or four competitive models, and decided on the final details. Complete drawings were then made and tenders invited from the parts industry for the various components. Prices were definitely fixed after comparison, and a list of manufacturers for every component drawn up. Components were tested by the Heinrich Hertz Institute, a research foundation formerly subsidised by the industry and today financed by the Government. Radio firms assemble sets from these standard components. They may, of course, be manufacturers of certain components as well and get these from their own workshops, as well as supplying them to other firms. Loud speakers were at first excluded from the list of such components. They had to be bought from the loudspeaker industry, as this group was at the time suffering from the decline in loudspeaker sales due to the disappearance from the market of sets with separate speakers. This is mentioned as typical of the spirit of collaboration prevalent in the German manufacturers' association and enabling the comparatively smooth working of these co-operative schemes.

It should also be remarked that the Government has limited itself to supplying the first suggestion and the general outlines of the scheme, after consultation with those concerned. There is, of



Chassis views from above and below of Model DKE. More than 700,000 were sold in the first five months of production.

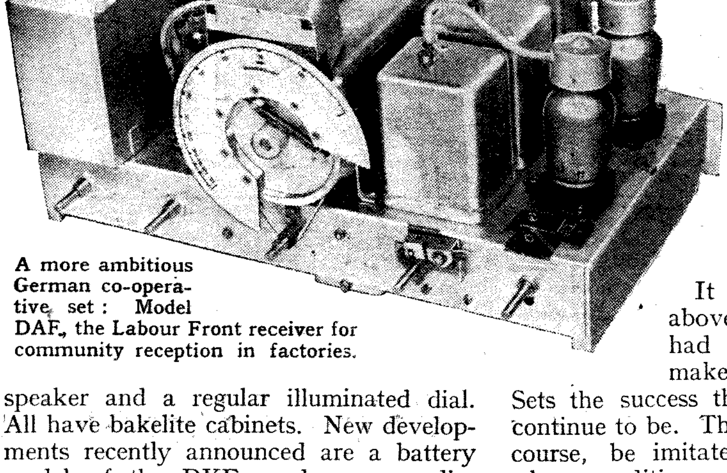
The People's Set—

course, no denying the fact that co-operation within the industry might not have been what it was without active Government interest and all this might imply for potential dissenters.

The indubitable success of the first People's Set, which was a simple two-valve regenerative detector with electromagnetic speaker, originally priced at 76 marks,* and later reduced to 65 marks,* led to the creation of several other "co-op." sets. The first of these, the DAF, was designed for community reception in factories, and has a very high-class specification for sound quality. It is used as a receiver in conjunction with amplifiers of different power. A small battery portable, the Olympia Koffer, was brought out in the year of the Olympic games, hence its name. It was developed by a firm with special experience in the portable field and manufactured by several, but not all, others. An improved edition of this straight four-valve receiver was brought out in 1937.

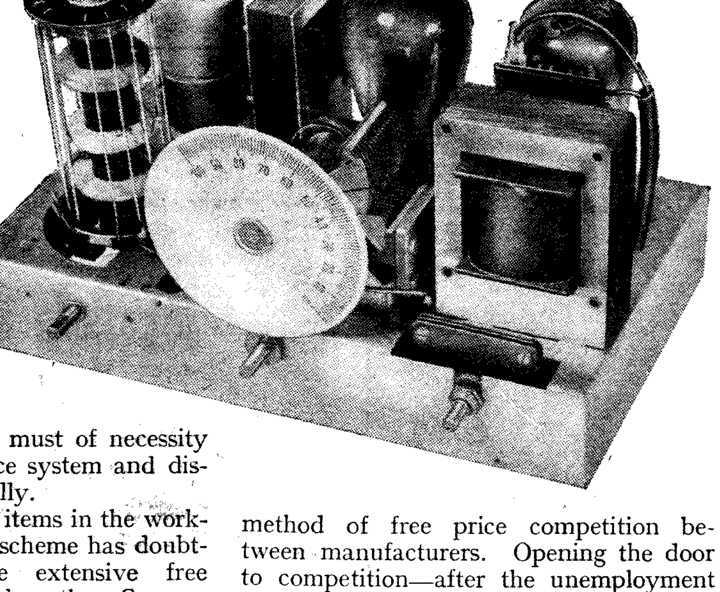
For Germans Overseas

The next was a special battery short-wave superhet for Germans living in overseas countries and complaining—as have many British folk in the Dominions and Colonies—that they were compelled to buy American sets because no competitive sets were available from the Fatherland. These sets were not produced in any considerable numbers, and most firms abstained from manufacturing them. The subsequent models of the People's Set, however, shared the success of the first. The AC model was followed by a DC, an AC-DC, and a battery set. Then came the new midget, the DKE, an AC-DC model with the same specification as the original People's Set, but priced as low as 35 marks. Finally, an improved edition of the 65 mark set with moving-coil speaker and a regular illuminated dial. All have bakelite cabinets. New developments recently announced are a battery model of the DKE, and a car radio, a cheap superhet, for the People's Car.



A more ambitious German co-operative set: Model DAF, the Labour Front receiver for community reception in factories.

The fear that these sets would sap the regular set market has gradually subsided, the straight set having otherwise almost vanished from the market. The attempts to produce People's Sets on a co-operative basis in countries other than Germany, e.g., Italy, Switzerland, Norway, etc., have partly suffered from the failure to appreciate the importance of a sufficiently marked differentiation between a set with an artificially reduced price and the rest of the models on the market. If this fact is lost sight of, the cheap set must of necessity influence the entire price system and disturb the market generally.



Improved People's Set, Model VE301, an AC receiver with moving coil speaker.

One of the important items in the working of the co-operative scheme has doubtless consisted in the extensive free propaganda enjoyed by the German People's Set. The nation-wide organisation of the Nazi party—especially the wireless sections attached to all regional party centres—has been harnessed to this task, making it a kind of patriotic duty to listen in, and removing every excuse by easiest instalment terms for these already cheap sets. Special Government propaganda caravans have been touring the country for years, stopping at every village and giving free radio concerts over excellent PA systems. These propaganda tours work to a detailed schedule, enabling local dealers and manufacturers' agents to tie up with them and gather in the harvest, which, by the way, consists in sales of the more expensive proprietary sets as well. The huge increase in the number of listeners since 1933, bringing to Germany the biggest radio listener-ship in the world, with the exception of U.S.A., was largely arrived at by this systematic touring of the countryside by trains of PA vans.

It will be seen from the above that many factors had to work together to make the German People's Sets the success they actually were and continue to be. The scheme could not, of course, be imitated in other countries, where conditions are different, especially not in countries with a high degree of radio saturation, as in Britain, where the main problem is to substitute modern for antiquated sets, and where there appears to be no possibility of opening up a new low-price market. A corollary of this may be found in the fact that a reduction of proprietary set prices has now been attempted and achieved in Germany in precisely the same way as in all other countries, viz., by the time-honoured method of free price competition between manufacturers. Opening the door to competition—after the unemployment problem had ceased to exist—quickly had the effect of a chilly blast on the rather luxuriant price growth in the hothouse of a protected market. Sales of proprietary sets have increased by 34 per cent. this season, as against last year, regardless of the 700,000 DKE sets absorbed during the same period. German exports have also been rising as a result—an achievement which the People's Sets have never contrived. For these sets, which were so successful in Germany, were from the start almost unsaleable in other countries.

* Marks can be considered equivalent to shillings as regards purchasing value.

HENRY FARRAD'S SOLUTION

(See page 200)

IF the set could receive an American station (and others) above a certain wavelength on the short waveband, and at the same time not even morse below that wavelength, it is clear that the fault consists of a complete cut-out over part of the band without noticeably affecting the other part. Also, from the information given, it appears that the effect of somewhat higher battery voltages is to extend the active portion of the waveband slightly, for 25-metre stations were previously inaudible. As the receiver is a superhet., the most likely cause of the trouble is a stoppage of oscillation at the shortest wavelengths due to failing emission of the valve, which, if the one supplied with the set, has been doing fairly heavy service for over two years. One of the chief difficulties in the design of a battery superhet. is to ensure oscillation over the short waveband without excessive HT consumption; and it must be remembered that the set in question, although apparently fairly reliable, was produced in the early part of the "all-wave" boom.

Cure: A new frequency-changer (or oscillator, if separate) valve, and at the same time it might be as well to examine the others for approaching end of life.

Readers' Problems

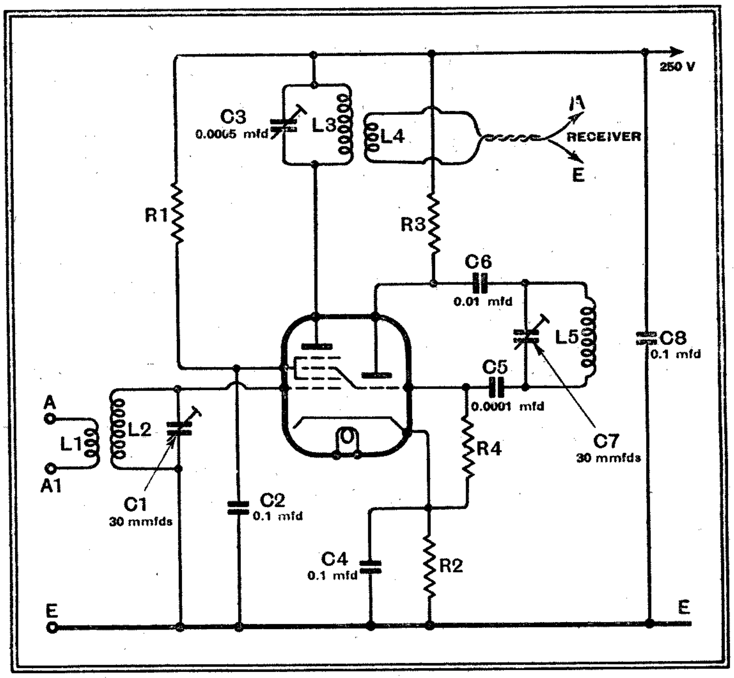
A Selection of Queries dealt with by the Information Bureau, and chosen for their more general interest, is published on this page.

Television Sound Reception

A SIMPLE ultra-short wave converter is wanted for the reception of the sound transmissions from Alexandra Palace. This unit will be used in conjunction with a small superheterodyne. We are asked if the converter could be pre-tuned, thus simplifying its operation.

As the converter is to be used only for the reception of one station it is practicable to adopt pre-set tuning, and if a circuit as shown in the figure is employed, tuning can be carried out on the main tuning dial of the broadcast receiver. Condensers C1 and C7 should be air-dielectric pre-set trimmers, whilst coils L2 and L5 can be made of stout gauge wire, No. 16 SWG En. being suitable. If a very rigid form of construction is adopted these coils need not be wound on formers, and about six turns wound as a self-supporting solenoid of ½in. diameter and ¾in. long will serve quite well.

The circuit L3, C3 connected in the anode circuit of the frequency changer is tuned to about 550 metres, whilst L4 is a small coupling coil for taking the IF output to the input of the broadcast set.



Circuit and component values for a pre-tuned ultra-short wave converter for the reception of the Alexandra Palace sound transmission.

Resistances R1, R2, R3 and R4 must have values to suit the particular frequency-changer value used. If a Mazda ACTH1 be employed, for example, suitable values would be R1, 25,000 ohms; R2, 250 to 300 ohms; R3, 50,000 to 75,000 ohms, and R4, 50,000 ohms. With a Marconi or Osram X65, R1=35,000 ohms; R2=300 ohms; R3=30,000 ohms, and R4=100,000 ohms.

The broadcast set should be tuned to about 550 metres and with the unit connected up C1 and C7 are adjusted to tune in the television sound transmitter. Henceforth tuning can be done on the broadcast set. It should not be difficult to work out a system for switching the unit in and out as required.

Rectifier in AC/DC Sets

AN AC/DC set is being modified for use on DC mains only, the alterations being to remove the mains rectifying valve and short circuit the appropriate connections on the valve-holder. We are asked if these changes will impair the performance of the set, as our enquirer sees no reason why the rectifier should be retained in his case.

If the set is a conventional AC/DC model the mains rectifier does have a purpose to serve, even on a DC supply. Sets of this kind are generally fitted with standard-type electrolytic condensers which, of course, are polarised and must not have a positive voltage applied to the negative electrode.

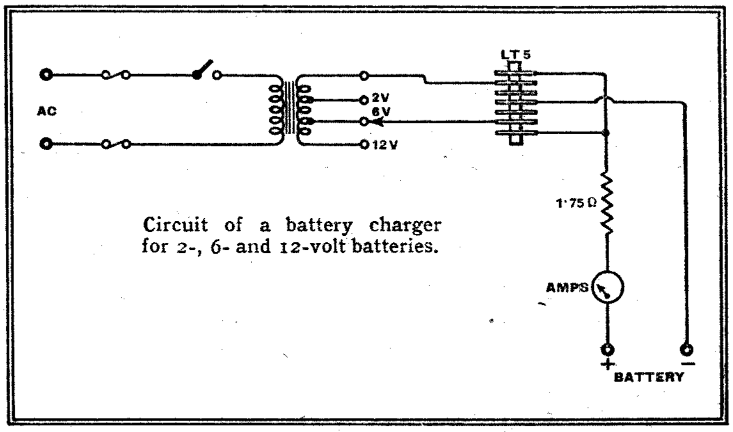
A non-reversible mains plug would prevent damage to the condensers, but it would be better to replace the electrolytics by paper dielectric condensers. By-pass condensers across grid bias resistances in the cathode circuit of valves are protected by the valve and need not be changed.

Charging Accumulators

A READER wishes to know if it is possible to make up a small battery charger which can be used for charging 2-volt wireless cells and also occasionally be employed as a trickle charger for a 12-volt car battery. There is an AC point in the garage.

A unit of this kind is not difficult to construct and even the mains transformer can be made if required. The circuit of a charger that will answer this purpose is given in the figure, and it will deliver one ampere to 2-, 6- or 12-volt batteries.

Tapping the secondary winding as shown for the different batteries is more economical than using resistance in the charging circuit to drop the surplus volts, and if this scheme is adopted the AC output from the tappings should be: 11 volts RMS for a 2-volt cell, 15 volts RMS for a 6-volt battery and 22 volts RMS for the 12-volt car battery.



Circuit of a battery charger for 2-, 6- and 12-volt batteries.

The metal rectifier shown is the Westinghouse Type LT5 and it gives a DC output of one ampere.

The construction of a charger embodying these suggestions was actually given in *The Wireless World* of February 2nd, 1934.

Transformer Windings

A READER wishes to add another LT winding to a mains transformer. Being a factory-made product, the "turns per volt" are unknown, and though this could be found by unwinding one of the existing LT windings and counting the turns, the coil would have to be wound on again as it is needed. We are asked if there is any other way of finding out the "turns per volt" figure for this transformer.

If our enquirer possesses, or can obtain the loan of, an accurate low-reading AC voltmeter, there is a comparatively easy solution to this problem.

Without dismantling the transformer, it should be possible to wind on a dozen turns over one of the existing coils and then measure the voltage delivered by the temporary winding. If, for example, it is found to give 2 volts or very close to this figure, it will be safe to assume that the basis of winding is 6 turns per volt.

The required LT winding can be calculated from this figure.

When dismantling the transformer to put on the extra winding, leads that join to terminals should be marked beforehand so that they will be reconnected to their correct terminals. Precautions should also be taken to ensure good insulation between the new winding and the one over which it is wound.

U-H-F Superhet Oscillator Valve

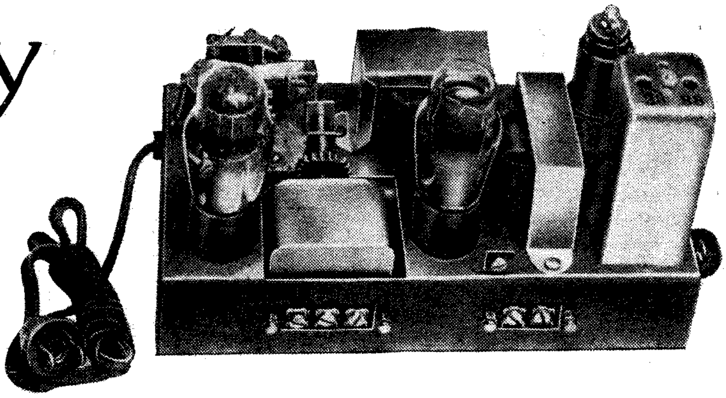
WISHING to effect a little economy in the construction of the Ultra High Frequency Superhet described in our issue of December 1st last, our opinion has been asked on the probable result of replacing the oscillator valve, which is an acorn, by an ordinary triode.

Strictly speaking, an acorn valve is not essential for this position, though its inclusion does lead to a neater and better layout of the frequency-changer stage.

Quite good results may be expected if a triode oscillator is employed, but the acorn RF valve, as the mixer part of the frequency-changer, must be retained if a performance comparable with that of the original set is to be obtained.

Dual-diversity Reception

SIMPLIFIED TWIN-AERIAL ANTI-FADING SYSTEM



Unit with cover removed: the aerial-selecting condenser is mounted under the cover between the valves.

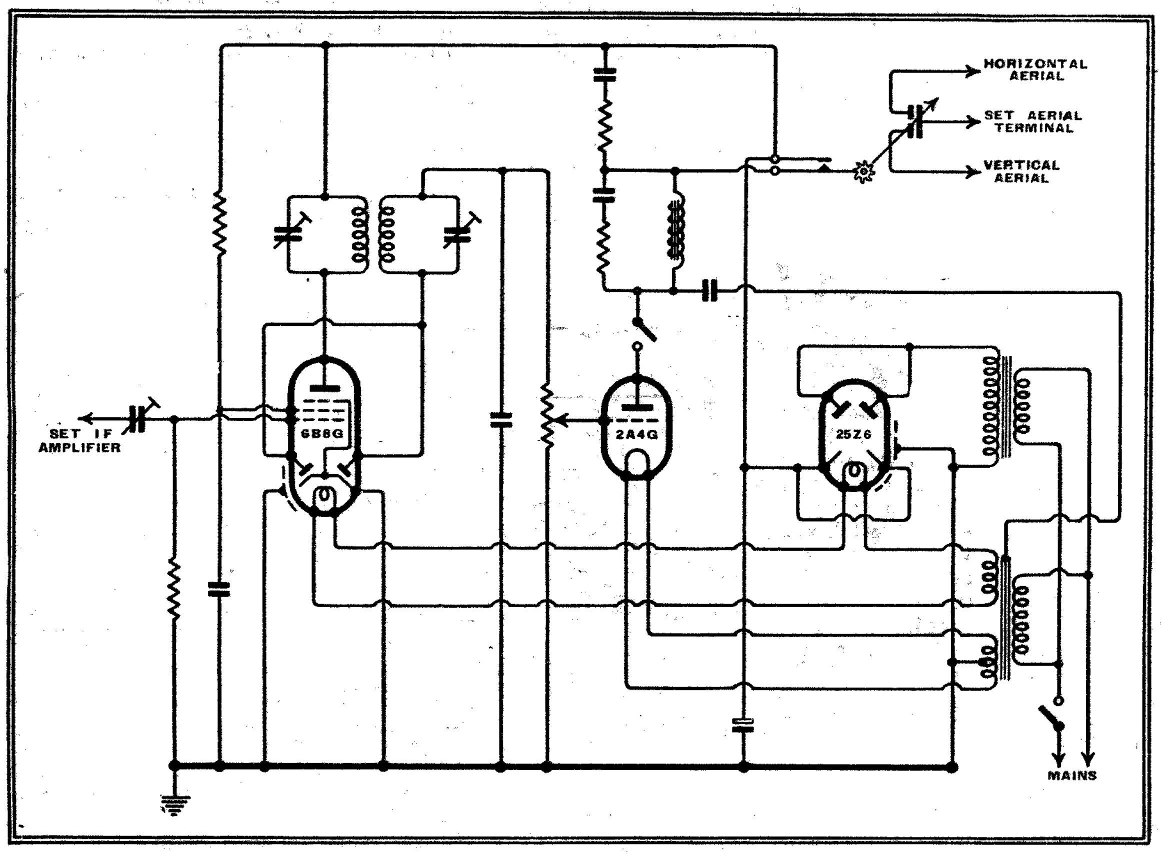
By McMURDO SILVER (*Edwin I. Guthman and Co., Inc., Chicago*)

DESCRIBING a method whereby some at least of the advantages obtained by elaborate diversity systems are made available at low cost for domestic reception. The unit illustrated is easily connected to any receiver; in effect, it acts as an automatic switch by which either one of two aerials is connected to the receiver, depending on which of them is at the moment receiving the best signal.

RECENT articles dealing with dual-diversity reception methods appear to have aroused much interest in amateur and commercial circles. The original method, necessitating two complete RF-IF receiver circuits with common AVC, while effective, does not completely solve all of the problems presented. Noise interference on weak signals, caused by thermal agitation due to the increased number of tubes of the dual receiver, plus alignment and mechanical problems, often vitiate the hoped-for benefits.

A new and greatly simplified method of dual-diversity reception has recently been disclosed by the writer. In its improved form, as here described, it retains the advantages of the multiple receiver diversity method, but eliminates the increased cost, noise and bulk necessary to this type of receiver. In practical form this new method may be reduced to a small accessory unit which will function in conjunction with any superheterodyne receiver having an IF of between 450 and 480 kc/s, either with or without AVC, and almost regardless of age. This unit, which is not rendered obsolete by receiver changes, provides the anti-fading benefits of dual-diversity reception with any single receivers now in use.

Proceeding from the premise that a fading signal does not fade simultaneously on two different aerials and that generally the signal can be found on one of the two aerials in the same plane if they are a wavelength apart, or on one of two aerials when one is in a vertical plane and one in a horizontal plane, a method was developed of automatically switching from one to the other, this switching action following the signal phase shift or fading. In the first experimental models a single-pole-double-throw switch actuated by the fading signal was employed. This did not prove entirely satisfactory because the signal phase shift was not invariably exactly 180 degrees, but often was but a fraction of 180 degrees, although the phase shift usually did eventually complete a 360-degree cycle. The switch was also discarded because of the "click" unavoidably associated with its make-and-break contacts, not to mention the disturbance of the AVC system during the brief interval of time during which no aerial was connected. Despite these disadvantages, this direct antennæ switching system worked and proved the soundness of the basic concept.



Complete circuit diagram of the unit, showing connections to receiver.

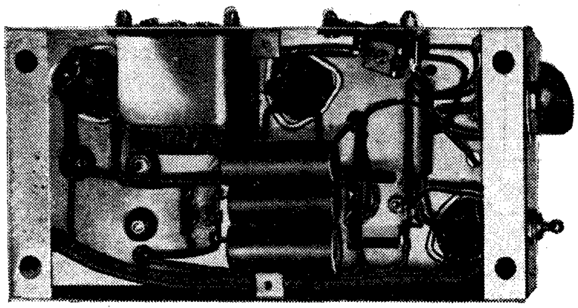
It became obvious that some means of automatic aerial selection was needed which was not abrupt and so could not introduce noise due to its own operation. To be ideal such an aerial-selecting method would have to be able to combine in varying degrees the signal voltage from the two aerials, and not merely to make a choice between them. The solution of this problem lay in the use of a balanced, or differential, variable condenser having two stator sections with a common rotor. The rotor was connected to the receiver aerial terminal, a horizontal aerial was connected to one stator and a vertical aerial to the other stator. As this condenser is rotated, one or the other aerial, or portions of both aerials, are connected to the receiver through the common rotor.

Analysis confirmed by experiment indicated that,

Dual-diversity Reception—

in conjunction with a 2A4G valve, the same relay as used in the experimental direct antenna-switching system, when augmented by a suitable amplifier and rectifier, provided an ideal means of operating the differential antenna-selecting condenser. This relay was equipped with a rotating shaft, which was connected by means of bakelite gears to the condenser shaft, the relay action being communicated to the two shafts by means of a ratchet. This proved to be the simplest method of effecting the desired aerial-selecting action.

Simulation of the condition of five distinct aerial angles was effected by a ratchet having eight teeth, giving 45 degrees of rotation for each relay impulse. Experimentally a sixteen-tooth ratchet which gave nine conditions was tried, while this showed some slight improvement over the eight-toothed ratchet on slowly fading signals, it was generally less satisfactory, as rapid movement sometimes becomes necessary when signals were fading rapidly.



Underside of the chassis on which all the components of the unit are assembled.

Where one aerial may have a better signal-to-noise ratio than the other, the coupler will link with the aerial having the best signal-to-noise ratio. This is because the noise impulses, being of short duration, do not develop sufficient voltage at the grid of the coupler amplifier tube to control the 2A4G. The aerial-selecting condenser will then continue to rotate until sufficient control voltage is developed at the grid of the 2A4G control valve from one aerial or the other to temporarily "lock" it.

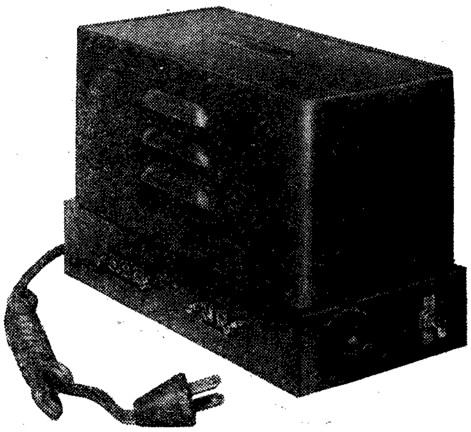
Relay Action

Rotation of the aerial-selecting condenser being dependent upon the ratchet for positioning it can readily be understood that, as the signal fades, the antenna-selecting condenser will continue to rotate until it finds a signal of sufficient strength to prevent the 2A4G from ionising and actuating the relay, the working of which is effected by the 2A4G, which in turn is controlled by its amplifier and signal voltages from the receiver.

Because many receivers still in use do not have amplified AVC and in some cases do not have adequate filtering networks to permit taking off a portion of the receiver-developed signal voltage for operation of the diversity coupler, a signal amplifier and rectifier is incorporated in the diversity coupler which facilitates its use as a control medium and enables the coupler to operate with receivers having no AVC. This amplifier and rectifier always provides adequate voltage for proper operation of the 2A4G relay control tube. From the anode of the last IF valve a small amount of the IF signal voltage is taken through a small variable coupling condenser mounted in the diversity coupler and applied to the grid of a 6B8 pentode-duo-diode valve. An intermediate frequency transformer of conventional design is used to couple the anode of this valve to its diodes. The amplified voltage developed across the diode load resistor is then used to control the 2A4G grid. This built-in amplifier, having a voltage gain of one hundred times and the minimum voltage required to prevent the 2A4G from ionising being nine volts, the grid of the 6B8 tube need only be supplied with less than one-tenth of a volt for complete control. When the voltage at the grid of the 2A4G tube falls below nine volts the tube ionises, suddenly increasing its plate current sufficiently to actuate the relay.

To obtain smooth control of this grid voltage a ½-megohm potentiometer having a reverse "audio volume control" taper is used as the diode load resistor. This permits of very critical set-up adjustment so that extremely small decreases in signal level to below any level established by the setting of this potentiometer causes the diversity coupler to operate. The greatest importance being attached to simplicity of operation and installation, the coupler was so designed that a minimum of adjustments are required; these are effected by one "on-off" switch and combined "standby" switch and level-setting knob.

When employed with receivers having six or more tuned circuits (two IF stages) the 6B8 grid coupling capacity should be adjusted to about ten m-mfd. For receivers having less than six tuned circuits (one IF stage) this capacity is set to approximately twenty m-mfd. The IF transformer of the coupler unit is tuned to the IF of the receiver. The last IF anode circuit trimmer of the receiver (feeding the 6B8 coupler valve) must, of course, be re-adjusted to compensate for the added capacity of the connecting wire.



The aerial-selecting unit is self-contained except for four external leads and a mains connection.

In operation it is only necessary to tune in the desired signal on the receiver and then adjust the potentiometer of the coupler so that the unit functions when the signal begins to fade. The coupler knob should be set so that it operates only when the downward signal fade is greater than can be taken care of by the AVC system or when the downward fade dips the signal unpleasantly into the region of noise.

A switch is provided for the convenience of the operator on the level-setting potentiometer. This switch is connected in the plate circuit of the 2A4G tube so the entire unit may be rendered inoperative. This allows accurate tuning of the receiver to the desired signal and observation of the amount of fade existing before putting the coupler into use.

It must be realised that the possibilities of this and other methods of dual-diversity reception as they effect the overall signal level to the receiver are entirely dependent on the presence of a signal on one or both of the antennæ in use. Although rare, in some cases a fade-out becomes complete on both antennæ, when no form of dual-diversity reception can possibly be of any help. But the benefits of dual-diversity reception are to-day clearly recognised, and this simple new coupling system allows almost any operator to enjoy its anti-fading advantages with existing single receivers, and at very small cost.

CLUB NEWS

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. W. Graham gave a lecture-demonstration on "Push-Pull Balancing Problems." He used an oscilloscope to illustrate his remarks. At the next meeting on March 7th Mr. P. G. Clarke will bring his new high-quality apparatus and discuss the latest improvements incorporated in it. The apparatus is based on certain *Wireless World* designs, but many modifications and improvements have been introduced.

Dollis Hill Radio Communication Society

Headquarters: Brainteroft Schools, Warren Road, London, N.W.2.
Meetings: Alternate Tuesdays at 8 p.m.
Hon. Sec.: Mr. E. Eldridge, 79, Oxgate Gardens, N.W.2.

The president has now started a series of talks on transmitters during which a power supply unit, a modulator and a power amplifier will be designed. The next meeting will be on March 14th.

Edgware Short-wave Society

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

A special discussion was held on February 22nd on the types of aerials and other equipment to be used in the National 20-metre Field Day organised by the R.S.G.B., in which four transmitters, who are members of the Edgware Society, are taking part.

Mr. Langford, of Webbs Radio, gave a very interesting talk recently on the "Hallicrafter SX.17." Messrs. Hamrad have also recently lectured on their equipment. Future activities include a discussion on aerials by G2A1 and an exhibition of members' apparatus.

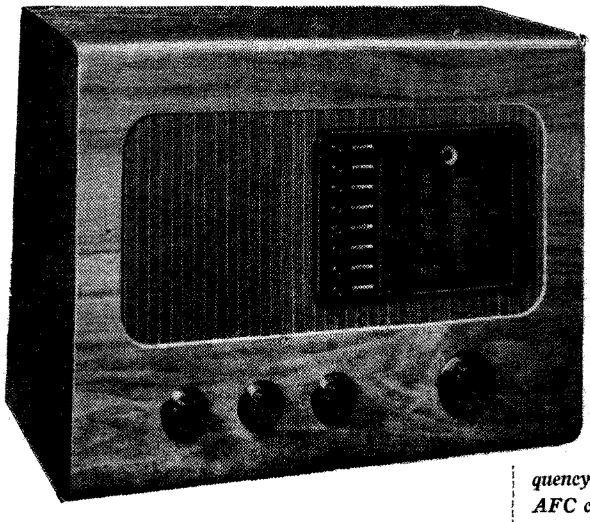
Surrey Radio Contact Club

Headquarters: 74, George Street, Croydon.
Meetings: First Tuesday in the month at 8 p.m.
Hon. Sec.: Mr. A. R. Willsher, 14, Lytton Gardens, Wallington.

At the last meeting Mr. Grinstead, of the Mullard Company, lectured on the "Technique of Valve Design and Construction."

The Institution of P.O. Engineers

A representative of Voigt Patents, Ltd., will lecture before the Institution at 8 p.m. on March 8th at Woodcocks Café, 260, Hillmorton Road, Rugby.



Murphy A52

AN EFFICIENT RECEIVER WITH A WELL-DESIGNED AUTOMATIC TUNING SYSTEM

FEATURES. ***Waveranges.*** — *(1) Short-wave bands: 16, 19, 21, 25, 31, 42 and 49 metres. (2) Medium waves: 200-550 metres. (3) Long waves: 950-2,000 metres.* **Circuit.**—*RF ampl.—first frequency-changer — second-frequency-changer or AFC control valve—IF ampl.—AFC rectifier—signal rect. AVC rect. and 1st AF ampl.—tuning indicator—output valve. Power rectifier.* **Controls.**—*(1) Manual tuning. (2) Waverange. (3) Volume and on-off switch. (4) Seven push-button settings on each waveband. (5) Tone. (6) Installation (sensitivity) control.* **Price.**—*£18 10s.* **Makers.**—*Murphy Radio Ltd., Welwyn Garden City, Herts.*

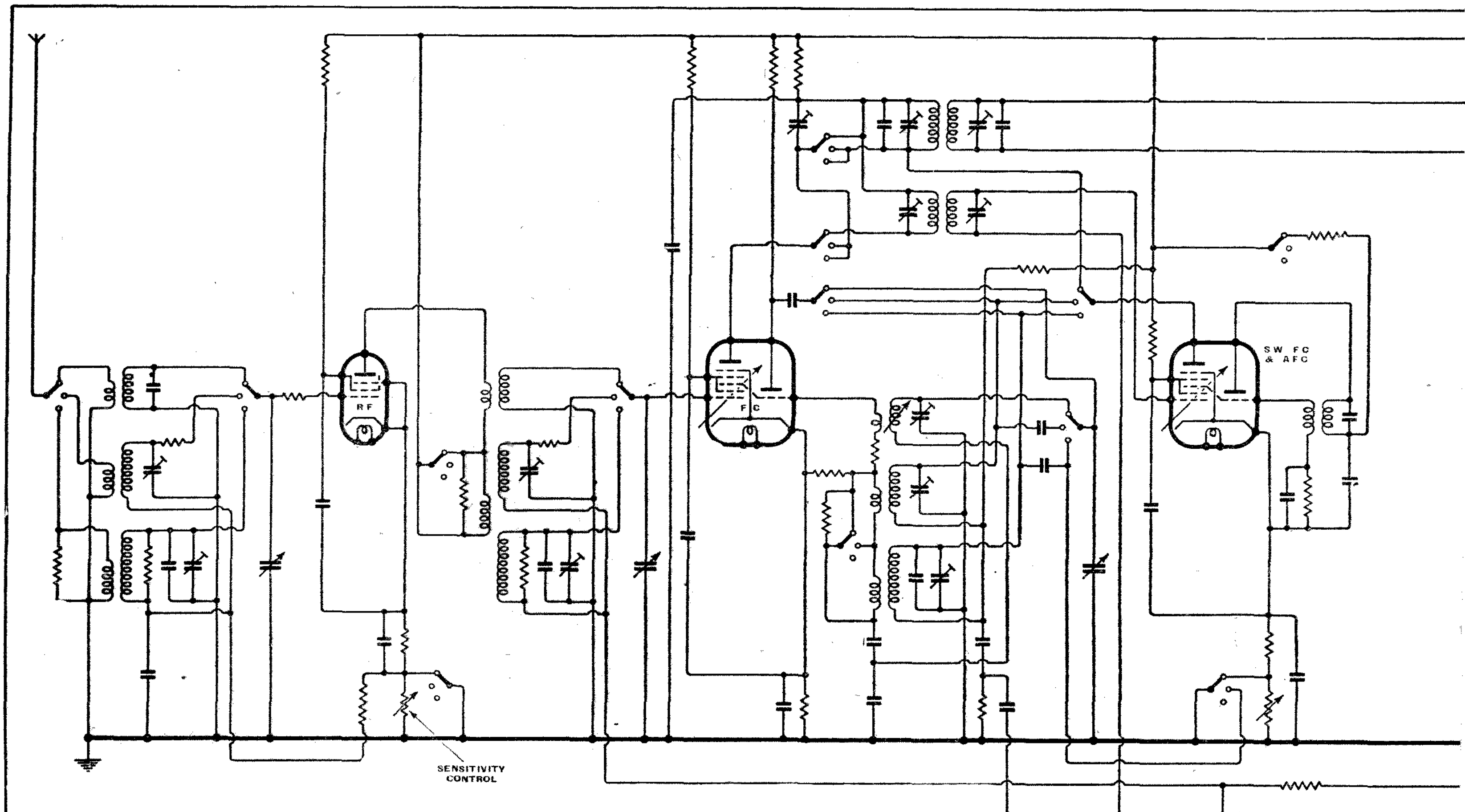
THE specification of this receiver includes the best points of many previous Murphy designs, and is made singularly attractive to the non-technical user by a push-button tuning system which is one of the best we have so far tested.

The exterior of the set gives no clue to the complex functioning of the tuning system, and the controls are extraordinarily simple and foolproof. Operation of the waverange switch automatically changes the identification tabs alongside each push-button and also lights up the appropriate tuning scale when the manual tuning control is required. It also changes over the tuning control mechanically from the main condenser to a separate variable inductance tuner on short waves by transferring the friction drive.

Seven stations may be selected on medium waves and an equal number on long. A happy thought was the inclusion of "Weather London" in the latter group as adjusted at the works. On short waves the push-buttons are used to select the seven principal broadcast and amateur bands, each of which is expanded to the full length of the tuning scale. When changing from one band to another the main tuning pointer is stopped automatically at a position approximately in the centre of the band.

There is no possibility of causing damage by pushing a button or turning the waverange switch without thinking. One should, however, refrain from turning the manual tuning knob before the "manual" button has been pressed. With automatic tuning there is a brief whirr of the motor mechanism, a click and a station or short waveband is ready to use. Its identity can then be ascertained by a glance at the push-button panel.

The selector mechanism is of the direct-homing type with a large-diameter disc.



Complete circuit diagram. Negative feed-back is used for sensitivity control in the RF stage and there are two frequency changers in operation on short waves. The second frequency changer becomes the AFC control valve for press-button tuning.

The contact brushes are well designed and medium- and long-wave groups are arranged on separate tracks on the outside and inside edges of the contact rail. The short-wave contacts occupy slots in the rail between the inner and outer tracks. Adjustments can be made after removing a semi-circular "window" in the back panel of the set.

Outstanding Short-wave Performance

Good as is the performance on medium and long waves, it is the short waves which must take first place in any assessment of the merits of this receiver. Not only does the electrical band spreading make their tuning as easy as that of medium-wave stations, but from the point of view of volume and signal-to-noise ratio the short-wave performance approaches much nearer to medium-wave standards than we had thought possible in a commercially produced receiver. In this respect the A52 is an advance on the A36, which at the time of its introduction was equally remarkable for its short-wave performance. Not only is the sensitivity higher but selectivity and image suppression show a corresponding improvement.

On medium and long waves clean and whistle-free reception of every worthwhile programme seems to have been the aim of the designers rather than record-breaking sensitivity and selectivity. It is recommended that the set should be worked at a level which avoids overloading of the frequency changer by the local station, and a preset control has been provided at the back of the chassis for this purpose. Selectivity on medium waves clears the London Regional station outside 1½ channels on either side of its normal setting when using the set at a distance of fifteen miles from Brookmans Park. On long waves there is appreciable interference from both Droitwich and Radio Paris on the Deutschlandsender between these two stations.

Quality of reproduction is clear with just the right amount of top, and no attempt has been made to compensate for the limitations of a table model by the introduction of a false bass. Harmonic distortion is evident only when the volume control is turned up too far, which it can be on most stations.

The two triode hexode valves are first to catch the eye in the circuit. The one following the RF stage converts to 465 kc/s on medium and long waves and to 3.1 Mc/s on short waves. Unlike the A36, the intermediate frequency in the A52 is fixed, and band-spread tuning is effected by changing slightly the inductance of the short-wave oscillator coils. Approximate tuning to the middle of each waveband is carried out by the main tuning condenser under push-button control.

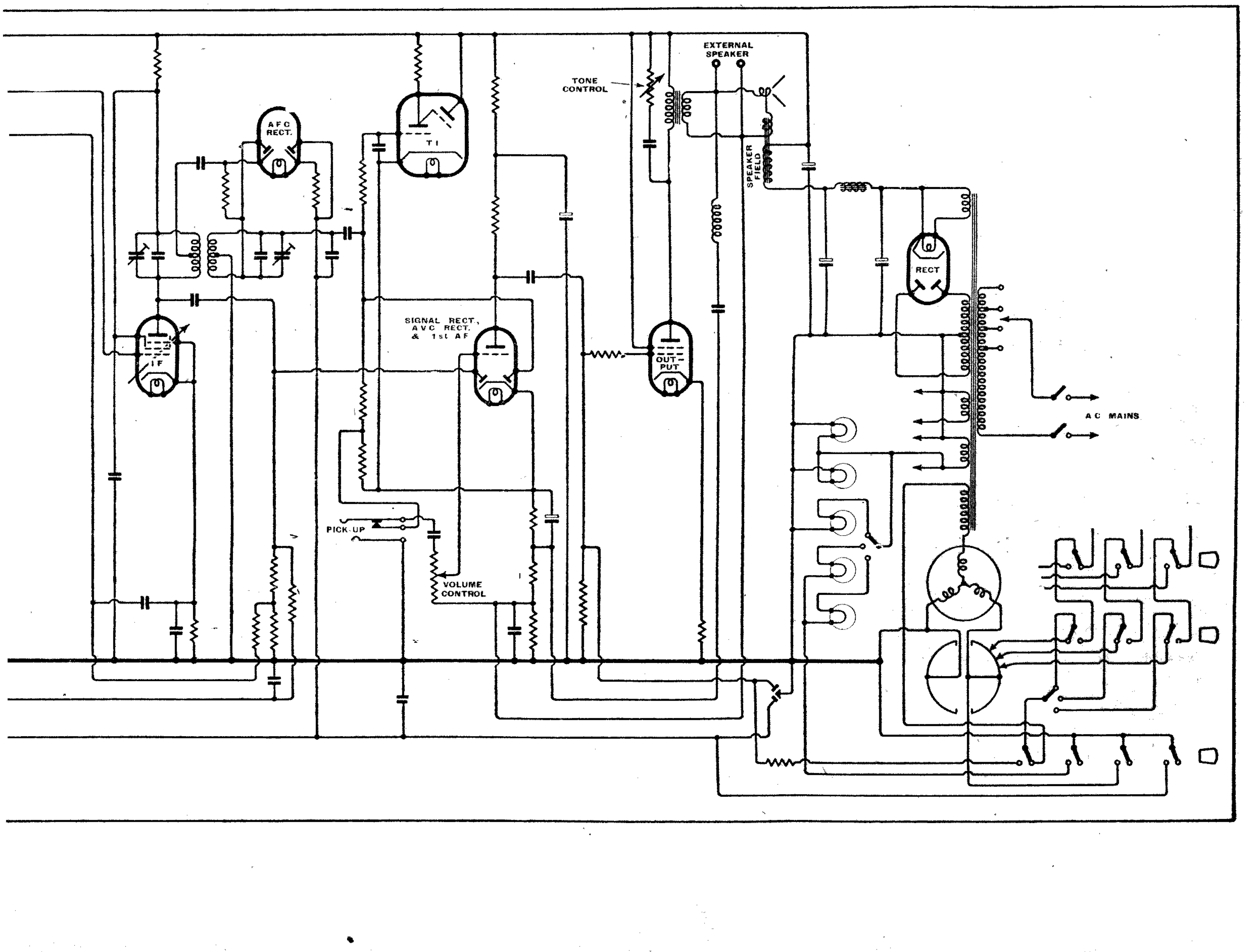
The second triode hexode acts as frequency changer from 3.1 Mc/s to 465 kc/s when the waverange switch is set for short waves, and on medium and long waves as control valve for the oscillator in the automatic frequency control circuits. Bias for this valve is derived from two diodes connected to the output IF transformer, and its magnitude is determined by phase differences in that transformer, depending on whether the intermediate frequency is above or below the resonant frequency of the tuned circuits.

A double-diode-triode provides delayed AVC for the IF and both frequency changer stages, in addition to its other functions of signal rectification and first stage AF amplification.

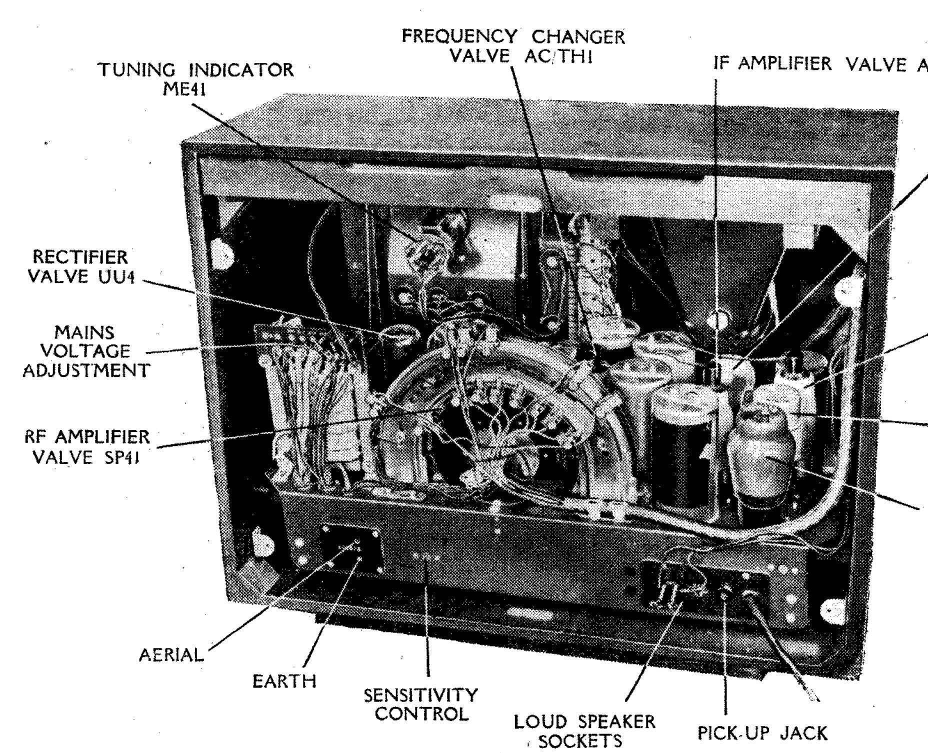
Feed-back in the RF Stage

The RF amplifier is not controlled as it is of the non-variable-mu type. It is a television valve with an exceptionally high gain and good signal-to-noise ratio at high frequencies. The high magnification is something of a liability on medium and long waves and may result in whistles if the frequency changer is overloaded. Accordingly, the overall gain of this stage is reduced by negative feed-back on the two long waveranges. The control consists of a variable cathode resistance, without by-pass condenser, which is automatically short-circuited by the waverange switch on the short-wave range.

Negative feed-back is also applied in the output stage in such a manner as to



Murphy A52—
reduce the valve resistance as well as harmonic distortion. To suppress heterodyne whistles a filter circuit has been included in the feed-back line, and this method has distinct advantages over a general depression of the high note response by means of the conventional forms of tone control. The usual variable resistance - capacity filter has been included across the primary of the output transformer, but this is not the kind of set which makes frequent calls upon

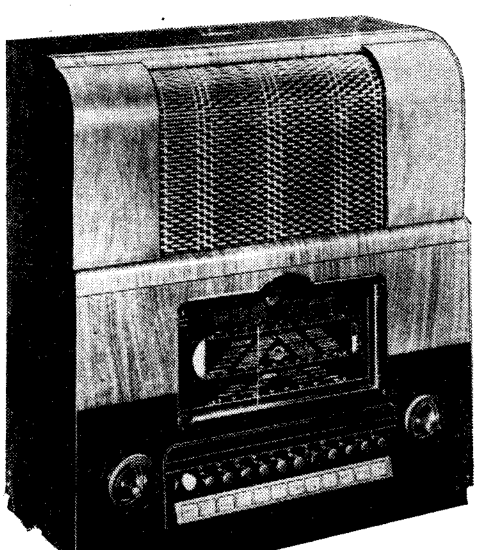


A large diameter selector disc ensures accuracy of initial setting before the automatic frequency control comes into operation. Three separate groups each of seven contacts are provided for the short, medium and long-wave ranges.

its services. Short-, medium- and long-wave stations are all alike in giving good programmes with the minimum of background noise, and throughout the course of our tests we were always able to enjoy the full response of which the loud speaker is capable.

NEW MARCONIPHONE SETS

FIVE models, including push-button receivers for battery as well as mains operation, have been added to the Marconiphone range.



Marconiphone Model 874.

The Model 874 for AC mains is basically a four-valve superheterodyne with an additional double diode for automatic frequency control. This is a refinement in a push-button receiver with individually tuned circuits, as also is the exceptionally wide tuning range associated with each pre-set circuit. There are two long-wave buttons and six on the medium-wave band. The latter are divided into two groups, one of which covers 195-310 metres and the other 300-580 metres. The short-wave range is from 13.8 to 50 metres and an auxiliary vernier scale has been provided to facilitate accurate logging of stations. The price of the Model 874 is 15 guineas.

In the battery push-button set (Model 872) a mechanical system of station selection is employed in which the main tuning condenser is rotated to predetermined points. Six buttons are provided, any of which may be used for medium- or long-wave stations. Adjustment can be carried out by the user from the front of the set. There are five valves in the superheterodyne circuit, the two final valves being tetrodes arranged in quiescent push-pull. A short-wave range (16.5-52 metres) is included and the price complete with batteries is 12½ guineas.

The remaining sets in the new series are the Model 875, a 5-valve (including rectifier) table model AC superhet. at 10½ guineas; the Model 876 TRF 3-valve battery receiver at 8 guineas; and an 8-valve (including rectifier) radiogramophone with automatic record-changer at 29 guineas.

THE AMATEUR TRANSMITTING STATION

The final instalment of the series of articles covering the complete design of a simple amateur transmitter will be included in next week's issue, when the planning of the Aerial and Feeder system will be described.

"GANGED PERMEABILITY TUNER"

A Correction

In Fig. 2 of the above article a redundant connection was shown in the section of the diagram showing the press-button tuning assembly. This connection has the effect of short-circuiting the input coils, and should, of course, be omitted.

For the Service Man

THE Mullard Wireless Service Co., Ltd., have developed a new cathode-ray oscillograph specially for use in broadcast receiver and television servicing. It is the Type 3154 and will be available to service dealers at a special price. Technical details will be published in an early issue.

A new valve voltmeter (Type GM 4150) has also been introduced. This has four ranges of 0.5-2, 1.5-10, 6-50 and 30-250 volts and an input resistance of 10 MΩ at 150 kc/s.

The Wireless Industry

CONSTANT voltage rectifiers operating without barretters or saturated chokes and known as the "Noregg" and "Westat" types are described in a leaflet recently issued by the Westinghouse Brake and Signal Co., Ltd. A circuit diagram shows the principle of operation.

◇ ◇ ◇

Visitors to the British Industries Fair, Birmingham, may be interested to know that the sound amplifying equipment in the Royal, Bradford and Conference Rooms has been installed by the British Thomson-Houston Co., Ltd. The same firm was responsible for the PA services at the recent launching of H.M.S. *George V*.

◇ ◇ ◇

Halford Radio, of 31, George Street, Hanover Square, London, W.1, announce that they have taken over the manufacture, sale and service of Epoch speakers. They will concentrate principally upon the 16-inch Auditorium model.

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In addition to the Radiolab AC All-purpose Tester, Everett, Edgcumbe are now producing a combined volts, amp. and ohms meter for DC only. The various ranges are selected by means of a switch, two terminals only being used for external connections; a self-setting switch renders the instrument practically immune from overload damage. Resistance is 1,000 ohms per volt.

NEWS OF THE WEEK

CINEMA TELEVISION

Success of Big Fight Transmission

MR. F. W. OGILVIE, Sir Noel Ashbridge, Mr. Baird and members of the Television Advisory Committee, were among the 1,200 who saw the reception on a 15ft. × 12ft. screen at the Marble Arch Pavilion of the B.B.C.'s television transmission of the Boon-Danahar fight for the British Lightweight Boxing Championship at the Harringay Arena last Thursday, February 23rd.

This, of course, was not the first time that we had seen Baird's large-screen television, but this *was* the first time that the man in the street had been given the opportunity of paying to see a cinema television show, and the general consensus of opinion was that the results were extraordinarily good.

Comparison with Films

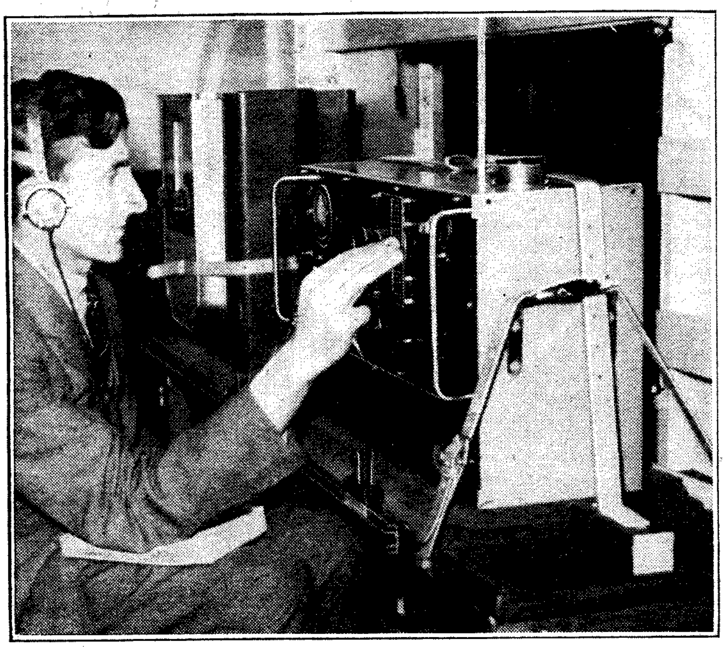
Surely the highest praise which could be accorded such a demonstration was that given unwittingly by the audience—they forgot the medium by which they were seeing the fight and cheered and encouraged the boxers just as if they were at Harringay.

Some of the critics of the daily Press have said that the reception was shadowy. Whilst this is partially true, it must in fairness be emphasised that the definition when Jasmine Bligh made the initial announcement direct from the studio at Alexandra Palace was comparable to that of most news reels. That the operators of the apparatus at the theatre had to boost up the contrast of the transmission from Harringay due to the poor lighting was shown when at the close Miss Bligh again came on the screen and for a few seconds was in "soot and whitewash."

The *Wireless World* representative had a seat in the row in front of the Television Advisory Committee, which row was 30 yards from the 15ft. × 12ft. screen. This distance was ideal, for it is the optimum viewing distance for a screen of that size. Three cameras were used, one giving a pre-view in the dressing-room, another a view of the whole ring during intervals between rounds, and the third, fitted with a telephoto lens, gave close-ups throughout the fight.

On one or two occasions the picture dissolved into irregular patterns, but it was gratifying to hear the commentator say that the vision transmitter was causing a little trouble, thereby exonerating the Baird operators for whom it must have been a nerve-straining evening.

Next door to the Marble Arch Pavilion the new Monseigneur News Theatre was showing the transmission with the Scophony system. At the Tatler News Theatre also a full house saw the Baird system.



RADIO NORMANDIE'S FIELD STRENGTH. One of the engineers adjusts the Marconi-Ekco field-strength measuring set in the International Broadcasting Company's Reception Test van which is surveying the service area of the new 20-kW Radio Normandie Station at Louvetot.

FROM THE VATICAN. N.B.C.'s European director Mr. Max Jordan, is here seen at a window overlooking St. Peters to give American listeners commentaries on the happenings in the Vatican city. Ancient and modern methods of signalling will be used to announce the name of the new Pope. As in the past a chimney in the Vatican will pour out black smoke during the Conclave. This will change to white smoke when the new Pope is to be announced. This age-old method will be supplemented on this occasion by a radio announcement.

STATION TO LOSE 450-kW

High-Power Transmitters not Wanted in America

AS the result of representations from all sections of the American radio world, the Federal Communications Commission at Washington has decided to withdraw permission for the famous station WLW at Cincinnati to broadcast on a power of 500 kW.

The station is the only one in the country to use more than 50 kW., and has been broadcasting on "super power" for nearly five years under an experimental licence. In refusing further extension of this authorisation, the Commission declared that the high power had been proved superfluous, and continuation of the experiment was not likely to offer promise of substantial contribution to radio development.

The station has been conducting experiments on sun spots, directional aerials and the elimination of blind areas. It had, however, been alleged that the station authorities had been using the power to obtain more commercial advertisers.

WLW's licence to operate on 50 kW with a frequency of 700 kc/s will not be affected by the Commission's decision.

SHORT-WAVE INTERFERENCE

A World Conference?

THAT the B.B.C.'s Empire short-wave service from Daventry suffers from interference is becoming increasingly apparent. No change has been made in the short-wave allocations for broadcasting since the Washington Conference of 1927. An enormous increase in international broadcasting has taken place since then; with the result that most of the narrow wavebands have become so congested that few channels are free from interference. The outlook is serious.

The European broadcasting conference at Montreux can, perhaps, consider itself lucky, in that its deliberations will be confined to medium and long waveband problems. It is inevitable that another and separate conference be called to deal with this more difficult question of the short and ultra-short waves, and such a conference will not be confined to European authorities, as in the past when medium and long waves were the sole theme. It will necessarily be world-wide.

USW IN AUSTRALIA

Victoria to Tasmania on 7.5 Metres

EXPERIMENTS which are expected to result in the perfection of a new ultra-short-wave radio telephony system in Australia are being conducted by the Postmaster-General's departments in Victoria and Tasmania.

The object of the experiments is to provide a reliable system for communication between Tasmania and the mainland as a supplementary service to the cable. Engineers are conducting the experiments across Bass Strait from a hill near Apollo Bay on the Victorian Coast, to Circular Head, near Stanley, Tasmania, over 160 miles away.

Wavelengths of about 7.5 metres are being used for the experiments, the engineers having satisfied themselves that communication on this wavelength is possible over the distance.

ITALIAN BUILDING PLAN

THE total aerial power of the Italian transmitters will be increased during this year to 937 kW, when it is expected the E.I.A.R. will have 53 broadcast-

News of the Week—
ing stations under its control. Fifty-one of these stations, which number includes the short-wave centre at Prato Smeraldo and the two USW transmitters at Monte Mario, near Rome, will be in Italy, one is in Tripoli and one in Abyssinia.

Eighteen of these proposed transmitters will be low powered.

In the proposed wavelength plan which is being discussed at Montreux, Italy is to have the following six exclusive frequencies:—532, 734, 1,015, 1,222, 1,240 and 1,366 kc/s, and share six frequencies with other countries.

ANTI-INTERFERENCE CAMPAIGN

ACTING upon the recommendations of a commission led by Professor B. Wuolle, the Finnish authorities have commenced an energetic anti-interference campaign. They have ordered all lifts to be fitted with suppressors at the houseowner's expense, and are distributing free a leaflet on interference causes and elimination. A scheme is also under way to eliminate interference from electric trams and trolley buses.

The Commission has made a special study of the central aerial system and found that unscrupulous "experts" have hoodwinked the public. A report made by the Commission on this subject has necessitated the authorities making very strict rules regarding the construction and installation of common aerials in large blocks of flats. At the moment there are about 100 such common aerial installations in Helsinki, and a large number of them will have to be rebuilt in order to comply with the new regulations.

INVENTIONS EXHIBITION

FOR the first time the annual Exhibition of Inventions was introduced to the public by television when a number of exhibits were televised from Alexandra Palace. The exhibition was as varied as ever, containing an assortment of articles ranging from a boat-davit to a rat-trap.

A comprehensive range of television receivers was demonstrated by Baird, and an iodine accumulator of theoretically unlimited life was brought from the Continent by Sadac of Huy, Belgium. A deaf-aid, expressly designed for use in churches, was demonstrated by Fortiphone, who also showed an earpiece which weighed less than a third of an ounce. The Psycho Radio Robot previously seen at Radiolympia dominated one end of the Hall with stentorian observations.

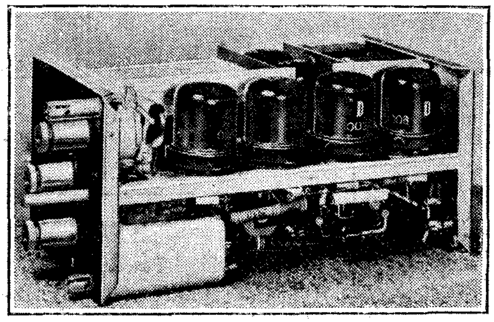
RADIO AT THE GERMAN MOTOR SHOW

Brief Summary of the Exhibits

NEARLY all the German firms which manufacture car radio have produced new sets using metal valves. Prices for these sets, which are fitted with separate loud speaker and tuning dial, range between 300 and 350 marks (approx. £25 to £30).

The new Körting set, which is extremely small, measuring roughly 3½ inches high, 12 inches wide and 8 inches deep, and weighing about 17 lb., employs six valves and has seven circuits. Provision is made in this set for fitting a microphone and additional loud speakers when the set is installed for use in touring coaches.

Ideal Werke, which manufactures Blue Spot apparatus, has changed its name to Blaupunk Werke, thereby incorporating the trade name. As well as an improved car-set, which like most others consumes only about 25 watts, this firm has introduced something new to Germany by producing a portable which can be operated from the car battery or from the mains, the voltage of which varies from 110 to 240 according to the locality. This set covers the long-, medium- and short-wave bands, the latter being from 16.5 to 51 metres, and is stated to give very good quality.



GERMAN CAR-RADIO. The new all-metal valves have been used extensively in the new car-radio receivers which were to be seen at the Berlin Motor Show. There is no waste space in the 6-valve Körting receiver, shown here.

WIRELESS HONOUR FOR SARNOFF

HOW many readers picked up the N.B.C. transmission of an unusual ceremony on February 11th, when David Sarnoff was presented with the Marconi Memorial Gold Medal of Achievement by the Veteran Wireless Operators' Association? Mr. Sarnoff, who is now president of the Radio Corporation of America, first operated a wireless key at Siasconsett, Mass., in 1908.

During the same broadcast, several men who have performed meritorious service at the wireless key were presented with silver Commemorative Medals and Scrolls of Honour. Among them was Jack Binns, who sent the "CQD" distress call from the s.s. *Republican* in 1909, and T. D. Haubner, who sent the first "SOS" when this call had superseded the "CQD."

NEW DAVENTRY TRANSMITTERS

TWO extra transmitters have recently been installed at Daventry to cope with the Spanish and Arabic services, so that the station now possesses five high-power transmitters, one of medium power, and two of low power.

The Arabic transmission is given on 31.32 metres with the call-sign GSC; Spanish programmes for Central and South America go out under the call-signs GSO and GSB, with wavelengths of 19.76 and 31.55 metres respectively.

FROM ALL QUARTERS

B.B.C. Seeks Lower Film Tax

THE B.B.C. pays 5d. per foot import duty on film-recorded programmes. This is equal to the amount imposed upon talkie films brought from America for public exhibition in this country. The Corporation considers the fee disproportionate, and is making representations to the Government for a reduction.

Interference Suppression

AT an Informal Meeting of the I.E.E. Wireless Section to be held at 6.30 p.m. on Tuesday, March 14th, at Savoy Place, London, W.C.2, Mr. E. M. Lee, B.Sc., of Belling and Lee, will open the discussion on "Interference Suppression at the Listener's End."

Facsimile Newspapers

AMERICA'S facsimile newspaper service, announced in these pages on February 16th, has begun experimentally from stations KMJ, Fresno and KFBK, Sacramento, owned by McClatchy Newspapers, sponsors of the service. The production, *Radio Bee*, has been received on 100 sets in the two cities and the surrounding districts.

The Aurora and Television

ON the evening of February 24th, when Auroral displays were observed, a peculiar form of interference with television reception was noticed by Mr. H. West, of Worlingham, near Beccles. On the sound channel there was an accompanying rumble and some distortion, while on the vision the picture was marred by dark horizontal bands which changed their positions rapidly. Did other readers notice similar effects?

French Radio Shows

THE Spring Radio Exhibition will be held within the Paris Fair from May 13th-29th, in the Exhibitions Park, Porte de Versailles, Paris. All the exhibitors will present their new models for 1939-40, but no prices will be given. The exhibits will be limited to receivers, components and accessories. This exhibition is the herald of the Autumn Salon de la Radio-diffusion which will be held in the Grand Palais des Champs Elysées from September 7th-17th.

The New Wavelengths

THE European Radio-Electrical Conference arranged by the Chambre Syndicale des Industries Radio-Electriques as a preliminary to the Montreux wavelength meeting is reported to have been a success and although the Italian report has not yet been received, it seems that the decisions and recommendations of the conference were generally approved. The British delegation headed by Mr. J. H. Thomas, President of the R.M.A., was constituted by Mr. J. H. Williams, Mr. A. B. Calkin and Dr. R. C. Williams.

Forging Ahead

IT was announced last week by a German Post Office television official that new television stations are already being constructed at Hamburg, Nuremberg and Munich. The transmitter on the Brocken Mountains is nearing completion and Berlin's station is said to be working with full power.

PA in Police Boxes

To facilitate the dissemination of information to the public in times of emergency, Mr. McEntee, M.P., has suggested that loud speaker equipment should be installed in police telephone boxes.

The New Radio-Paris

THE new 450-kW Radio-Paris transmitter, testing on 1,648 metres, is not expected to take over its regular duties until May when the wavelength will probably be altered to 1,639 metres.

Dry-Cell Pioneer Dies

WE regret to announce the death of Consul-General Valdemar Ludvigsen at the age of 77, who, in 1892, evolved the well-known Hellesen dry cell and founded the world-famous Copenhagen firm, Hellesens Enke & V. Ludvigsen. Before the end of the last century the firm had established its position in the world market, and to-day exports its products to 60 different countries.

"Women in Broadcasting"

MRS. F. W. OGILVIE, wife of the Director-General of the B.B.C., was among the guests, who included the outstanding women of Broadcasting House, at a dinner to "Women in Broadcasting," given by the Technical Group of the Forum Club on February 17th, which was presided over by Miss Caroline Haslett, O.B.E., Comp. I.E.E., director of the Electrical Association for Women.

Norwegian Amateurs

THE prefix LB has been provided for Norwegian portable amateur transmitters, that used by stationary transmitters being LA.

Random Radiations

By "DIALLIST"

A New Use for Loud Speakers

THE other day a number of bathers on the famed beach of Manly, in Australia, were caught by an unexpected big wave and carried out to sea. Luckily the installation of loud speakers on the high observation tower of the bathing pavilion had been completed, and by means of these the members of the volunteer life-saving club were summoned to the scene in a few moments. Thanks to the speed with which the loud speakers enabled the rescue to be organised, every one of the bathers was safely brought to shore. I wonder if we'll ever see loud speaker equipment installed in the safety boats at Continental bathing places to take the place of the tin-trumpet affair that the man in the boat sounds if you venture more than a yard or two out of your depth?

Extraordinary Reception

IN one of the lay papers I see it reported that direct wireless communication was recently maintained between the Air Ministry in London and a 'plane belonging to the New Zealand Air Force whilst it flew over Christchurch in the course of night manœuvres. If the report is accurate, this must be a record for long-distance direct communication with a 'plane. Do you remember in the old days how we used to follow 'planes from Croydon to Continental air ports? The ground station, though its rating was only half a kilowatt, was always easy enough to tune in, but it was a bit of a feat to pick up a pilot's reply to enquiries when his 'plane was on the other side of the Channel. That, of course, was on about 900 metres; there wouldn't have been the same difficulty had the transmissions been on the short waves.

The Valve Case

THE law courts case in which a man was prosecuted for selling at low prices valves supplied to him on special terms, on condition that they should be sold as parts of complete receiving sets, attracted a good deal of attention and received considerable publicity in the lay papers. The case revealed that valve makers have two quite different prices for their wares. Set manufacturers, who buy in large quantities and undertake not to dispose of valves apart from receiving sets, obtain them at prices very much lower than the man-in-the-street has to pay when he seeks a replacement for one of his that has gone west. It is natural that there should be a difference in the two prices; the man who buys valves by the hundred thousand is clearly a much more valuable customer than he who purchases an odd one at long intervals. But, frankly, I have never been able to see why the price differences should be so wide. I have always felt that this policy has led to semi-stagnation instead of progress in receiving equipment, for people are afraid to buy a set containing more than four or five valves when they think of the possible bill for new ones if those that come with the set wear out or are blown up. High prices are also one of the reasons why so many folk continue to use valves that should have been in the dustbin long ago. America has had low-priced valves for years, with the result that her receiving sets are, on the average a good deal larger than our, and that few Americans worry about the possible cost of replacing a "dud" valve.

This Would Be Useful

THE *Wireless Trader* published recently particulars of well over a hundred types of domestic vacuum cleaner for the benefit of those radio dealers who sell appliances of this kind as well. All sorts of details were given about each; but there was one very important omission. About none of the types was it stated whether or not it radiated interference with wireless reception. Rightly or wrongly, it seems to me any shop which deals in both wireless sets and electrical equipment is doing its best to kill its own pig if it encourages the sale of interference-radiating apparatus. Many—perhaps most—electrical shops deal also in wireless. Probably they don't realise the tremendous force that they could bring to bear upon manufacturers if they banded themselves together and refused to stock or to recommend to customers anything likely to cause trouble of this kind. Better still, they might make a point of labelling prominently with the words non-radiating all innocuous appliances and of taking every opportunity of explaining to their customers the exact significance of those labels. Interference with wireless reception is, I firmly believe, very largely responsible for the fact that so many folk make do with ancient receivers instead of going in for up-to-date models. What is the use, they argue, of buying good wireless sets if interference prevents you from getting the best out of them?

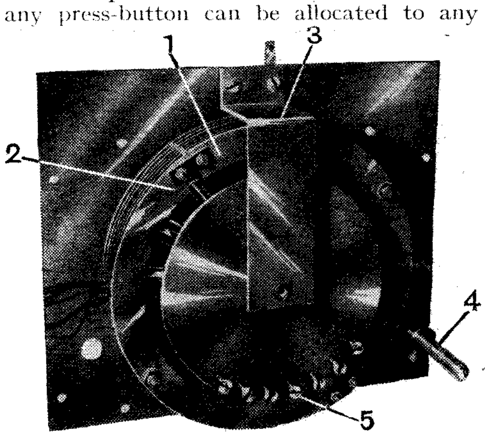
Lucky Poplar

LOCAL councils which are also suppliers of electricity have varied a great deal in their treatment of their customers who own wireless sets when changes from DC to AC were made. None of them, naturally, wanted to throw money away by giving new sets for old indiscriminately. Most of them acted on the whole pretty fairly, though I have known instances in which they undertook to convert sets from DC to AC working and didn't make much of a job of it. Some, again, tried to find ways and means of wriggling out of their obligations. The Poplar authorities seem to have found a very happy solution of the problem. They had about three hundred customers with wireless sets of the DC type who were covered by agreement. Going into figures, they found that the cost of conversion would be considerable. They took a look round the market and were able to pick up a quantity of 4-valve sets at such a low figure from a manufacturer's surplus stock that it paid them far better to exchange new sets for old than to carry out conversions. Everybody concerned must be pleased, for the DC sets covered by agreement must be pretty ancient ones.

An Improved Remote-control Mechanism

IN conventional automatic tuning systems of the disc direct-homing type, the speed of traversing the scale is limited by considerations of overrun and possible "hunting" at the gap. An average figure is five seconds for the full 180-degree movement.

Reduction of this delay is one feature of the latest automatic station selector designed by the "Laboratories Yardeny," of Paris, and demonstrated recently in this country. As in the earlier model described in our issue of December 29th, 1938, separate selector discs are provided for each station, so that any press-button can be allocated to any



Selector mechanism in the latest Yardeny automatic tuner. (1) and (2) homing discs, (3) bridge connection to travelling contacts, (4) manual tuning spindle, (5) clamping screws for station settings.

part of the waveband. Adjustment is from the front of the receiver. When the selector contact reaches the locating notch it bridges both segments of the disc and sends opposing currents through the driving motor, which instantly stops the rotation of the armature. In series with the forward and reverse windings of the motor are two coils wound in opposition on the core of a relay. One coil alone is able to hold down the relay contact which is in the common connection to the motor, but when the station is tuned-in and the current is opposed by the second coil, the motor, having completed its work of arresting the mechanism, is switched off. To reset the relay when another station is required, auxiliary contacts are provided in the latch bar of the press-button unit.

An alternative arrangement is available in which the relay is dispensed with. In this model the press-button is kept fully depressed until the station is in tune (as indicated by a pilot light), and the slight action of the press-button is used to switch off the current to the motor.

We have seen one of the relay-operated machines in operation at a speed up to four seconds for full-scale movement, and we are informed that it is possible to reduce this time to two seconds. The tuning position is accurately located, and there is no chattering or "hunting" when the contact notch is reached.

Enquiries relating to this tuner should be addressed to N. Barron, c/o Grove Grange, Ltd., 17, Holborn Viaduct, London, E.C.1.

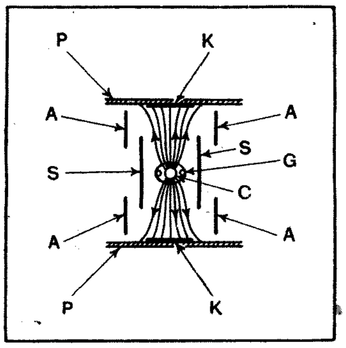
Recent Inventions

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

SECONDARY-EMISSION AMPLIFIERS

VALVES in which secondary emission is utilised as a means of amplification are generally subject to the limitation that a point comes when any further increase in anode voltage results in an excessive increase in output current. In effect, the device tends to "boil over," the internal resistance simultaneously falling to an undesirably low value.

The invention aims to prevent this by splitting up the primary electron stream into separate beams, and by so arranging the electrode system that as the anode voltage is increased the "beams" widen out, the result being that a larger proportion of primary electrons is diverted away from the secondary-emission electrode, so that further increase in the anode or output current is restrained.



Electrode system of a secondary emission tube in which the primary electron stream is divided into separate beams.

The figure shows a cross-section through the electrode system, comprising a central cathode C, control grid G, screening grid S, anodes A, and a strip K of secondary-emitting material laid on a part only of the surrounding electrode P. As the voltage on the anodes A is increased, the electron beam from the cathode widens out, as shown, so that some of the primary electrons miss the emissive strip K, and thus do not add their quota of secondary electrons to those collected by the anodes.

N. V. Philips Gloeilampenfabrieken. Convention date (Holland), September 1st, 1936. No. 496705.

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AN ELECTRONIC ATTENUATOR

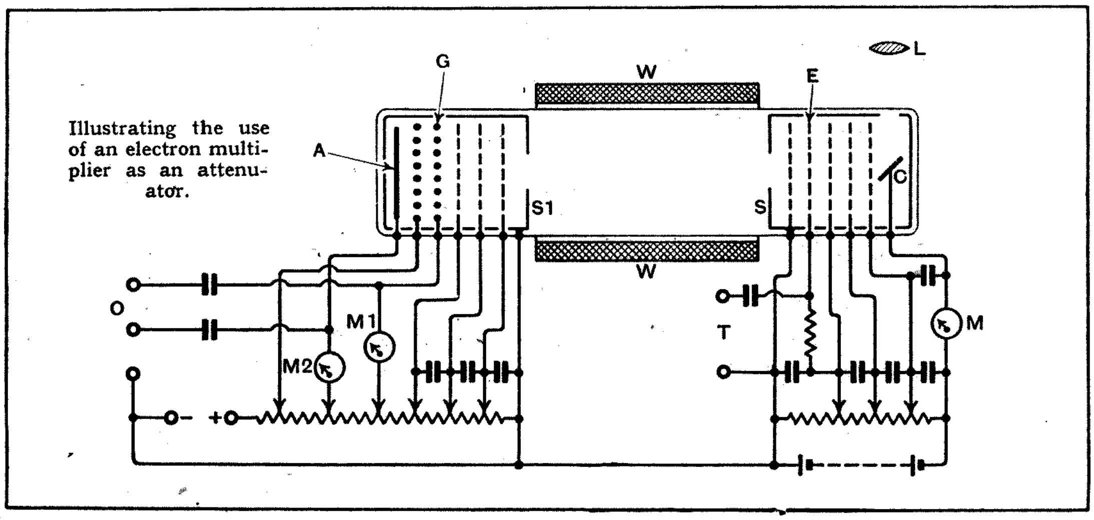
IT is sometimes desirable to be able to reduce the amplitude of an available signal by a given amount, in order, for instance, to feed it to an amplifier which is under test. According to the invention, an electron-multiplier type of tube is used for this purpose.

As shown in the figure, light from a source L falls upon the photo-electric cathode C of a group of secondary-emitting electrodes enclosed in an earthed screen S. The amount of primary emission from the cathode is measured by a microammeter M, and the signal to be attenuated is applied at the terminals T to a modulating electrode E.

The modulated stream passes out from the screen S and is focused by an electro-magnetic winding W so as to enter a second set of electrodes enclosed in an earthed screen S1. The potentials applied to these electrodes are such that a predetermined fraction of the modulated stream is picked up by a perforated electrode G.

At the same time, an equal stream of secondary electrons is liberated from the anode A, so as to give an attenuated push-pull output across the terminals O. The current flowing to and from the electrodes G and A is measured by meters M1, 2.

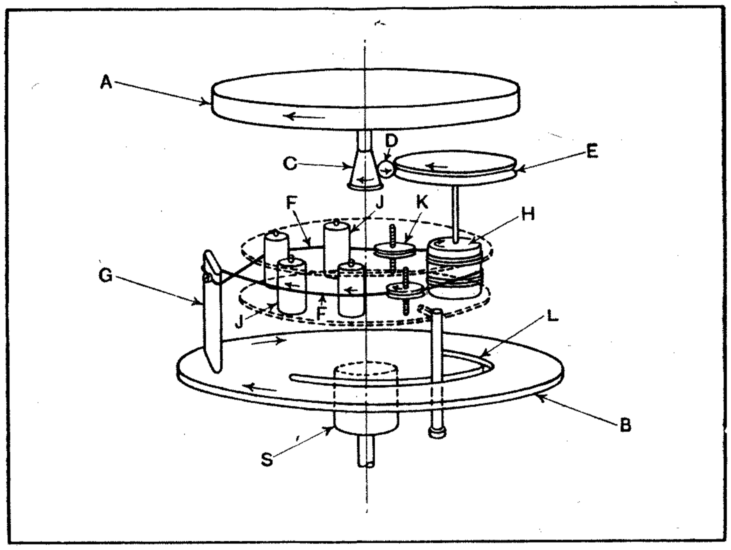
Baird Television, Ltd.; V. A. Jones; and T. C. Nuttall. Application date, June 1st, 1937. No. 496398.



Illustrating the use of an electron multiplier as an attenuator.

SLOW-MOTION DRIVES

THE Figure shows, in purely schematic form, the arrangement of a slow-motion drive between a tuning knob A and the shaft S of a variable condenser. For normal operation the knob A is pushed down until an outwardly coned flange formed on it engages with an inwardly coned flange on a lower plate B, so that there is a direct friction drive between the two on to the shaft S. (The conical flanges are not shown in the drawing.)



Schematic diagram of two-speed variable condenser drive mechanism.

For fine tuning, the knob A is drawn away from the plate B into the position shown, where a coned stub C comes into frictional contact with a ball D which engages and drives a grooved wheel E. The ball is held in position by a cage (not shown). This reduces the drive to an extent determined by the relative diameters of the stub C and wheel E. The reduced drive is transmitted by a cord F, which is fastened at one end to a member G fixed to the plate B, the cord being tensioned by a series of rollers J and pulleys K. At the other end the cord is wound up in one direction, and simultaneously unwound in the other, from a drum H driven by the wheel E. In these conditions only the member G is free to move, and it rotates the plate B, and therefore the condenser shaft S, within the limits of the curved slot L.

Standard Telephones and Cables, Ltd., and R. E. Hall. Application date June 25th, 1937. No. 497749.

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DIRECTION FINDING

VARIOUS factors are known to affect the accuracy of the bearings of a distant transmitter as given by any type of direction-finder. The presence of a nearby conductor may, for instance, produce an apparent shift in the direction of the incoming wave; or it may give rise to the "quadrantal" type of error which varies from point to point of the compass.

The invention is concerned with the correction of such errors in cases where a cathode-ray tube is used to give a direct indication of the desired bearing.

According to the invention, the cathode-ray tube is provided with a series of external pairs of deflecting coils, in addition to the usual set of internal deflecting coils. The external coils are arranged to rotate around the CR tube in synchronism with the frame aerial (or with the search-coil of a radiogoniometer) and the current passing through each coil is then adjusted by a variable resistance until, in each case, the auxiliary control-field applied to the electron stream is sufficient to correct for any observed deviation, so that the true bearing is shown on the DF scale of the fluorescent screen.

Marconi's Wireless Telegraph Co., Ltd., and L. E. Q. Walker. Application date June 26th, 1937. No. 497761.

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

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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 Finance

A Possible Solution

ALTHOUGH the campaign to popularise television has had results that, judged by ordinary standards, must be considered satisfactory, it seems that there is little chance of the new art enjoying the same meteoric rise to popularity as sound broadcasting.

One of the chief reasons is that the appeal is being made to a much more sophisticated world than that of 1922 ; a world that is satiated with scientific wonders, and one that judges any new thing on a strictly utilitarian or value-for-money basis. This perhaps explains why something like a deadlock has arisen. The B.B.C. apparently does not consider itself justified in spending vast sums of money in extending the television service, both in coverage and programme hours and quality, until the number of viewers has increased. The public, for its part, is presumably waiting for these service extensions before becoming viewers.

On another page a contributor examines the possibilities of a scheme that seems to offer a way out of this deadlock. It has recently been proved that collaboration between television and the cinemas is practicable ; he suggests that the idea should be extended into a working partnership, the cinemas to contribute towards the cost of television in return for the right to use the transmissions for the benefit of their patrons.

That the scheme could be made to work, and that it has certain attractions, are facts that will hardly be denied. The cinema world has shown so much interest in television from its very inception that there is little doubt that it is anxious to co-operate, and, if it did so, the benefits to television as envisaged by our contributor might well accrue.

Perhaps the greatest objection to the plan is the risk that control of television would in fact, though doubtless not in theory, tend to pass out of the hands of the B.B.C. Again, promoters of events forming the subject-matter for television broadcasts would probably adopt a very different attitude in negotiating with the B.B.C. if they come to regard that body as the agent for a group of profit-making organisations, and not as a public service corporation. The Television Advisory Committee will have many knotty problems to solve when it comes to discuss the matter next week.

Radio Research

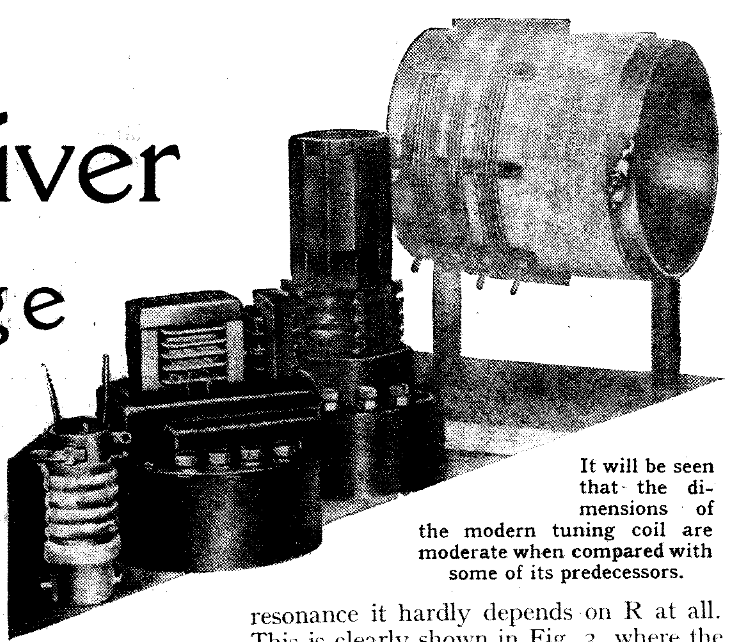
Pure versus Applied

AT a recent meeting of the Wireless Section of the I.E.E. one or two or those taking part in the subsequent discussion suggested that some of the investigations conducted under the auspices of the Radio Research Board were of too practical a nature. A strong plea, backed by telling arguments, was entered in favour of the Board devoting more of its energies to pure research.

Few commercial organisations can afford to carry out pure research into matters that do not promise any immediate financial return ; such work seems to be essentially a matter for bodies financed by the State, or by university foundations. At the meeting in question it became clear that some at least of the matters investigated by the R.R.B. had also been the subject of research by commercial firms. Some overlapping is inevitable, but unnecessary duplication is to be avoided.

The Modern Receiver Stage by Stage

In this second article of the series the discussion of the details of the modern receiver starts with the aerial tuning system. Nowadays the aerial itself is not tuned, but the term is still often applied to cover the first tuned circuit in the set.



It will be seen that the dimensions of the modern tuning coil are moderate when compared with some of its predecessors.

Part II.—AERIAL TUNING

HAVING dealt in Part I with the general arrangement of the Three-Band AC Super, we now come to the details. At first we shall ignore the direct-current circuits and concentrate upon the radio-frequency aspects. Consequently, the earlier diagrams will not show by-pass condensers, grid bias resistances, screen voltage supplies, etc. These will come later.

The valve is a voltage-operated device, for in most cases its input impedance is high compared with the impedance of the input circuit. There are exceptions to this rule, especially at short waves, but for the moment it is sufficiently accurate.

It is clear that the greater the signal voltage that we can apply to the first valve the smaller need be the total amplification to provide a given output. This voltage depends on three factors: the field strength of the signal, the aerial, and the coupling between the aerial and the valve.

The field strength is out of the control of the user of a receiver, and the aerial is not usually considered a part of the receiver. As far as the designer is concerned the problem of the aerial tuning circuit is the design of a method of coupling an aerial of unknown characteristics to a valve. This, of course, is an impossibility, and it is essential for him to assume that the aerial characteristics have definite values.

He does this, in practice, and there are certain standard values laid down and which are assumed by most designers. It is inevitable, however, that as an actual aerial always differs somewhat from the assumed one, the performance of the receiver will vary somewhat with different aerials.

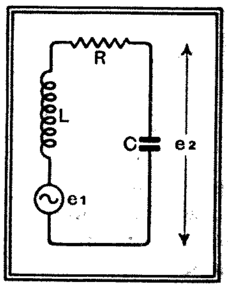


Fig. 2. This diagram shows the equivalent circuit of the series resonant tuned circuit.

Nowadays the aerial circuit itself is not tuned because the tuning would be greatly affected by quite small changes in the aerial. Instead, the aerial is coupled in some way to a tuned circuit.

The basic circuit is shown in Fig. 2, and is known as a series resonant circuit. The resistance R is not usually present as such, but it represents the inevitable resistance of the coil L and condenser C. The generator e_1 is also not present in practice, but here it represents the voltage injected into the circuit by the aerial. We shall soon consider how it is injected.

Now the reactance of an inductance to alternating current is proportional to frequency and is classed as positive, while the reactance of a capacity is inversely proportional to frequency and is classed as negative. It follows that in Fig. 2 there is one frequency for which the positive inductive reactance is equal and opposite to the negative capacitive reactance. At this frequency the two cancel and the total reactance is zero.

The current which flows as a result of the application of e_1 is only limited by the resistance R; at all other frequencies, however, the reactance is not zero and the circuit impedance is higher than R. If we plot a graph showing the variation of current with the frequency of e_1 for a constant amplitude of e_1, we shall obtain the familiar resonance curve of Fig. 3.

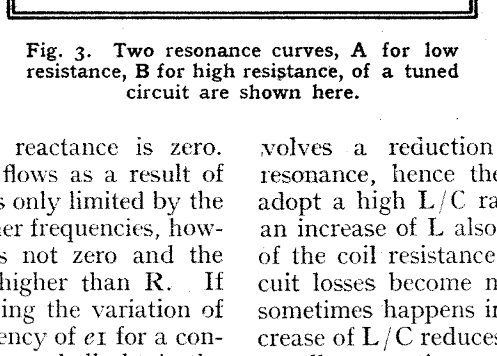


Fig. 3. Two resonance curves, A for low resistance, B for high resistance, of a tuned circuit are shown here.

The current at resonance depends on R, but at a frequency differing widely from resonance it hardly depends on R at all. This is clearly shown in Fig. 3, where the dotted curve B illustrates the results with about double the value of R used for curve A. This circuit, therefore, is not only less efficient, but less selective.

In practice, of course, current as such is not required; we want voltage to operate the valve. We obtain this by connecting the valve across the condenser C (Fig. 2). The voltage e_2 is equal to the product of the current and the reactance of C.

Now in practice most of the circuit resistance lies in the coil, and at resonance the reactance of the coil and condenser are equal. It is consequently convenient to ignore the condenser and refer everything to the coil. When this is done it is easy to show that the ratio e_2/e_1, often termed the magnification of the circuit, is $\omega L/R = Q$ ($\omega = 6.28 \times$ frequency in c/s and L in henrys).

It is clear that for a given injected voltage e_1 the voltage e_2 applied to the valve is proportional to Q and the selectivity also increases with Q. A high value of Q is thus desirable; it should be noted that it is possible to make Q too high for good quality, but we need not yet discuss this.

Now if Q is to be increased at a given frequency it can be done only by increasing L or reducing R. An increase of L necessarily involves a reduction of C to maintain resonance, hence the common advice to adopt a high L/C ratio. Unfortunately, an increase of L also involves an increase of the coil resistance and some other circuit losses become more important. It sometimes happens in practice that an increase of L/C reduces Q. In fact, there is usually an optimum value of L/C which gives the maximum Q.

We cannot pay much attention to this in the case of the RF circuits, however,

The Modern Receiver Stage by Stage—

for we have very little choice in the values of inductance and capacity. The circuit must be tunable over a wide range of frequencies, and this is done by varying C, L, or both L and C, and theoretically variable inductance tuning has many advantages. In spite of attempts to introduce it, however, capacity tuning still holds the field and seems likely to continue to do so.

A standard variable condenser has a maximum capacity of about 500 $\mu\mu$F. and a minimum of some 20$\mu\mu$F. This does not represent the total capacity in the circuit, however; the coil will have a self-capacity of 5-20 $\mu\mu$F, the valve will have an input capacity of 3-15 $\mu\mu$F, the capacity of the wiring and switching may be 5-10 $\mu\mu$F, and there may be a certain effective capacity transferred from the aerial. In extreme cases, the circuit capacity may be 13-45 $\mu\mu$F.

If we take the latter figure to be on the safe side, we have to add, say, 5 $\mu\mu$F for the minimum capacity of a trimming condenser, bringing the total to 50 $\mu\mu$F. Each ganged circuit is provided with a trimmer so that the capacities of all circuits can readily be equalised.

It should be pointed out that this figure of 50 $\mu\mu$F is often reached in practice and may be considerably exceeded with careless design. In early receivers it was more often exceeded than not, since the various factors upon which it depends were then not fully understood.

The Tuning Range

The total circuit capacity in a typical case is thus likely to vary between 70 $\mu\mu$F and 550 $\mu\mu$F for tuning. The ratio of maximum to minimum frequencies which can be covered is equal to the square root of the ratio of the capacities; in this case $\sqrt{550/70}=2.805$-1. If the highest frequency is made 1,500 kc/s (200 metres), the lowest will be 535 kc/s (561 metres).

The inductance needed is given by $L=1/\omega^2C$ with L and C in henrys and farads. It works out at 162 μH. Actually, the standard value of inductance for the medium waveband is 157 μH, giving a tuning range of 1,540-550 kc/s with the capacities we have assumed.

It will thus be seen that as the inductance is in most cases fixed by the tuning range required, Q can be increased only by reducing the resistance. Technically, values of Q of the order of 200-300 are possible on the medium waveband; practically values of 75-150 are more usual.

With an unscreened air-core coil the Q increases with the physical dimensions, and very high values can be obtained with a diameter of 3-4in. Screening reduces the efficiency unless the screen is large compared with the coil. Screening is essential, however, if all sorts of stray couplings are to be avoided, and the larger the coil the more is the screening necessary. Obviously, there is no room in the compact modern receiver for some nine coils of several inches diameter, each housed in a large screening can.

By using special high-frequency powdered-iron cores, coils of high Q but small dimensions can be constructed. Compared with an air-core coil of similar or slightly larger dimensions, the iron-core coil has a higher Q, but is usually more expensive. It often has a higher self-capacity, and it is more difficult to couple another circuit to it.

Before going on to discuss coupling it should be noted that Q is not a constant but holds for one frequency only. The value of R usually decreases with frequency, and ωL does so also. The two do not necessarily change at the same rate, but over a limited range Q is very roughly constant.

Coupling

Constant selectivity, however, does not demand constant Q but a constant value of L/R. This is unobtainable with condenser tuning, and in practice selectivity increases as the resonant frequency decreases.

On the medium and long wavebands the aerial can be well represented by the series combination of an inductance, a capacity and a resistance. In fact, it is a series resonant circuit. Its resonant frequency cannot conveniently be varied for tuning, however. In the early days it was commonly tuned by using a loading coil and series condenser; the setting of this condenser follows a different law from that of the receiver circuits proper, and so it cannot be ganged. This could be overcome if the aerial characteristics were always the same, but they are not.

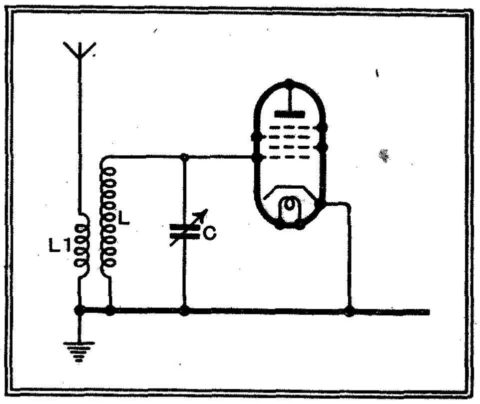


Fig. 4. The usual aerial coupling and tuning system are shown here.

The general practice, therefore, is to leave the aerial circuit untuned and couple it to a tuned secondary. Usually a coil is included in series with the aerial and coupled to the tuned winding as shown in Fig. 4. The voltage injected into L by the primary circuit now replaces $e1$ of Fig. 2.

The effect that the primary has on the secondary depends on the impedance of the whole primary circuit and upon its coupling to the secondary. There is always an optimum coupling at which the voltage developed across the condenser C is a maximum.

Now the resistance and reactance of the primary are reflected into the secondary to a degree which depends on the coupling and increases with it. The optimum condition is when the effective secondary resistance is doubled by the presence of the aerial circuit.

If we start with loose coupling and gradually increase it, we find that the setting of the condenser C for resonance alters. If L1 is small, C must be continually reduced as the coupling is increased, whereas if L1 is large, C must be increased. For one particular value of L1 no change in C is needed.

This is the resonant condition when the whole aerial circuit, including L1, resonates at the same frequency as LC. This condition must always be avoided, for as the primary circuit has no variable tuning it can hold only for one frequency. If it is made to occur within the desired band, say 1,540-550 kc/s, there will be wide variations in the tuning law of C on either side of the aerial resonance, and the coupling will be either much too tight at the resonance or much too weak at other frequencies.

Until recently the general practice has been to make L1 small, so that it has one-quarter to one-sixth the turns of L. The aerial resonance is then higher than any frequency within the tuning range; the effect of the aerial circuit is then to increase the effective value of L by an amount which varies with frequency.

Recently, however, it has become common to make L1 large, so that the whole aerial circuit resonates at a frequency lower than any within the tuning range. Provided that its resonance is a good deal lower, the aerial circuit then reduces the effective value of L by an amount which is nearly independent of frequency. This can obviously be corrected by increasing L. It is found, too, that the tuning of the secondary circuit LC is much less affected by changes in the aerial itself with this system.

Constructionally, L may be a single-layer coil or a short bank winding, while L1 is a multilayer coil and is usually coupled loosely to the grid end of L. This is done to obtain a small capacity coupling between the two circuits. With the mutual inductance coupling only as shown in Fig. 4, it is found that with small L1 the efficiency falls off as frequency decreases, whereas it increases with large L1. By adding a little capacity coupling to the mutual inductance, the efficiency with large L1 can be made much more nearly constant over the waveband.

The Short Waveband

On short waves, however, this course cannot be adopted. The aerial can no longer be represented by a simple series resonance circuit. Its capacity and inductance are actually distributed throughout its length and it is no longer accurate to treat it as if they were lumped.

The result is that aerial resonances occur at harmonics of the main resonance frequency and more than one is likely to fall within any one short waveband. It is, therefore, usual to use only a small primary winding on short waves.

The Diode Detector with Positive Bias

By K. R. STURLEY, Ph.D., A.M.I.E.E.

REDUCING DETECTOR DISTORTION

IT has long been known that the detector is more likely to introduce distortion than an amplifier and efforts have continually been made to improve it. The introduction of the diode was a great advance, but it is by no means free from the possibility of causing serious trouble. In this article the conditions are examined and the correct method of operation is indicated.

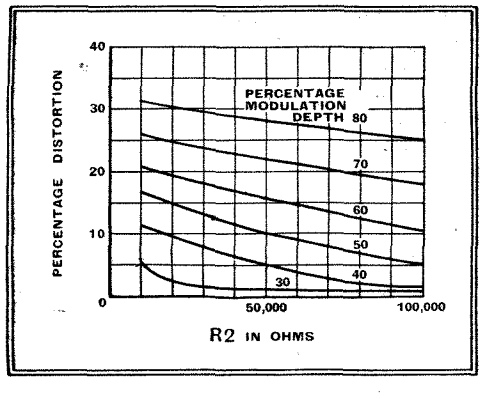


Fig. 3.—These curves show the effect on distortion of varying R2 for various modulation depths. The signal input is 40 volts peak.

SOME four years ago it was pointed out in *The Wireless World*[1] that the coupling circuit between a diode detector and an AF amplifier (see Fig. 1) had a very marked influence on the distortion of the AF output voltage from the detector. It was shown that a low value of grid leak R2 in the amplifier causes serious distortion as soon as the modulation percentage exceeds a certain value. More recently W. T. Cocking has indicated[2] that this form of distortion can be eliminated by applying positive bias to the diode. However, F. C. Williams in *The Wireless Engineer*[3] casts doubts on the usefulness of positive bias and suggests that it produces another form of distortion.

Prior to the publication of Williams' paper the author had determined experimentally the effect of positive bias and had come to the conclusion that Cocking's claim was justified as far as the detector itself was concerned. The detector is only a part of the whole circuit, however, and positive bias must be applied carefully if it is not to cause the distortion effect to which Williams referred.

We will deal first with the experiments, offering later an explanation of the results. The tests were carried out at a carrier frequency of 465 kc/s and a modulation frequency of 400 c/s. The diode input and output circuit is shown in Fig. 2. The input was supplied from a standard signal generator through an RF amplifier valve and the output was taken through a suitable AF amplifier to a distortion factor meter. The RF and AF circuits were all carefully designed to give the smallest possible distortion. The AF output circuit from the diode was arranged as shown to reduce the coupling distortion to a negligible value, and the actual coupling distortion effect was produced by the 0.1 μF capacity C2 and R2 in parallel with the total diode DC load resistance (0.545 MΩ).

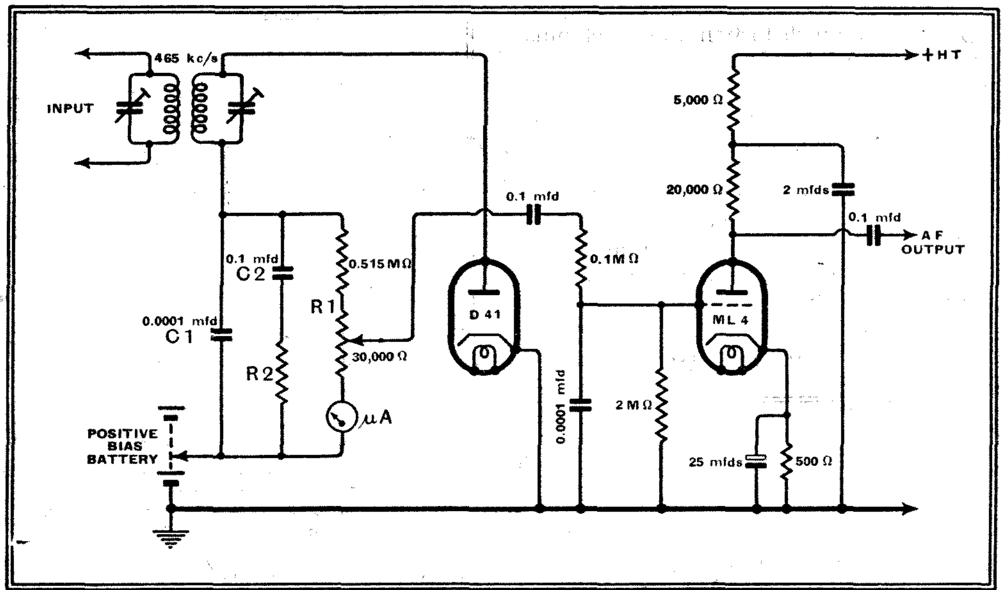


Fig. 2.—The circuit is shown here of the apparatus upon which the measurements were taken. The shunting effect of the AC load is provided by R2.

For the first experiment the distortion produced by varying R2 at different modulation percentages was measured. The results are shown in Fig. 3, and we see that distortion increases as R2 is decreased, though its effect is less for lower modulation percentages. This confirms the conclusions of the first article mentioned above.

For the other experiments the value of R2 was fixed at 50,000 ohms so as to magnify the distortion effects. Fig. 4 shows that positive bias does reduce appreciably the distortion, but that as the bias is increased there comes a point where distortion increases again. This result is at variance with the view expressed in Cocking's article that the required value of positive bias is determined simply by the maximum carrier voltage. The range of bias voltage over which distortion is a minimum is shown to be determined for a given carrier voltage by the modulation percentage, and the range decreases as the modulation percentage increases.

An interesting feature, the implication of which is discussed later, is the effect of

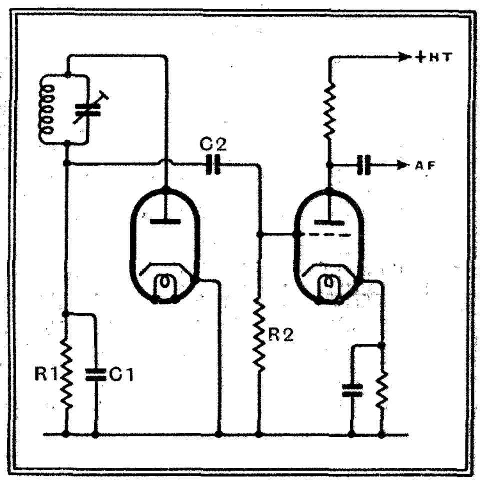


Fig. 1.—This diagram shows a typical diode detector with the following AF amplifier.

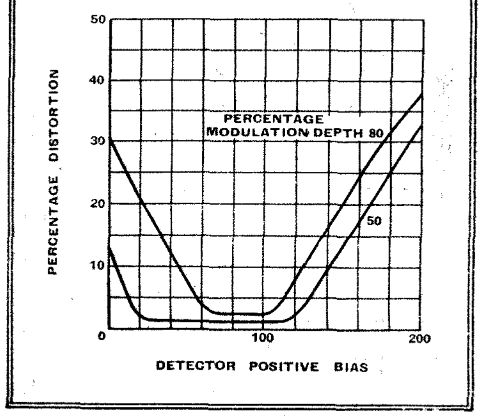


Fig. 4.—The effect of positive bias on distortion is shown here for two modulation depths. The signal input is again 40 volts and R2 is 50,000 ohms.

The Diode Detector with Positive Bias—

shorting C2 indicated in the curves of Fig. 5. We see that positive bias can itself produce distortion irrespective of the AF coupling circuit, but that distortion does not begin until the positive bias reaches a particular value, which increases as the modulation percentage decreases. Another important point to observe is that the distortion for C2 shorted and zero positive bias is practically equal to the minimum distortion reached with C2 open circuited and positive bias.

The experimental work was completed by obtaining curves (Fig. 6) of R2 against the positive bias required to reach minimum distortion for 80 per cent. and 50 per cent. modulation. These indicate that a higher positive bias is required as R2 is decreased and the percentage modulation increased.

Now let us consider the reason for the experimental results. It is worth while, even at the risk of covering familiar ground, to recapitulate the theory of coupling circuit distortion and its elimination by positive bias. Typical diode anode volts—anode current curves are given in Fig. 7 and we can use these to determine the output voltage by drawing suitable load lines. For example, if there is no AF coupling circuit the output voltage is simply determined by drawing a load line such as OB corresponding to R1, and projecting the intersection of this line with the appropriate carrier voltage lines on to the horizontal anode voltage axis.

The output voltage wave shape for a

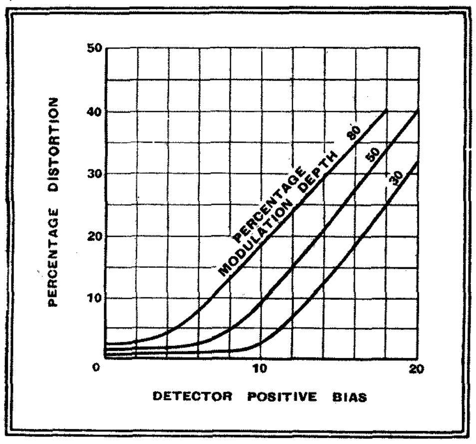


Fig. 5.—With C2 short-circuited the AC and DC loads are equal and have a value of 45,800 ohms. The application of positive bias then increases distortion.

carrier peak voltage of 2 volts modulated 50 per cent. is shown beneath the anode voltage axis. (Note that 50 per cent. modulation varies the carrier amplitude from 3 volts to 1 volt.) The conditions when an AF coupling circuit is connected across R1 are represented by a load line such as FG; this must pass through the intersection of OB with the carrier voltage line of 2 volts, because R2 (subject to certain reservations) cannot affect the DC current in the diode, which is fixed only by the carrier voltage and R1. To variations of carrier amplitude C2 does not isolate R2 and the reactance of C2 is generally low enough to say that as far as these variations are concerned R1 and R2 are in parallel. Hence the line FG corresponds to a resistance of R1R2/(R1+R2). Since FG is steeper than OB it must cut the anode voltage axis before the carrier amplitude reaches zero, and in our particular example we get a distorted wave shape as shown at (b) beneath the anode voltage axis. (The diode current cannot go negative.) We see that distortion only occurs if the carrier amplitude variation, i.e., modulation percentage, falls below a certain value. An approximate formula for this critical modulation is

$$M=\frac{R_2}{R_1+R_2}$$

We can obviously increase M by increas-

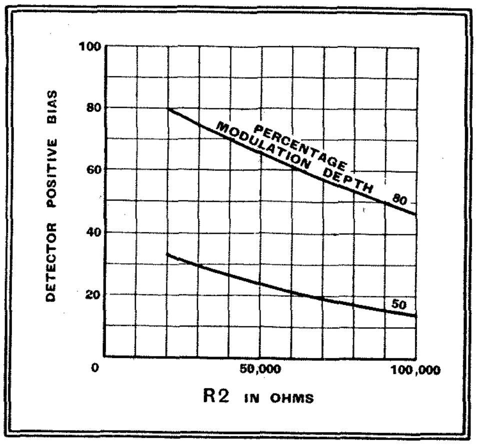


Fig. 6.—These curves show the relation between R2 and the positive bias for minimum distortion; again, for a signal input of 40 volts.

ing R2, but we can also achieve the same result by lifting the line OB so that FG cuts the anode voltage axis at a lower carrier voltage. Now raising OB is accomplished by applying positive bias, so that instead of starting at $Ea=0$ the line starts at some point $+Eb$. The critical modulation approximate formula then becomes

$$M=\frac{E_c+E_b}{E_c}\cdot\frac{R_2}{R_1+R_2}$$

where E_c = carrier peak voltage and it is clear that M can be raised to 100

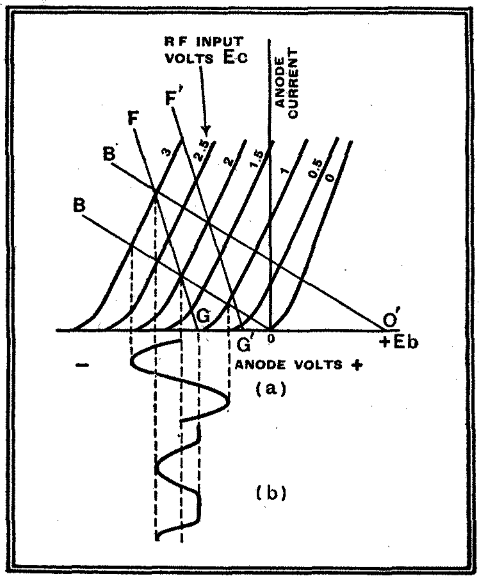


Fig. 7.—The DC load line is indicated by OB and the AC load line by FG. If the former only were operative the output would be undistorted (a), but when FG is the working line there is distortion as shown at (b). The use of positive bias shifts the load lines to O′B′ and F′G′ and obviates the distortion.

per cent. for any value of R2/R1 provided Eb is increased sufficiently. Cocking suggests that all we need do is to decide the highest carrier voltage we wish to apply to the diode and then calculate the value of Eb to give $M=1$. Lower values of carrier voltage can then be accepted without distortion, for they give M greater than 100 per cent.

Unfortunately this is not the whole story and, as pointed out by Williams, positive bias causes damping of the tuned circuit supplying the diode. The equivalent resistance across the tuned circuit decreases as the carrier voltage decreases, and when the carrier is small it finally

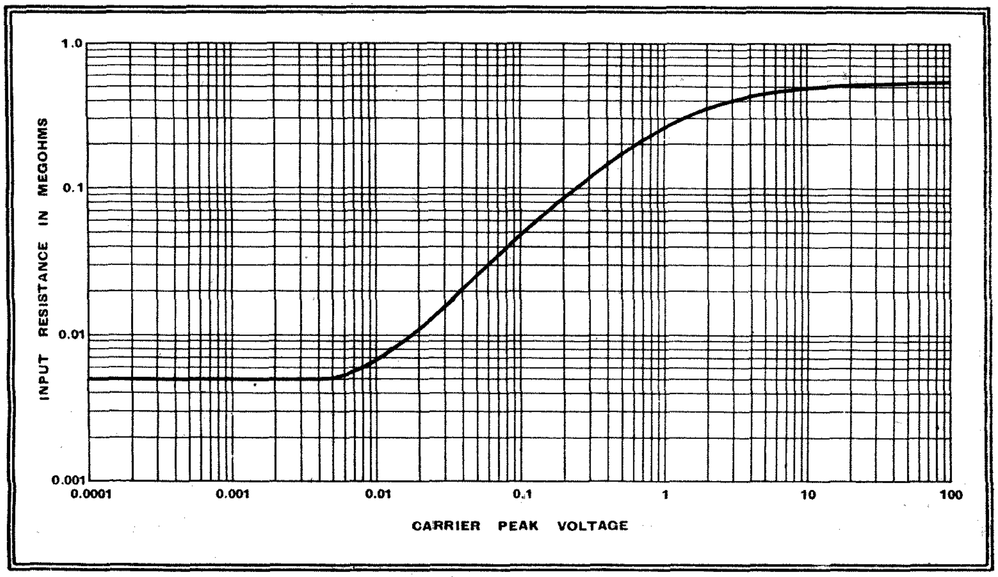


Fig. 8.—This curve illustrates the variation of input resistance with signal input voltage for 1 volt positive bias on the diode and R1 equal to 1MΩ. The diode AC resistance is 5,000 ohms.

[1] Diode Detectors. J. B. L. Foot, *The Wireless World*, December 28th, 1934.

[2] The Diode Detector. W. T. Cocking, *The Wireless World*, January 27th and February 3rd, 1938.

[3] The Properties of a Resonant Circuit Loaded by a Complex Diode Rectifier. F. C. Williams, *Wireless Engineer*, November, 1938.

The Diode Detector with Positive Bias—

reaches the AC slope resistance of the diode. An example of this resistance variation due to the diode is shown in Fig. 8, and it causes the gain of the RF amplifier feeding the tuned circuit to vary with carrier amplitude changes, a much lower gain being given for small amplitudes than large. The result is a distorted modulation envelope as shown in Fig. 9, and it is this that causes distortion to rise again (see Fig. 4) when the positive bias is increased.

As a rough rule, we can say that if the carrier amplitude causes the AF variation on FG (Fig. 7) to cross the anode current axis, then positive bias distortion is introduced. The range of positive bias must, therefore, be limited for a given modulation percentage to values which allow the

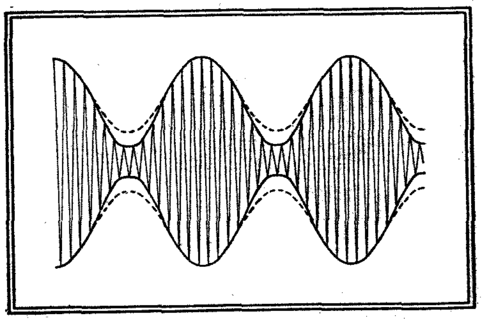


Fig. 9.—The variation in the input resistance of the diode affects the damping of the tuned circuit and distorts the input voltage waveform as shown here.

AF variations along FG to cut neither the anode voltage nor the anode current axis, and the range is naturally decreased as M is increased. The ideal arrangement would be to make the positive bias keep step with the carrier voltage so that FG always passes through $Ea = O$; we should then be able to accept a 100 per cent. modulated carrier with practically no output distortion.

A proof of our arguments is that we should expect in the practical case that the distortion at a given modulation percentage would be the same for C2 shorted and zero positive bias as for C2 open circuited

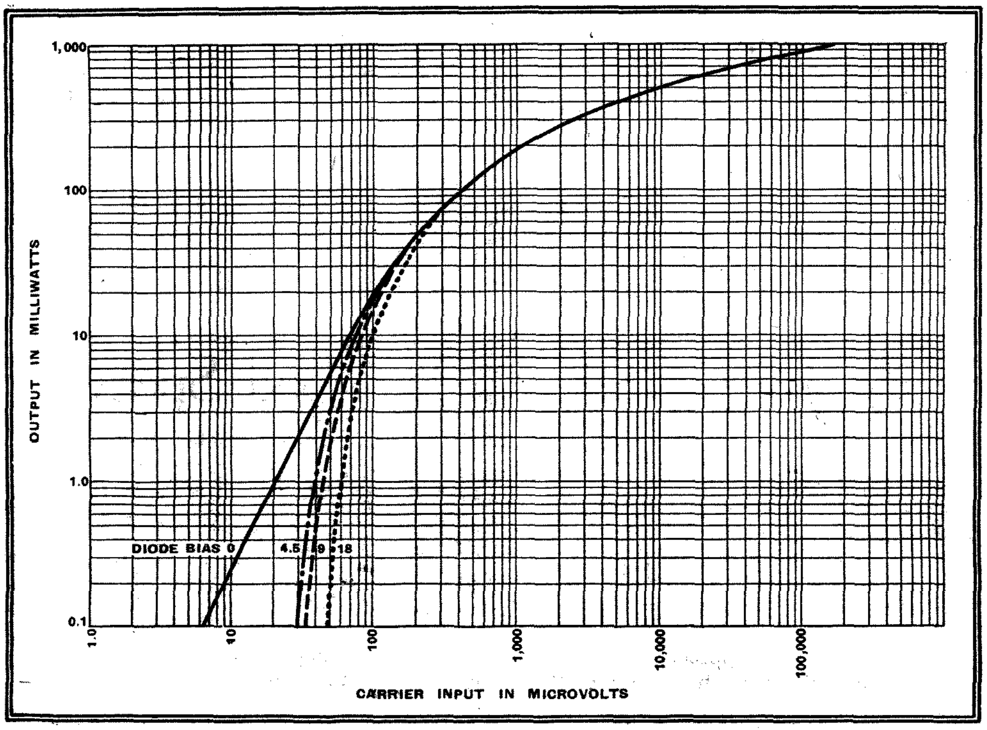


Fig. 10.—A muting action can be obtained by the use of positive bias on the diode and this is well brought out by these input-output curves of a receiver.

and the diode biased for minimum distortion. At the same time we should expect distortion to appear at quite a low value of positive bias with C2 shorted and that there would actually be an increase in distortion by shorting C2 when the positive bias is high. All this is proved in the experimental results shown in Figs. 4 and 5.

It is interesting to note that noise suppression in a receiver may be produced by positive bias on the diode detector by making use of the damping property. A typical input-output curve for a receiver is given in Fig. 10 and it shows the effect of positive bias noise suppression.

We may now summarise the results of our investigation as follows:

(1) Positive bias can be applied to a diode to reduce detector distortion due to the AF coupling circuit.

(2) Distortion at a given percentage modulation is reduced to a minimum value, viz., that which would be measured at a detector having a DC load resistance equal to the AC load resistance.

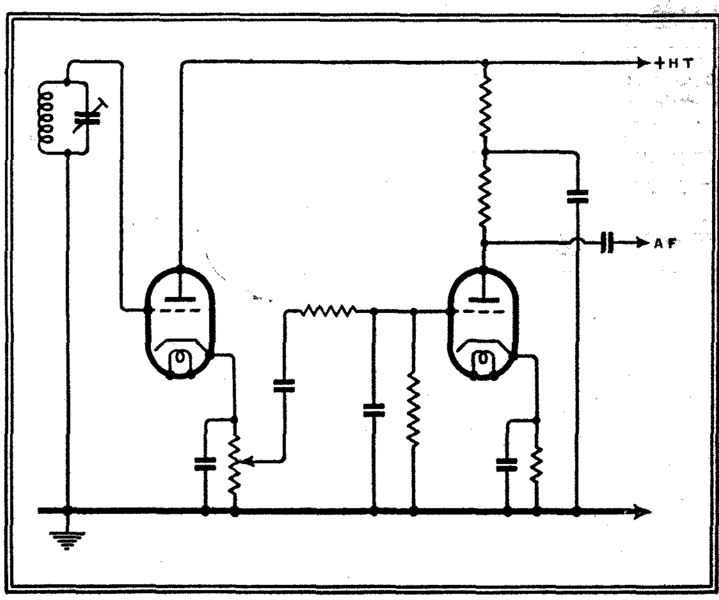


Fig. 11.—This diagram shows the circuit of the negative feed-back anode-bend detector.

(3) Distortion can be reduced to a minimum by a range of positive bias voltages. The range decreases as the modulation percentage increases until at 100 per cent. modulation only one particular value may be used.

(4) Reduction of distortion by positive bias is only really satisfactory if the bias voltage is controlled by the input carrier voltage so as to increase as the latter increases.

Before concluding this article we should refer to a detector which has all the characteristics of a diode detector with positive bias without the disadvantage of positive

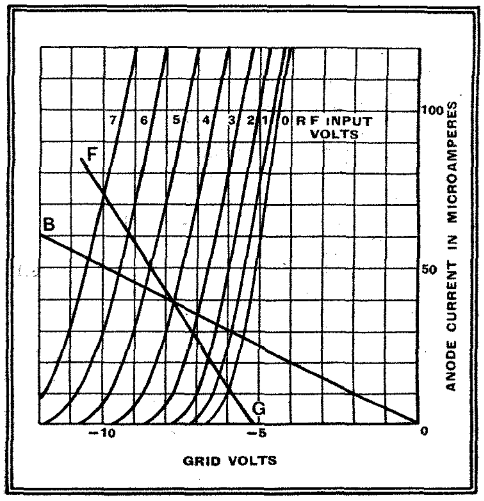


Fig. 12.—The grid-volts anode-current curves of the negative feed-back detector reveal its close relationship to the diode with positive bias.

bias damping. This is the so-called anode bend detector with negative feedback.[4] The circuit diagram of this detector is shown in Fig. 11 and typical detection grid volts—anode current curves in Fig. 12. The action of the valve is identical with that of a diode with positive bias, the value of which is fixed by the anode voltage, increasing as the latter increases. The

[4] New Detector Circuit. W. N. Weeden. *The Wireless World*, January 1st, 1937.

The Diode Detector with Positive Bias—
grid of the triode merely controls the electron stream and takes no current. There is, therefore, no damping on the input circuit; indeed, there is usually a regenerative effect[5] due to the capacitive cathode load.

The negative feed-back detector, therefore, has the advantage over the diode not only of a higher input resistance but of being able to operate with the equivalent of a fixed positive bias without introducing distortion. It is thus simpler than a diode with automatic variable positive bias, and it is more efficient, considering the circuit as a whole, because the tuned input circuit is undamped.

Acknowledgments should be made to the Marconi Company for permission to publish the results which were obtained in the laboratories of the Marconi School of Wireless Communication.

[5] Cathode Coupled Circuits. W. T. Cocking. *The Wireless World*, December 15th, 1938.

Voigt "Light Coil Twin" Loud Speaker

TO take full advantage of recent improvements in the quality of some of the B.B.C. transmissions, particularly from the Alexandra Palace, the frequency response of the Voigt twin diaphragm loud speaker has been extended in the upper register and lifted to maintain the general level of the output up to at least 12,000 cycles even when the unit is used with the domestic corner horn. It will be appreciated that this is a more difficult task than producing a level response on the axis, for the corner horn is designed to give even distribution of high frequencies through an angle of 90 degrees in the horizontal plane and also for a considerable range in the vertical.

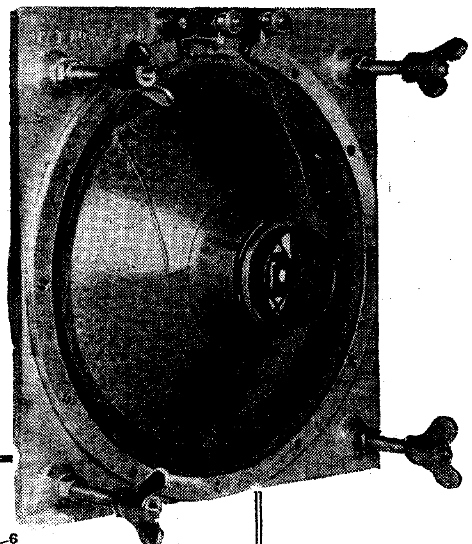
There can be no doubt that the work involved has been worthwhile, and as the result of a week's listening to all types of programme, we are satisfied that the lily has, in fact, been gilded. Transient response is as good as ever and the bass chamber in its latest form extends the response below the natural cut-off of the horn smoothly and with no hint of artificial resonance. Every type of transmission has the authentic mark of the original and, without the sense of sight, a listener coming into a darkened room during a good pianoforte or quartet recital might easily expect to find the actual performers in the room when the lights were switched on.

For some B.B.C. transmissions, however, there is an excess of top and a filter can be supplied with the loud speaker to compensate for such inequalities in the characteristics of microphones, etc.

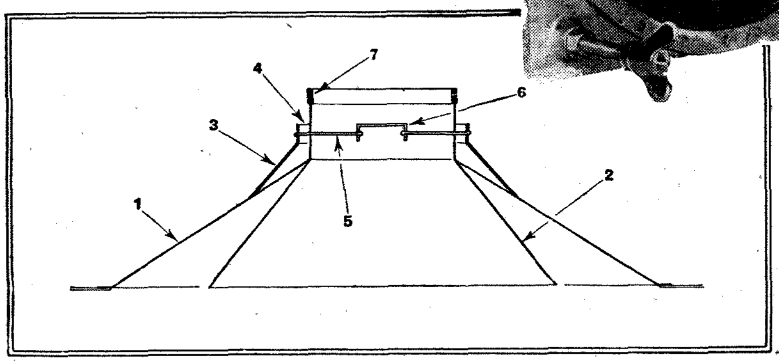
The technical details of the changes which have brought about this improvement in performance may be of interest to those who possess or who are familiar with the original twin diaphragm. All the modifications have been in the direction of lightening the mass of those parts of the diaphragm which are in motion at high frequencies. The centring threads are no longer attached to the speech coil former, and being relieved of this radial strain it has been reduced to a thickness of only 0.003 inch. As in previous diaphragms, the layers of the speech coil are wound inside and outside the paper former.

The speech coil has been lightened by the use of a finer gauge of aluminium wire, but the DC resistance remains approximately as before. The magnet gap has been reduced by a liner ½ mm. thick and the flux density has consequently gone up from about 16,500 to 18,000 lines/cm². Since the poles are supersaturated the coil inductance is negligible and this in turn has resulted in a further increase in the high frequency output. Incidentally, the clearances between speech coil and pole pieces have not been reduced by these alterations.

The price of the light coil twin unit, including components for the transmitter correction network, is £16, and corner horns in white wood are available at £2 15s. for the simple H.C. corner horn, or £17 5s. for the domestic corner horn with bass chamber.



The new light coil twin diaphragm is interchangeable with earlier Voigt diaphragms and a liner can be supplied for the air gap of existing magnets.



Details of the sectional drawing are as follows: (1) main diaphragm, (2) high frequency diaphragm, (3) new suspension cone, (4) flexible dust seal, (5) thread passing through clearance hole in coil former, (6) centring washer, (7) speech coil.

PROBLEM CORNER—10

Test Your Powers of Deduction

HERE is another letter from the postbag of Henry Farrad, who, as regular readers will know, has a reputation among his friends for diagnosing faults in broadcast receivers.

13, Slickbilt Villas,
Wyringham.

Dear Henry,

A most peculiar thing has happened to our wireless, and as it is completely beyond my comprehension I am wondering whether you can shed any light on it. Last Sunday night we came home from a weekend away to find the wireless busy playing. I started to tick Joan off for not switching it off before she left, until she pointed out that it *was* switched off! Of course, that shut me up pretty quick, but we are equally fogged to know how on earth it can happen. I find we can still work it by switching off with the volume control knob instead of at the wall socket. We always used to use the wall switch, but now that makes no difference whether it is on or off, although I unscrewed the cover and made sure that the switch is all right.

Well, first of all can you enlighten me as to how it can work when it is switched off, and then I would like to know if any harm can follow our present procedure.

Oh, and another thing—I believe we are to be changed over to AC soon, but the man who sold us the set said it would make no difference to us. But will the switch mystery upset things?

Sincerely yours,
George.

(For Henry Farrad's solution turn to page 234.)

New Accompaniment Records

TWO new lists of gramophone records have recently been issued by (*a*) Messrs. Bosworth and Co., Ltd., 8, Heddon Street, Regent Street, London, and (*b*) Messrs. Boosey and Hawkes, Ltd., 295, Regent Street, London. These catalogues contain recordings specially made to provide both entertainment and incidental items of varying character and length for use where music is required and where actual performers are not available, *e.g.*, in cinemas and cafés. The other important use for these records is as a non-synchronous sound accompaniment to silent films, particularly useful to amateur cinematographers.

The object of selecting certain musical items to accompany films is, of course, apart from swamping distracting noises, to stimulate the audience's imagination and to help in establishing the atmosphere and mood for the most favourable reception of the film.

To facilitate the choice of suitable "mood music" the various discs have been classified, in the case of (*a*), under such headings as "Mechanical," "Agitatos," "Nautical," "Oriental" and for (*b*) described as "Treachery and Vengeance," "Catastrophe," "Appassionata." An interesting feature of the lists is that the playing-time of each item (at 78 r.p.m.) is given in minutes and seconds. The price of these double-sided solid-stock discs, all 10 inch, is 2s. 6d. each. Both the companies above will forward copies of the catalogues free on application. D. W. A.

Designing an Individual

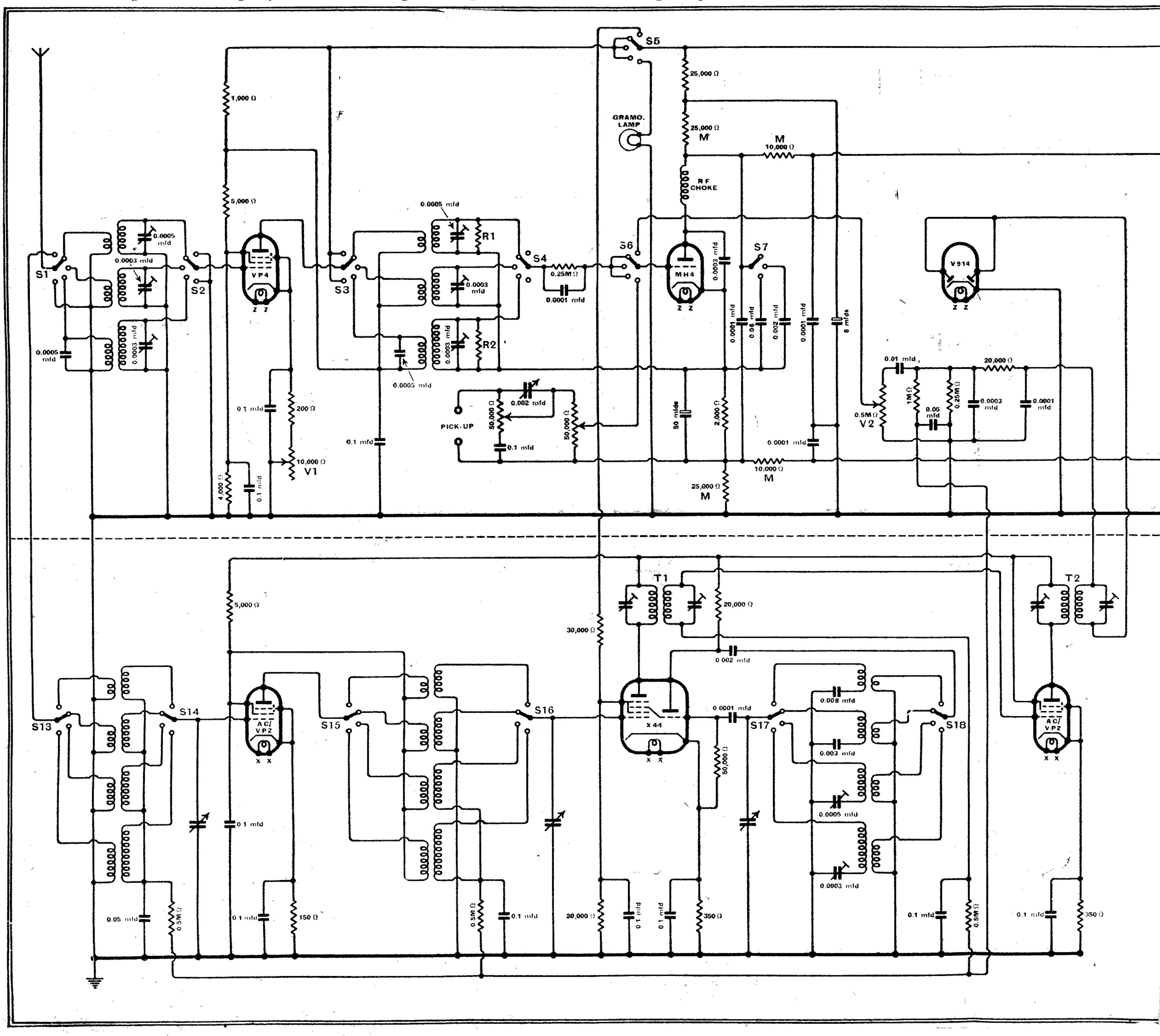
Multiple-unit Set for Local and Distant Reception

(Concluded from page 203 of last week's issue)

HAVING decided upon the design of the local-station unit and the AF section, the choice of the superhet tuner had to be made, and various advertisements were studied with a view to obtaining the required performance at reasonable cost. In the end the choice fell on a tuner made by the Radio Development Company, incorporating an RF valve, the frequency-changer, and a single IF stage in its chassis. This provided two short-wave bands, 12-35 and 30-80 metres, as well as the usual medium and long wavelengths, the RF stage being tuned on all bands.

The output of this unit was, of course, at the IF of 465 kc/s, and could be fed straight to the diode in the pre-tuner chassis; AVC was to be taken from the output of the strapped anodes, and was to be non-delayed; it was applied to the RF and IF valves only on the medium and long settings, and to the frequency-changer also on the two short-wave bands. The circuit followed, in common with most of those given in *The Wireless World*, gives considerable fading compensation without bringing all stations to the same level, and is thus rather easier to tune than one where the AVC action is such that the use of a tuning indicator becomes almost essential.

Since the acoustic characteristics of the room in which the set was to be used, and also the response to the speaker, were known, it was evident that there would be no need for any great measure of tone



Receiver

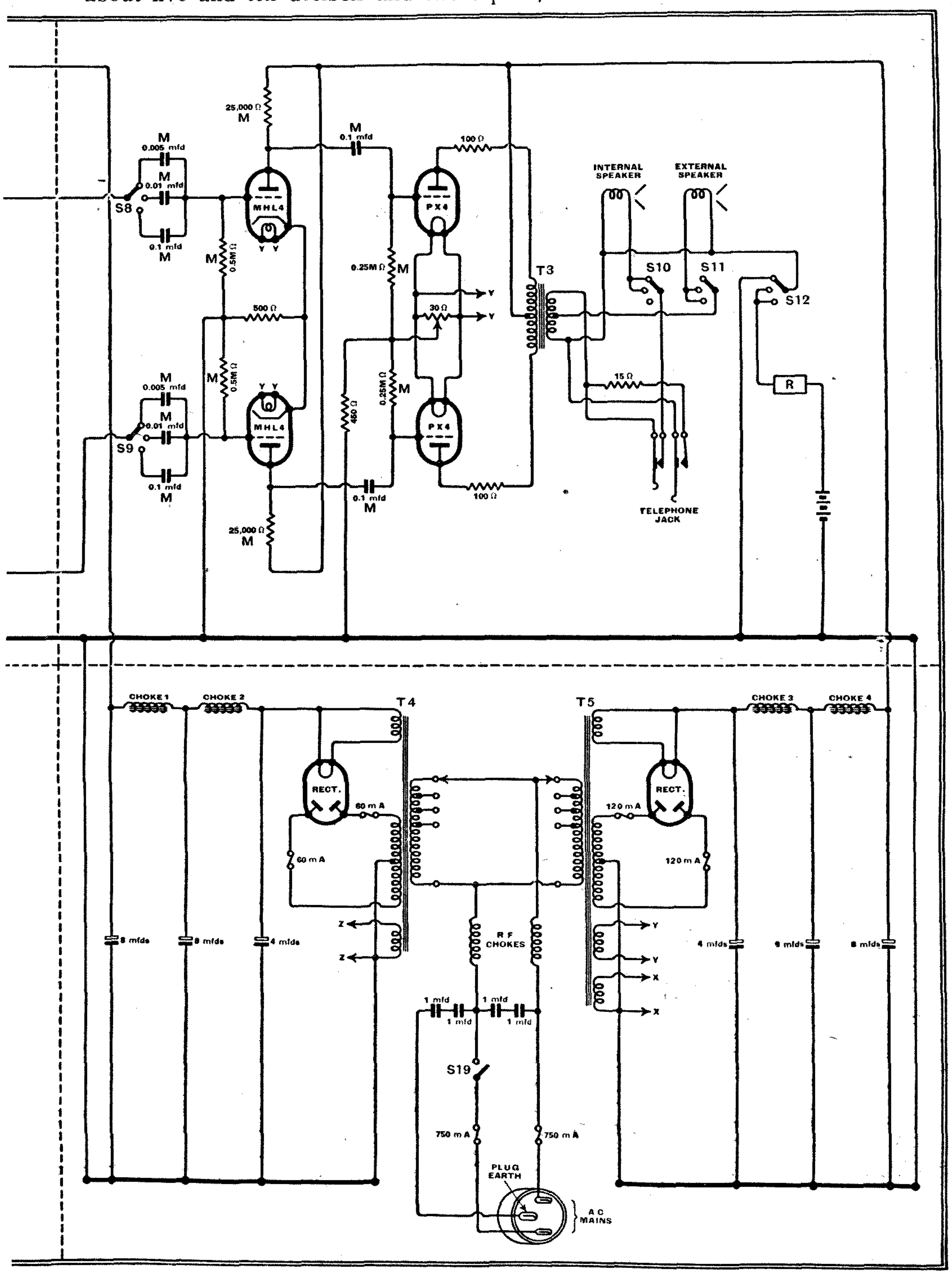
THIS is the concluding instalment of an article in which the writer discusses his own particular requirements in the performance of a broadcast receiver and then details the steps taken to satisfy them.

By R. H. WALLACE

control in order to even up the reproduction. The most that might be necessary on completion of the set would be a slight rise in the treble; even this might not be required on the pre-tuned unit. Some cutting of the top register would be needed on the best of the distant stations, and this would be looked after by the tuned circuits of the superhet side. Thus the only tone control necessary was that required to allow intelligible reception of the more distant stations, and this could be brought about by two bass cuts of about five and ten decibels and two top cuts. The treble circuit would be better in the form of a low-pass filter, as this would permit the removal of the 9-kc/s heterodyne whistle on the local station, while retaining the maximum response possible; since units of this type were available with two cut-off frequencies it was decided to incorporate one giving a top cut of 8,500 or 6,000 at will.

The bass cut was most easily provided by variation of the capacity of the condensers coupling the phase-changer to the first RF valves of the amplifier, and it was decided to use three pairs of condensers at this point. So far as the design of the amplifier was concerned, the use of these extra condensers and the provision of switching for the output were the only alterations needed to *The Wireless World* design—other than the rather obvious one of providing for the higher rating of the PX4's now available, the bias resistance for the latter being changed to secure this condition. The set speaker had an impedance of 15 ohms, and the extensions ranged from three to seven ohms, so that a transformer with ratios of 25 to 1, and about 50 to 1, was needed; a transformer having these ratios was available in the Varley range and was adopted.

Complete circuit diagram, showing interconnection of the various units. The temporary treble tone control mentioned in the text is included. Components marked M are matched in value to within one per cent. Volume controls V1 and V2 are ganged. R1 and R2 are for equalising volume. T1, T2; IF transformers (465 kc/s): T3; 50 : 1 centre-tapped P and S: T4; outputs 4V, 2A; 4V, 4A; 250-0-250 V.: T5; 4V, 2A; 4V. 4A; 4V 4A, 350-0-350 V. Choke 1; 32H: Choke 2; 200H: Choke 3; 50H: Choke 4; 20H. Switches :—S1 . . . S6; ganged selector switch: S7; treble-cut tone control: S8, S9; bass tone control: S10, S11, S12; extension switch: S13 . . . S18; ganged wavechange switch.



Mounting the Units

The next step in the design was the translation of these decisions into an actual working layout for the set. The chosen tuner had the dial ½in. out of centre, and as the internal width of the cabinet was 24in., and the tuner 8in. over the terminals, there was left slightly more than 8in. on the left and 7in. on the right, when the dial was central. The natural place for the pre-tuner unit seemed to be on the left, and this also gave the most convenient disposition of the aerial and earth leads, so the chassis for this unit was made 8in. by 14in., leaving 7in. by 14in. for the amplifier. The terminals of the superhet portion were on the side, and so the leads from this to the pre-tuner would be screened between the two chassis, while the external connections to the set could most conveniently be taken out at the back; the exception to this being the leads from the power equipment underneath, which were taken to the underside of the pre-tuner and amplifier sections.

With this arrangement of the units it was clear that the layout of the chassis to give the shortest RF wiring would bring the first valve of the pre-tuner to the rear of the chassis, and this would need to be in a separately screened compartment, with its accompanying switching. In front of this the phase-changer and the

Designing an Individual Receiver—

diode would need to be fitted, the latter on the left, as this would be nearest to the superhet chassis. The small tuning coils chosen could be disposed in the two compartments, thus obviating the need for individual screening, while the leads to the switches would be very short; a variable-mu RF pentode, the VP4, was used for the first valve and an MH4 as combined detector and phase-splitting valve; with the coils selected transformer coupling would be used, and the volume could be controlled, in the usual way, by variation of the bias on the RF valve.

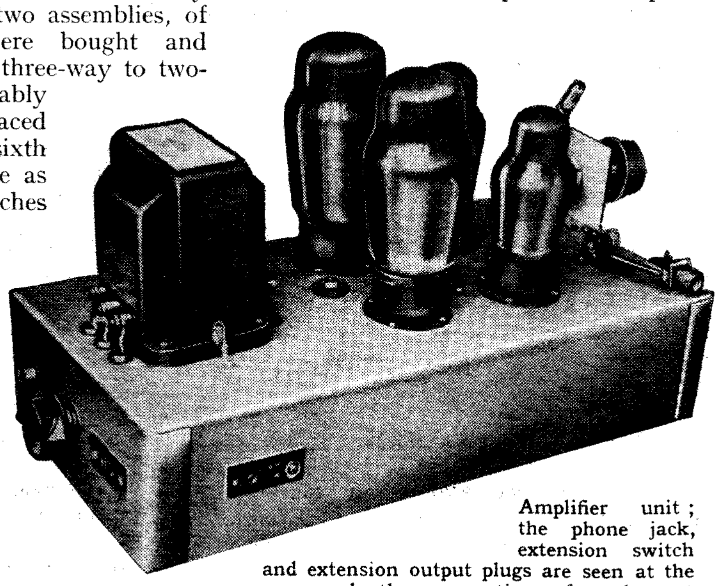
Detector Change-over

The switching for the detector called for the grid leak to be changed from one to another of the three coils, in the pre-tuned section, to give the three positions for local reception, and for the grid of this valve to be taken direct to the diode load in the "Tune" position, also for the pick-up leads to be suitably connected at the fifth setting.

Passing now to the HT switching, it was necessary to remove the supply from the RF valve of the local station unit in the first and last settings of the switch, and to disconnect it from the superhet unit in the second to fourth positions. In the fifth setting the gramophone lamp had to be connected across the HT supply terminals. In order to avoid any breakthrough of signals, the switch was also arranged to earth the grid of the VP4 and short-circuit the coils in its anode when the other tuner was in use.

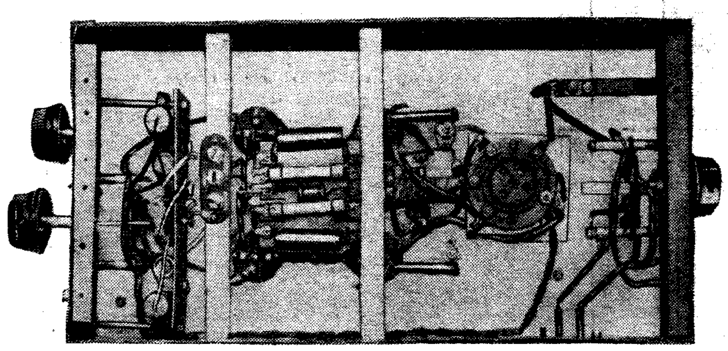
The aerial had also to be transferred from the superhet, in the first position, to the three primary windings of the coils in the grid circuit of the VP4, in the appropriate settings. Similar changes were required in the secondary connections of these coils and those of the other stage. The choice of the switch was the next step. From the decisions already made, it followed that six poles would be required, and if the same switch was also to perform the duty of changing from one unit to the other, and to gramophone, then at least five ways would be needed; the so-called "Yaxley" type was the most suitable, and in order to leave room for a further position if needed, six ways were decided upon, thus leaving one spare. It was not thought advisable to have the grid and HT switching on the same wafer, on account of the possibility of leakage of positive potentials on to the grids, and a switch of four wafers was thus wanted, one in the aerial section and three in the detector portion; as these were not readily available at the time, two assemblies, of two wafers each, were bought and altered from four-pole three-way to two-pole six-way, and suitably ganged, a stop being placed so as to exclude the sixth position until such time as it might be needed; switches are now available which would have saved this trouble.

It was decided, in the interests of simplicity, to gang the volume controls of the two radio units; this was easily done with Meccano gears. The volume control for the gramophone was to be in the most suitable and most natural place; namely, the motor-board.



Amplifier unit; the phone jack, extension switch and extension output plugs are seen at the rear and the connections for the set speaker at the side.

The amplifier layout was somewhat modified from that adopted for the original design in *The Wireless World*, as the power equipment was separate, and there were the extra switches for the bass tone control and the extension speakers to be included. Most of the smaller parts were mounted on two sub-assembly boards, instead of being slung between the larger components, since this gave greater rigidity, while permitting a good deal of the wiring to be done before the boards were put in the chassis. Due care was taken to keep the grid connections well away from the anode resistances, to prevent any tendency to grid current, and saw cuts were made between the tags, so as to increase the surface path from one to another.



Base of amplifier chassis; the AF input terminal strip is carried on a bridge, bass tone control switch is at the front of the unit and the extension switch at the rear. The hum-neutralising potentiometer across the output valve filament supply is underneath the power bias resistor.

The bass tone control called for a two-pole three-way switch, and this was mounted in the front of the chassis, with the strips locating the coupling condensers immediately behind it. The set main switch was fixed on a bracket, above and to the right of this so as to correspond with the position already chosen for the treble control, at the other side of the cabinet. In view of this arrangement it was natural to put the first pair of AF valves at the front of the amplifier, and this gave shorter leads to the extension terminals at the back.

The switch controlling the extension wiring had to give positions where either the set speaker, or the external one, or both were in use, and to perform the appropriate circuit alterations for the relay, so that this was not operative when the extensions were cut out. These requirements were satisfied by a three-pole three-way switch of the "Yaxley" type mounted at the rear, near the output transformer. In order to provide for phone operation, when required, a jack was mounted near this switch; there was some difficulty in connecting the phones, since with a push-pull amplifier there is no suitable point in any early stage. It was found, however, that the voltage available across a 15-ohm speaker, or resistance, was just about of the right order to give a satisfactory signal, with high-resistance phones, at normal settings of the volume control.

Maintaining Correct Loading

The insertion of the plug was arranged to cut out the set speaker, but to leave the extension connections unaltered. Further, so as to maintain the correct load on the output valves, a 15-ohm 10-watt resistance was connected across the transformer, these alterations being automatically performed when the plug was inserted.

The gramophone correction circuit was interposed between the moving iron pick-up and the phase-changing valve, this position having the advantage that the pick-up characteristics could be compensated independently of the tone controls of the set, although these remained effective in addition. The circuit adopted gives a bass boost sufficient to allow for the well-known cut in this region, and also a variable rise in the treble to make up for the reduced response of the pick-up at the higher frequencies; about 60 per cent. of the available voltage is lost with this method, but it has advantages over any resonant methods and there was, in any case, plenty of output to spare.

So far as the actual construction goes, little explanation is needed, as the photographs show most of the components clearly; it should be noted that some of the parts on the assembly boards are

Designing an Individual Receiver—

underneath, and thus not visible. A good deal of the connections on these, and on the pre-tuner switch, were made before their fitting in the chassis, as they would have been difficult to reach afterwards. The resistances were disposed so that there was plenty of space for cooling air to flow between them, and the potential divider was put above the chassis, and a hole provided beneath it, so that it should run cool in spite of the considerable heat dissipation; it was protected against accidental shorts by a perforated metal cover shown. Most of the components were of the usual type, but all the composition resistances were very conservatively rated, so that there should be as little change in their values as possible. Special note should be made of the fact that those coupling resistances and condensers in the two channels of the amplifier were matched to within 1 per cent; any discrepancy here is cumulative, and might lead to considerable mis-matching.

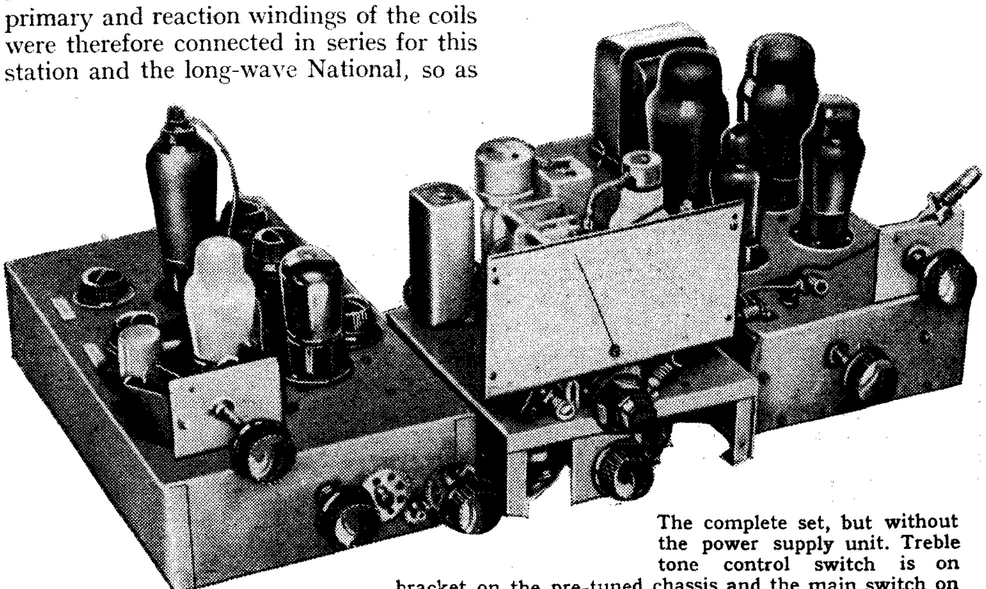
Screened wire was avoided, as far as possible; indeed the only connections where this was necessary were that to the anode (top cap) of the VP4 in the pre-tuner, the AF output leads from this chassis to the amplifier, from the latter to the speaker, and, of course, the wires from the pick-up. It was found on trying out the pre-tuner that there was no need for reaction on the North National; the primary and reaction windings of the coils were therefore connected in series for this station and the long-wave National, so as to give increased signal transfer, and to damp the circuits more; on the Regional, however, it was found that there was hardly enough transfer, so the primary provided was removed and three times as much wire wound on; this gave quite satisfactory results. Later it was found that it was better to shunt the long-wave primaries with 0.0005-mfd. condensers. When these alterations had been made there was ample volume on the local stations.

The power units followed normal practice, there being two chokes in each to give a low hum level. An anti-interference filter was made up of two series-connected pairs of 1-mfd. condensers, one across the mains and one from neutral to earth; following these came two RF chokes of solenoid type, to remove the last traces of the interference. The earth lead from the filter, and the screening and cores of the mains transformers, was taken to the earth pole in the wall plug, so that no interference should be injected into the normal lead to the tuned circuits.

Since the controls numbered eight, and there were as many as five positions to some of them, it was thought that some indication of their purpose, and setting, ought to be provided; a separate window over each with a disc behind it would have served the purpose, but the use of a wood panel with so many holes in it would have given an unsatisfactory appearance. The choice finally fell on the use of a mirror with the windows over the knobs left unsilvered, and also a larger space for the tuning dial to show through similarly treated. The glass was obtained from one of the mirror makers with the holes drilled and the silvering cut away in accordance with the plywood template supplied to them; it was not unduly expensive and looked very pleasing in the finished set, with a bulb behind each aperture, and paper discs to show the positions.

The performance of the finished receiver was satisfactory, the quality on the local stations left little to be desired, and that from the superhet section was reasonably good, the need for variable selectivity not being felt. It was a pleasure to change at will from one local programme to another, or to the tuner, and when some short-wave station had been found, and the home programme was wanted for a time, to change back by the simple movement of a knob. The ample space in the cabinet gave good cooling, and there was no noticeable drift on the short-wave bands, even during the warming-up period. The performance on distant stations was as good as was to be expected, and with a good aerial there was no difficulty in tuning in almost any worth-while programme without serious background noise. The short-wave bands gave many good transmissions, and there were few of the more powerful short-wave stations which did not at some time or other give a good account of themselves; some second-channel interference did manifest itself on the lower half of the 12- to 30-metre band, but was not serious. The calibration was fairly good and only a few discrepancies were found.

It will naturally happen that, for the very reason that this was an individual design, most readers will find much to criticise in the specification, and in the manner in which it was fulfilled. It is hoped, however, that this article will encourage others to carry out their own designs: the writer can assure them that they will find great pleasure and much valuable experience in so doing.



The complete set, but without the power supply unit. Treble tone control switch is on bracket on the pre-tuned chassis and the main switch on the corresponding bracket at the right. The gears which gang the two volume controls are clearly shown.

The Wireless Industry

A LEAFLET giving particulars of the seventy ranges provided by the new Model 80 universal meter has been issued by the Taylor Electric Instruments Co., 77-77a, Queen Victoria Street, London, E.C.4. Three models are available with sensitivities of 2,000, 5,000 and 20,000 ohms/volt; the latter costs 14 gns

Audio-frequency transformers for all purposes with characteristics flat within 1 db. from 30 to 2,000 cycles are described in a well-prepared technical catalogue in English issued by Unitran Elektro-Technische Fabriek, Looierslaan 3, Voorburg, Holland.

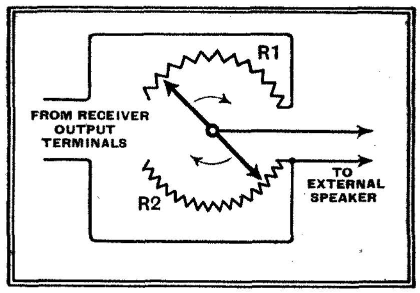
Thompson, Diamond and Butcher, 34, Farringdon Road, London, E.C.1, have produced a triple-purpose record cabinet for use with the H.M.V. and Columbia record players. A table model receiver may be placed on top, the record player fits into an upper compartment, and a lower compartment takes 100 records. The price is 52s. 6d. or 59s. 6d according to finish.

EXTENSION LOUD SPEAKERS

Connections of the Volume Control

IN the circuit diagram of a typical constant impedance volume control given on page 10 of the supplement to last week's issue, the "top" connection from the external loud speaker sockets should have been made to the right-hand end of R1. This will ensure that as R2 is decreased to reduce volume, R1 is increased to maintain a constant resistance across the receiver output terminals.

To make the matter quite clear, we have indicated the direction of rotation of the contact arms which will result in an increase of volume.



Constant impedance volume control near the "minimum" position. As volume is increased R1 is reduced and R2 increased. The value of R1 should be approximately equal to the loud speaker impedance and R2 about five times the resistance of R1.

UNBIASED

By FREE GRID

In Defence of the B.B.C.

ALTHOUGH I will yield to none in my denunciation of the B.B.C.'s policy of diagonalising the programmes so that what you hear from one transmitter on one night you will see from another on the next night, yet all the same I do not like to hear its efforts unfairly compared with the cinema to the advantage of the latter. I therefore hotly resent the recently published remark of a certain cinema magnate, in which he draws unfair comparisons between the alternative programme policy adopted by the B.B.C. and the cinema, for if there is one type of entertainment which does *not* offer any alternative programme, it is the cinema.

When you go to the cinema you have simply got to sit wearily through the one programme offered or get out. There is no alternative programme, although I do remember that in my home town in the early days of this century there was an attempt made to offer alternative programmes, and I have never heard any official explanation as to why it never caught on. The idea was simple. There was a screen at each end of the hall, each with its appropriate projector, and as all the seats were swivelled you could look at whichever programme you fancied, there usually being a serious film on one screen and a comic one on the other.

I can well understand, of course, that this system could not ordinarily be used in the case of talkies because of the confusion of sound which would arise, but

An ultra-modern flapper.

before the cinema industry starts throwing stones at the B.B.C. I think that it might well cast a stone at itself and thereby kill two birds, namely, the one-programme-only bird and the echo-variation-distortion bird.

This they could do by having swivel seats and a screen at each end, as already referred to, but using headphones instead of loud speakers. We should thus have an alternative programme and also get rid of the annoying variation in the quality of sound reproduction due to the continuous change in the acoustic characteristics of the hall as the different members of the audience, with their widely different sound-absorption factors, come and go. After all, when a scantily clad ultra-modern flapper takes the seat vacated by an elderly Victorian female wearing half a dozen red flannel petticoats, you can hardly expect their sound-absorption factors to be the same. Headphones would get rid of this nuisance, as well as enabling alternative programmes to be given.

It would, however, be a far better idea, in my opinion, and one more likely to appeal to cinema proprietors, if, instead of alternative programmes, half the ordinary programme were to be given at one end and half at the other end of the hall. This would stop the nuisance of having to sit through the part of the programme you don't want to see until the film you do want to see eventually comes on. The whole programme scarcely ever appeals to every section of the community, and so in this way the proprietors would obtain a much quicker turnover in the audience and so effectively double the capacity of their cinemas without increasing their running costs in the matter of hiring extra films.

The Effects of Spring

NOW that spring is in the air once more I expect that most of you are hard at work making plans for outdoor wireless activities, including, of course, the designing of portable sets. Actually, I started some time ago as my new instrument is of a type which has taken a considerable amount of hard work to complete. It is a push-button type, for I see no reason at all why this system of simplified tuning should not be applied to portables. Actually, in my opinion, it is of greater value in portables than in other sets, for portables are usually employed under conditions which do not permit of careful tuning in the ordinary manner, and it is a great advantage to have a few stations "on tap."

The most obvious push-button system to use in a portable is the so-called "pre-selector" arrangement, in which a predetermined value of capacity is slung across each tuning circuit when a particular button is pressed. However, this did not suit me at all, as I wished to go the whole hog and make my portable a remotely controlled one, since in the past I have found it very inconvenient when at a picnic to have to carry on a conversation at the top of my voice, owing to the noise of the loud speaker. It is easy enough to get over this difficulty, of course, by putting the set a few yards away, but if you do this you lose the ability to change the programme, as it is usually impossible, once the picnic has started, to get up without upsetting the tea and putting your foot in the jam; at least, I have always found it so at the picnics I have attended.

The necessity for remote control postulated the employment of a battery-driven tuning motor. Fortunately the motor is in actual use for a relatively short time and so it is easily within the capabilities of the ordinary LT battery. Now I do not seek to take unto myself any great kudos for the design of a push-button portable, and probably I should not have referred to it had it not led to a most unfortunate incident. I had arranged by telephone to bring the portable to London to demonstrate it to the Editor, and find-

Seized from behind.

ing, when I arrived in town, that I had an hour or two to spare before the time of my appointment with him, I determined to park the set in the left-luggage office while I went to do some shopping.

Unfortunately, when I dumped the portable on the ledge of the left-luggage office the jar must have caused some fault to develop in one of the push-button connections which set the motor in motion. The slight whirring noise was scarcely audible, but it had a truly startling effect on the attendant. Quickly picking the set up he dumped it hastily into a nearby bath of water, while at the same time I found myself seized from behind. The net result was a very unpleasant couple of hours in the local police station. I am not a student of the daily newspapers, but apparently there has been an epidemic lately of what are usually termed "infernal machines" being dumped in cloakrooms, and so I was the unfortunate victim of circumstances. What I now want to know is, who is going to pay for my ruined receiver?

An Apology

WHEN Mrs. Free Grid was spring-cleaning my desk the other day she unfortunately came across a lot of unanswered correspondence, some of it dating back to my pre-marital days. The unfortunate part about it is that there were several letters among them which had been sent to me by readers. Now I should not like you to think that I do not bother to reply to letters I receive from you; on the contrary, I invariably reply individually to everybody. I should therefore like to offer my sincere apologies to all of you whose letters have not been answered. Please write again.

NEWS OF THE WEEK

THE B.B.C. IN 1938

Finance, Engineering and Administration

THE Twelfth Annual Report of the Governors of the B.B.C., which covers last year, was presented to the P.M.G. last week. As is to be expected, expenditure during 1938 increased by £329,016 to £3,534,795, of which £352,846 was in respect of television, and £38,958 was for foreign language broadcasts. The total income, however, for 1938 amounted to £3,800,051, an increase of £443,977. Of the B.B.C.'s total income, 90.29 per cent. came from licences and 9.62 per cent. from publications.

Expenditure on programmes accounted for 49.79 per cent. of the B.B.C.'s income for the year —over £162,000 more than in 1937, although the percentage of the total income was less. The engineering side accounted for 17.73 per cent., expenditure on which increased by over £75,000. The report adds that additional transmitters and the extension of transmitting hours accounted for most of this increase.

More Power for London

The first official intimation that the London and North Regional transmitters are to be replaced by transmitters of higher power is given in the closing paragraph of the Report, which adds that a considerable proportion of the cost of these developments and those of the transmitters at Start Point, Clevedon, and Daventry, the extension to Broadcasting House, the new studio and offices at Belfast, and additional studio accommodation at Alexandra Palace, will fall to be met during 1939.

It will be seen that the outlook is not altogether pleasant unless an increased grant is forthcoming from the Treasury. An effort is expected to be made to secure for the B.B.C. another shilling from each ten-shilling licence, making the amount available to the Corporation, free of income tax, 8s. 9d. per licence. On the assumption that there will be nine million licences before the end of the year, this would amount to an increase of £450,000.

Dealing with the engineering side, the Report states that the aggregate time for all transmitters (excluding the Empire station) was 79,525 hours 13 minutes. The corresponding figure for 1937 was 77,714 hours 46 minutes. The breakdown percentage was 0.023, exactly the same as in 1937. The aggregate time for the Empire transmitters was 32,846 hours 8 minutes, as compared with 23,779 hours 18 minutes in 1937. The aggregate time for the television sound and vision transmitters was 2,679 hours 5 minutes, compared with 1,619 hours 6 minutes in 1937.

Concurrently with the issue of the Report, the B.B.C. published its Handbook for 1939, which deals with much of the material included in the Governors' Report and many more interesting facts about the B.B.C. and its work during 1938. The distribution of wireless licences on November 30th, 1938, is given in the Handbook, which, incidentally, costs 2s., showing that the number of licences per 100 families in Great Britain and Northern Ireland was 71. The counties with the highest percentage are Dorset and Wiltshire (with Bournemouth), which jointly have 84 licences per 100 families.

CHAIRMAN AT MONTREUX. Dr. A. Muri, Director-General of Swiss Posts and Telegraphs and leader of the Swiss delegation, has been elected chairman of the Wavelength Conference, which position he held at the Lucerne Conference in 1933. The inset shows the post-mark, "Conférence Européenne de Radiodiffusion, 1939," of the special post office installed at the Palace Hotel, Montreux.

GERMANY'S AERIAL POWER

What Will Happen at Montreux?

"WAR in the Ether," writes one of the German delegates before leaving for the Montreux wavelength conference, "will be a sure thing should the conference disperse without having found a solution to the wavelength problem." It is, however, felt in some quarters that, even if a solution is found, there will, in all probability, be some countries who will not be signatories, so that the situation will be only partly relieved.

In view of the German delegate's statement, it is interesting to review Germany's position. She has thirty-four broadcasting stations with a total aerial power of nearly 1,300 kW. Two transmitters have a power of 120 kW and eight 100 kW. A new high-power transmitter is to be built at Graz to replace the present one of 15 kW, Saarbrucken's power is soon to be increased, and the present 60-kW long-wave Deutschlandsender is to be replaced by a very high-powered transmitter.

It is proposed that Germany should retain nine of her present twelve exclusive channels. Even if this is accepted, she will then have three times as many exclusive wavelengths as Great Britain, whose total aerial power for her seventeen stations is approximately 870 kW.

OVERSEAS RELAYS

B.B.C.'s Increased Use During 1938

A SURVEY of relays from overseas broadcast by the B.B.C. during 1938 shows that those taken by the international telephone lines of the Post Office have increased by 69 per cent., and those taken by radio, including Post Office radio-telephone services, by 52 per cent., compared with 1937. Of the 469 foreign relays which were carried out, 262 were from Europe and 142 from America. It is interesting to see that 87 per cent. of the 207 attempted SW relays were completely successful.

Improvements in the telephonic circuits between this country, Yugoslavia and Lithuania made relays from these countries possible for the first time, while a programme from Uruguay was taken by telephone line from Montevideo to Buenos Aires and thence by radio-telephone link to London.

CENSUS OF EMPIRE LISTENERS

B.B.C.'s Latest Research

HOW many overseas listeners has Daventry? The B.B.C. can only make the vaguest estimate, but an effort will soon be made to arrive at a reliable figure. It is understood that plans are afoot for a Listener Research campaign throughout the Empire.

Such a campaign will take time, and, from start to finish, the process may occupy six months. The Questionnaire is unlikely to be on so extensive a scale as that used for the home audience. Programmes will be the main subject of investigation, but information will also be sought on the technical side, particularly in relation to signal strength, suitability of wavelengths for various localities at different times, fading, and quality of reception.

Although it is understood that the scheme will be confined to listeners within the Empire, many foreign listeners may show interest in the campaign, and the B.B.C. will welcome information from any source.

BRITISH TRANSMITTERS FOR IRAN

WE learn on good authority that instructions have been given to Standard Telephones and Cables for the manufacture and installation of two short-wave transmitters, one with a power of 20 kW and the other of 2 kW (capable of being extended to 20 kW) for the Government of Iran. Two mobile radio links are also to be supplied.

These broadcasting stations will form the basis of Iran's new broadcasting network, and we understand that this is being installed for the furtherance of education and to give entertainment to dwellers in the remote parts of the country.

ILLUMINATIONS SWITCHED ON BY SUN

THE inauguration process of San Francisco's £10,000,000 Golden Gate International Exhibition was mainly effected by means of wireless.

President Roosevelt, speaking from Florida, performed the opening ceremony by wireless, and the 1,400,000,000 candle-power illuminations of the Exhibition were switched on from Bombay, where at mid-day the rays of the sun were made to

News of the Week—

operate a photo-electric relay from which the impulses were transmitted by All-India Radio and Cable and Wireless to London and thence to New York and San Francisco.

INTERNATIONAL DX'ERS ALLIANCE

Epsilon Chapter for London

A NEW London Chapter of this organisation is to be formed, the chief activities of which will include technical discussions, comparison of DX logs, study of magnetic disturbances, field days, code lessons, etc. New members will automatically receive the publications issued by the I.D.A. covering the latest commercial and amateur short-wave news. Special programmes arranged by short-wave stations are already in operation.

Will interested readers please apply for further particulars to Mr. R. G. Baker, 40, Stile Hall Gardens, Chiswick, London, W.4?

LICENCES IN THE EMPIRE

THE B.B.C. has just compiled a list of licence figures within the Empire. They are as follow:—

Australia (end of November)	1,099,272
Canada (April 1st to December 31st, 1938)	1,162,800
Eire (end of December)	148,811
New Zealand (end of October)	289,919
Union of South Africa (end of October)	210,000
India (end of October)	60,634
Ceylon (end of December)	6,007
Newfoundland (from a recent report)	12,000
British Guiana (end of July)	2,328

Malaya had 13,516 licence holders at the end of 1938 and Palestine had 35,708, compared with 28,515 at the end of the previous year.

It was with the aid of wireless that last week people in every corner of the world knew almost as soon as the Cardinals in Rome had made their decision that his Eminence Cardinal Eugenio Pacelli was the new Pope. Pope Pius XII is a firm believer in the potentialities of wireless as an instrument of peace, and his friendship with the late Marchese Marconi bears evidence of his keen interest in the science. This picture of the two men was taken at the christening of Marconi's daughter several years ago. The B.B.C. relayed the broadcast of the original announcement of the Pope's election and plans to relay in full the broadcast from the Vatican Radio station of the Coronation ceremony next Sunday.

FROM ALL QUARTERS

Berlin Television

THE German Post Office has denied the rumour, current recently, that the 441-line television transmitter at present being used experimentally on the Amerika House was to be moved to the top of the old Witzleben Radio Tower. It is, however, pointed out that the present transmitter does not give complete coverage of Berlin from its present site.

Swedish Station in Shanghai

A SWEDISH merchant of Shanghai, Mr. Holdo Stromwall, has taken the initiative to erect a broadcasting station near Shanghai for the benefit of Scandinavians in China, and its programmes will exclusively be devoted to Scandinavian music and news from the northern countries. The scheme is being supported by Scandinavian societies, shipping companies and large exporting firms that have interests in the Far East. The programmes will be entirely non-political.

Another New Norwegian

FOLLOWING the inauguration of the 100-kW medium-wave broadcasting station at Vigra, another 100-kW Norwegian station is nearing completion at Ullanhaug, near Stavanger, the transmitting equipment for which is being supplied by the Marconi Wireless Telegraph Company. The aerial is supported by two 330ft. masts.

News from China

THE new Chinese Government station, XGOY, on 9.5 Mc/s (31.58 metres), the channel immediately below Daventry GSB, is now radiating a news bulletin in English at 11 p.m. G.M.T. Except for occasional heterodyne interference the station provides a good and fairly consistent signal at about that time.

Cost of Television Service

IN reply to a question in the House of Commons the Assistant P.M.G. stated that the annual revenue costs of the television service, together with depreciation on capital expenditure, were £111,500 in 1936, £277,149 in 1937, and £352,846 last year.

Wireless and Reuter's

THE Government Supplementary Civil Estimates provide for the payment of £6,000 to Reuter's News Agency in respect of their increased daily output of foreign news since September, 1938. The expenses arise mainly from the cost of transmission of additional words by Post Office wireless-telegraph stations. The expanded service was put into operation at the request of the Government.

Danish Licence Fee

IT was not as a drive to increase the number of licences that the reduced Danish licence fee was in force, as was stated in a paragraph on page 110 of February 2nd issue. The fact is that the licence fee of 10 kroner covers the year from April 1st to March 30th. Should a listener take out a licence after December 15th he pays 5 kroner only, for he will have to renew his licence again on April 1st.

Another Indian Station

ACTING under the guidance of Mr. Goyder, the A.I.R. Chief Engineer, the Government of the Travancore State are contemplating the establishment of a 5-kW medium-wave station at Trivendram. The Government also proposes to install 100 receivers in State colleges and schools.

German 11-hour Transmissions for Australia

CONTINUOUS programmes covering an eleven-hour daily schedule are being transmitted as from March 1st from the German short-wave station at Zeesen for reception in Australia and New Zealand. Two directional beams working on different wavelengths are used simultaneously to give listeners a choice of wavelength. Transmissions begin at 6.5 a.m., the wavelengths being 19.74 and 16.81 metres.

Lithuanian Amateur Organisation

THE first amateur transmitters in Lithuania started operating as early as 1922, but no official licences were issued until 1933. The number of licensed amateurs is now 45, and they have recently formed the first national organisation of amateur transmitters. The abbreviated name of the new organisation is L.R.M., and its address is P.O. Box 100, Kaunas, Lithuania. LY1J was elected first president of the organisation.

Marconi Monument

PLANS have been submitted to Signor Mussolini for the monument to Marconi which it is proposed to erect in the Imperial Square at the 1942 Rome exhibition.

Radio Mediterranean

THE I.B.C. has opened a new avenue for sponsors by resuming transmissions from Radio Mediterranean (Juan-les-Pins) on 230.2 metres with a power of 27 kW. Broadcasts are scheduled to take place between approximately 9.15 and 10 p.m. and 10.15 and 11 p.m.

Australia's Naval Station

IT is reported that the new high-powered naval radio station at Canberra, which is claimed to be the largest in the southern hemisphere, is nearing completion. Five separate transmitters are being installed, all of which may be used simultaneously. The equipment will enable the Australian Naval Board to maintain continuous communication with the British Admiralty, with Singapore, and with New Zealand. It will also, in emergency, keep the Board in touch with Canada, South Africa, and British islands in the Pacific.

More Television from the Theatre

THE next London theatre to be visited by the television cameras will be His Majesty's, for an excerpt from "Magyar Melody," towards the end of this month. It is understood that, in addition to the regular television broadcasts from the London Coliseum, an effort will be made to include a theatre transmission once a month.

Worked All States

THE first Danish ham to achieve verified QSO's with all North American States is OZ4H, who has obtained the WAS certificate. According to the organ of the Danish amateurs, only three European hams have previously received the WAS.

New A.I.R. Stations

DACCA, Bengal, and Trichinopoly, Madras Presidency, the last two medium-wave broadcasting stations in the programme of development undertaken by All-India Radio are expected to open shortly as independent stations and not, as was suggested, as relay stations.

Brussels Radio Show

WITH the Brussels International Fair, to be held from March 12th to the 26th, will be incorporated the Radio Exhibition. The traders' show of components and accessories will be held from March 25th to 29th.

Italian Short Waves

ACCORDING to the latest list of Italian stations, Italy has commenced transmitting on the 42-metre band and has added three more call signs to her list, namely, I2RO11, I2RO12 and I2RO13. The 41.55-metre wavelength is at present being used by the first.

Broadcasting in Ceylon

IN welcoming the Governor of Ceylon to the thirteenth anniversary celebrations of the Colombo Broadcasting Service, the Minister of Communications said that there were about 6,000 licence holders in the island.

Facts about R.C.A.

MORE than 2,248,214 square feet are occupied by the R.C.A. Manufacturing Company, which at peak production times employs more than 12,000 persons in its factories, offices and laboratories. The Company's daily output of complete broadcast receivers varies from 3,000 to 5,000, depending upon the season.

A PARTNERSHIP WITH THE CINEMA ?

Fairy Godmother for Television

By R. W. HALLOWS, M.A.

RECENT collaboration between the B.B.C. and cinema interests has raised some highly controversial issues that are discussed in this article. Although " The Wireless World " does not necessarily endorse the author's views, it will be generally agreed that his suggestions would, if put into effect, provide a way out of the financial deadlock that threatens to arise in the world of television.

EVENTS which go to make history have a curious way of passing almost unnoticed at the time. When they occur they may often appear to be matters of merely passing interest; it may not be until long afterwards that historians dig them out and assign them their real significance. No one who witnessed or read of the repatriation of Lenin from Switzerland to Russia in a sealed railway train can have had any idea of the future repercussions of that journey. No one in the 1880's can possibly have realised that Edison's discovery that the blackening of carbon-filament electric light bulbs was due to bombardment of the glass by minute particles ejected from the filament would one day have the profoundest effects on the life and outlook of humanity by paving the way for the invention of the thermionic valve.

Television is, I believe, destined eventually to play an even bigger part than "sound" broadcasting in civilised life, and it may be that when the history of television comes to be written in future ages the showing of the Boon-Danahar fight in three London cinemas on February 23rd, 1939, will be one of its landmarks. For that event, in which many saw no more than one of those teacup storms that are so often centred over Broadcasting House, may possibly have immense effects on the whole future of television, not only in this country, but all over the world.

Sponsored Programme ?

Over that broadcast there was feverish activity behind the scenes; the r.p.m. of wheels at work within wheels must have approached record figures. But the facts, as known by the man-in-the-street, are these. Gaumont-British announced their intention of showing the fight by big-screen television at two of their London cinemas in which Baird apparatus was installed. Permission was granted by the B.B.C., and it was hinted that, had they refused, the promoters of the fight would not have allowed it to be televised at all; it was only the large fee paid by Gaumont-British for the right to reproduce the broadcast in these two theatres that had made it possible to permit the televising of the fight.

In other words, the sponsored programme had come into being.

That this was so was made all the plainer by the next development. The company owning the Monseigneur news theatres asked the B.B.C. for leave to show the fight in one of their houses in which Scophony big-screen equipment had been installed. The B.B.C. referred the company to the promoters of the fight, who stated that they were powerless in the matter, since Gaumont-British had acquired the exclusive rights to reproduce in this way.

Gaumont-British are linked with the Baird Company. Having obtained the B.B.C.'s permission to show the fight, and having bought the theatre rights from the promoters, they were apparently in a position to prevent any rival big-screen system from making use of the transmission. That was an intolerable situation, and eventually a *modus vivendi* was formed by the arrangement that television reception of the fight should take place in both the Gaumont-British and the Monseigneur theatres. At all three it proved a tremendous success. Every seat was taken, and hundreds of people were turned away from the doors.

Gaumont-British have now announced that they are to proceed at once to equip more than 300 of their cine theatres with big-screen television apparatus. But there is more in it than that: Mr. Isadore Ostrer has expressed his conviction that commercial television is now a genuine possibility. He intends to show the Boat Race, the F.A. Cup Final, and other major sporting events. He is planning to put on to the television screen artists such as Grace Moore, Gracie Fields, Deanna Durbin, George Formby, Eddie Cantor, and Rudy Vallee, whose fees would be far

" Every seat was taken and hundreds of people were turned away from the doors."

Fairy Godmother for Television—

beyond the unaided purse of the B.B.C.'s television department. He means, in a word, to go full steam ahead with the sponsored television programme, confident that he will reap his reward from increased box-office receipts.

And so it seems possible that the cinema may become television's fairy godmother. Say what we may, we can't get away from the fact that television had hung fire, despite the drives and the campaigns that have been carried out to popularise it. "We can't sell more receivers unless you give us better programmes and increase the daily allowance from the Alexandra Palace," say the television manufacturers to the B.B.C. "We can't extend the hours or improve the programmes unless you sell more sets and provide more receivers to justify the expense," replies the B.B.C. to the television manufacturers. Are not the cinemas showing the way out of the deadlock?

Big-screen receiving apparatus in only 300 cine theatres means a potential increase of some 300,000-400,000 in the daily number of viewers. How many more theatres there are in the service area of A.P. I do not know, but, clearly, if all were equipped for television reception the possible number of those deriving entertainment from the broadcasts would be enormous.

When the cinemas of London and the London area have the benefit of television, it will not be long before the provinces clamour for their share, too. Knowing the golden harvest that awaits the new development, will not the cinema companies be more than willing to bear a large part of the expense of extending the television services farther and farther afield? We may thus see high-definition transmitting stations at work at Birmingham, Manchester, Cardiff, Leeds, Newcastle, Glasgow, and other large towns far sooner than the most sanguine well-wisher of television had anticipated.

Television at Popular Prices

The cinemas may be the means of solving what has hitherto seemed an insoluble problem—that of bringing television within the reach of the masses. Unless some basic new invention completely revolutionises the technique of television reception, there seems to be no possibility of producing a televisor with a viewing screen of respectable size at a popular price; there can be no television equivalent of the three-valve radio set, still less of the crystal set. But there is no need for anything of the kind if television is to be available for all for the price of a cinema seat.

I am not suggesting that television will be confined to the cine theatres. Far from it; the wonderful programmes made possible by subsidies from the cinema companies would provide every inducement for anyone who can afford it to install a television set in his house. And that would mean a boom in television on a par with the boom in radio that began soon after the inauguration of sound broadcasting.

The idea of sponsored programmes sticks in the gullets of many of us. We have never had them, and we are not always attracted by what we hear of them from other countries. I am sure we would never consent to anything that meant the interlarding of our sound or vision programmes with advertising matter. But there would be no need for anything of the kind to happen if the cinema companies were allowed to subsidise television. All that they would want would be to share the expense of O.B.s and studio programmes in return for the right to show them at their theatres. It would, of course, be necessary to safeguard television broadcasting from falling into the hands of the cine theatre companies; it would never do if, having partly paid the piper, they sought to call all the tunes. Strict control would be necessary so that they could not force the hands of the B.B.C. or compel them to broadcast undesirable items. One of the best safeguards against anything of the kind would probably be the weight of public opinion.

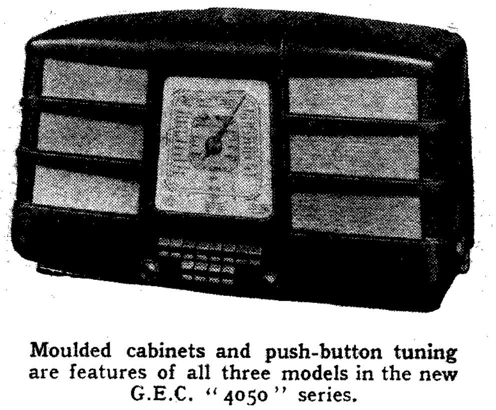
I can see little objection to the properly controlled sponsored programme—subsidised programme is perhaps a happier phrase—so long as it is purged of advertising matter. It should be borne in mind that the Television Committee in its original report mentioned the possibility of such programmes and was far from condemning the principle. But if feeling against the subsidised television programme proves unexpectedly strong, there is still a way out of the difficulty. The direct subsidising of particular programmes could be avoided and a partnership for their mutual benefit cemented between television and the cinema if the theatre companies agreed to make an annual contribution to the B.B.C.'s funds on the understanding that every penny of it was to be spent on television. The amount of the contribution might well be calculated on a basis of so much per seat of the theatres equipped with big-screen receiving apparatus. Any disagreement about the events, the people, or the subjects to be televised could be referred to a small independent committee empowered to say the final word.

One thing is certain. No cine theatre chain, whether or not it is tied up with a particular system of television, must ever be allowed to acquire exclusive rights of reproduction in public. The partnership, whatever form it takes, must be open to all cinema companies who desire to enter it. If there is to be direct subsidising of television programmes, and possibly of the development of the television service, it must be done by means of a pool to which all the companies who wish to show television to their audiences subscribe. Equally, every company must be free to install and to use the television system of its choice.

And in America

It will be most interesting to see whether this idea of the cinema as television's fairy-godmother takes root in the United States. I believe that it will. In that country there are, as you know, no receiving licences. The "sound" programmes now broadcast are paid for partly by the radio manufacturing concerns, but mainly by makers and vendors of a huge variety of goods, from soap to motor cars and from watches to patent foodstuffs, who buy "time on the air" to advertise their products. For some time now American television manufacturers have been wondering who is going to pay for the programmes that must be given if they are to sell their wares. As they have pointed out, the television public must for long be too small in numbers and too restricted in the area that it inhabits to appeal to the big national advertiser, who alone can spend the large sums needed. In the United States I believe that the cinema interests will not be slow to offer the helping hand or the television interests slow to accept it.

Once the ball is set rolling, other countries are likely to fall into line. And when that happens television may develop with spectacular rapidity throughout the civilised world. If that forecast is a true one, those three screens on which the Boon-Danahar fight was shown will have their place in history.



Moulded cabinets and push-button tuning are features of all three models in the new G.E.C. "4050" series.

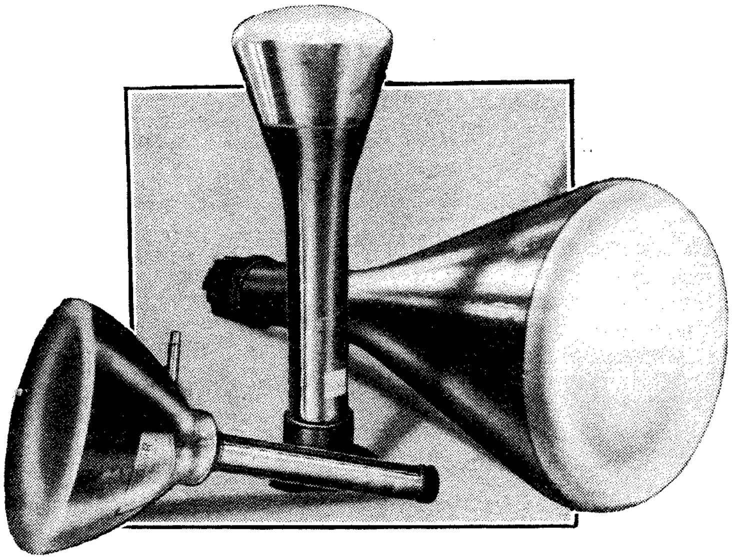
New G.E.C. Receivers

AC UNIVERSAL AND BATTERY SETS WITH PUSH-BUTTON TUNING

THE latest "4050" series of three receivers issued by the General Electric Co., Ltd., makes use of a five-valve superheterodyne circuit with a 4-watt output stage in the case of the two mains receivers and two QPP tetrodes giving $1\frac{1}{2}$ watts in the battery model. All three sets are housed in moulded horizontal cabinets of an attractively symmetrical design with central tuning dial.

Push-button automatic tuning is fitted in each case, and the buttons are arranged in two rows. The top row of eight buttons may be adjusted for medium- or long-wave stations or for one or more bands on the short-wave range. Four buttons are provided in the lower rank for waveband selection and for switching off the set. The waveranges are 16.5-50 metres, 192-550 metres and 1,000-2,000 metres.

Prices are as follows:—AC Model 4050, 10 guineas; AC/DC Model 4055, $10\frac{1}{2}$ guineas; battery Model 4056, $9\frac{1}{2}$ guineas.



Television Topics

PICTURE SIZE AND BRIGHTNESS

In this illustration are shown a 6in. Cossor electrostatic tube, a 9in. Baird magnetic tube, and a 12in. Ediswan electrostatic type.

IT is not always as easy as one might expect to decide on the optimum size of picture, in spite of the common idea that the bigger it is the better. Actually, this is not true, for at any given viewing distance there is a certain size which must not be exceeded for the best results.

This is easily determined by anyone. Start by looking at the television picture at a considerable distance, 12ft. or so. It is then obviously too small, and the detail cannot be made out. Now go nearer and it will be found that the results are better until a certain distance is reached. Thereafter the picture deteriorates because the line structure becomes very evident.

There is an optimum viewing distance which is found to be proportional to the linear picture size, other things being equal. The viewing distance is thus proportional to the screen diameter. It is found experimentally that with a 12in. tube this distance is about 5-6ft.

The distance undoubtedly varies somewhat with different observers, for it depends to some extent upon the sensitiveness of the individual to interline flicker. At about 6ft. the line structure can only just be detected in the case when interlacing is faulty so that the successive frames are superimposed. With perfect interlacing the line structure is only detectable at a distance of about 3ft. or less, provided that the eyes are quite steady. The slightest movement of the eyes, however, causes half the lines momentarily to disappear and the coarse raster of an uninterlaced picture is seen.

Even with perfect interlacing, therefore, the viewing distance should be greater than 3ft., and experience shows that 5-6ft. is highly satisfactory. With a larger picture than 10in. by 8in., the usual for a 12in. tube, the viewing distance must be greater. Thus, for a size 20in. by 16in., it should be 10-12ft.

With modern small rooms there are many cases where a viewing distance of 5-6ft. is inconveniently large, and then a cathode-ray tube smaller than 12in. in diameter is likely to be better. A 6in. tube should be viewed at about 2½-3ft., which is usually too short a distance for more than two or three people. The distance for a 9in. tube, however, is of the order of 4½ft. and meets many requirements admirably.

The picture size also has a most marked effect upon the brilliancy obtainable. The illumination is inversely proportional to the picture area for similar tubes and the same anode voltage. Assuming the linear dimensions of the picture bear a constant relation to the tube diameter, as is usual, the illumination is inversely proportional to the square of the screen diameter.

If we take a 12in. tube as our standard the brilliancy of the picture on a 9in. tube will be 1.8 times as great and that of a 6in. tube will be 4 times as great. On the other hand, a larger picture 20in. by 16in. will be only one-quarter as bright.

A bright picture is highly desirable because it makes a reasonable amount of room lighting permissible, so that those members of the family who do not want to look at television can do something else. Also, much less darkening of the room is needed for the afternoon programmes.

A good 9in. tube operating at about 4,000 volts gives a very bright picture which is satisfactory in normal daylight without any attempt at darkening the room. Direct sunlight must, of course, be kept out.

Now with a given tube the brightness depends on the density and velocity of the electrons in the beam, that is, upon the beam current and the anode voltage. The relationship is not necessarily a linear one, because of the characteristics of the fluorescent material, but very roughly we can take the brilliancy as proportional to the anode voltage, with constant beam current.

For equal brilliancy, therefore, with 12in., 9in. and 6in. tubes the operating voltages should be 7,000, 4,000, 1,800. This is probably nearly true of electro-

This unretouched photograph was taken with an exposure of 1/14th second and an f/4.5 lens. The picture was produced on a 9in. magnetic tube operating at 4,500 volts. There are a number of minor defects present; slight non-linearity of the vertical scan, slight defocusing at the edges of the picture, and no interlace.

Television Topics—

static tubes, if the first anode voltage is fixed. If the first anode voltage is made proportional to the final anode voltage, however, as is usual and in the case of magnetic tubes, then the beam current will tend to be proportional to the anode voltage. This will make the brilliancy vary roughly as the square of the anode voltage and the voltage required for a given brilliancy to become proportional to the linear dimension of the picture.

On this basis, 12in., 9in. and 6in. tubes should be operated at 5,300, 4,000, 2,650 volts respectively. Such general calculations are necessarily very rough, however, for tubes of different sizes are usually of somewhat different design. In particular, electrostatic tubes are usually built for a smaller beam current than magnetic tubes for the same voltage, and are thus inclined to be less brilliant.

There is another factor to be considered. The colour of the picture depends largely on the electron velocity and a good black and white is generally obtained only at a fairly high voltage. If the voltage is reduced it is readily observable that the colour deteriorates and often takes on a brownish cast.

Size of Scanning Spot

There is also the question of the size of the scanning spot. Ideally this should bear a fixed relationship to the size of the picture and should thus become smaller as the picture gets smaller. With a 6in. tube the spot size should be one-half of that with a 12in. tube.

The spot size, however, is very dependent on the anode voltage, and it gets larger as the voltage is reduced. We thus have the anomaly of requiring a higher voltage with a small tube than with a large one to maintain the same definition and a lower voltage to maintain the same brilliancy.

Again, however, everything depends on the tube design, but, in general, it is not possible to reduce the voltage on a small tube as much as one might expect from considerations of brilliancy alone. To put it another way, one can expect for similar brightness to get higher definition with a large tube than with a small one.

At the present time, experience indicates that on a performance basis a 9in. tube is about the best. A very bright picture of high definition is secured with the reasonable voltage of 3,000-4,500 and the viewing distance suits perhaps the majority of viewers.

A smaller tube is likely to give a somewhat poorer picture unless the operating voltage is high and the apparatus will then cost little less than that for a larger tube. The viewing distance is also rather on the short side. A larger tube than 9in. results in more costly apparatus because the tube itself costs more and it needs a higher voltage for the same brilliancy.

It should be emphasised that the relation between picture size and tube anode voltage for constant brilliancy is in reality quite complex. The relation that for constant brilliancy the tube voltage should be proportional to the tube diameter is true only for a somewhat idealised case. In practice, the general tube design exercises a modifying influence and in particular the fluorescent material exhibits signs of saturation above certain voltages and currents.

The extent of this varies with different materials, but it becomes marked at high voltages. There is, consequently, little to be gained by operating a tube at a voltage higher than its maker's maximum rating, and much may be lost in tube life. At voltages below the maximum rating, however, the relationship given is quite usefully accurate for the purpose of obtaining a rough idea of the voltage needed.

News from the Clubs

Slough and District Short-wave Club

Headquarters: 35, High Street, Slough.
Meetings: Alternate Thursdays at 7.30 p.m.
Hon. Sec.: Mr. R. J. Sly, 16, Buckland Avenue, Slough.

At the last meeting a discussion took place on R strengths and R meters, a demonstration being given with the aid of a Sky Champion receiver.
The Club's social was held on February 21st.

Maidstone Amateur Radio Society

Headquarters: 244, Upper Fant Road, Maidstone.
Meetings: Tuesdays at 7.45 p.m.
Hon. Sec.: Mr. P. M. S. Hedgeland, 8, Hayle Road, Maidstone.

The following programme has been arranged:—

March 14th.—Lecture by Mr. W. H. Allen on "Five-metre Operation."

March 21st.—R.S.G.B. Film Night.

March 28th.—Either a practical evening or a demonstration of the cathode-ray tube by Mr. Rich of the Mullard Wireless Service Co.

March 29th.—Mr. J. Clarricoats, R.S.G.B. Secretary, will speak on "The Amateur Movement To-day and To-morrow." This meeting will commence at 7 p.m. and refreshments will be provided free. Intending participants are asked to communicate with the Hon. Sec. by March 14th.

Exeter and District Wireless Society

Headquarters: Y.W.C.A., 3, Dix's Field, Southernhay, Exeter.
Meetings: Monday at 8 p.m
Hon. Sec.: Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

On February 27th members were conducted over the Exeter Telephone Exchange by kind permission of the Postmaster. Members were particularly interested in the apparatus with which it is possible to send twelve different carriers on one pair of wires.
On March 13th Mr. W. S. Pyrah will lecture on "The Manufacture of Starter Batteries."

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 roydon.

At the last meeting Mr. Greaves, of the Mullard Wireless Service Co., lectured on "Recent Valve and Television Developments." The lecture was illustrated with lantern slides.
On March 14th Mr. S. F. Webster will demonstrate his high-quality amplifier in conjunction with a Voigt loud speaker. This is the first time that Mr. Webster has demonstrated his apparatus.

Thorne Amateur Radio Society

Headquarters: 51, King Street, Thorne, Nr. Doncaster.
Meetings: Sundays at 2 p.m.
Hon. Sec.: Mr. G. Beaumont, 15, Marshland Road, Moor-Ends, nr. Doncaster.

Recent activities have included talks on "Valve Theory and Practice," "The Fundamentals of Electricity," and a lecture and demonstration on the primary stages of transmission by Mr. F. W. Benson.
Two artificial aerial licences have been granted, and further applications have been forwarded to the G.P.O. A half-hour of morse practice takes place at the commencement of each meeting. The Society's membership is increasing. The subscription rate is 6d. per meeting. The Club's activities encompass short-wave reception and transmission only, and all who are interested in these two phases of wireless communication are invited to become members.

Midland Amateur Radio Society

Headquarters: The Hope and Anchor Hotel, Edmund Street, Birmingham.
Meetings: Second Tuesday in the month at 8 p.m.
Hon. Sec.: Mr. F. E. Barlow, "Drakeford," Poolhead Lane, Wood End, Tanworth-in-Arden.

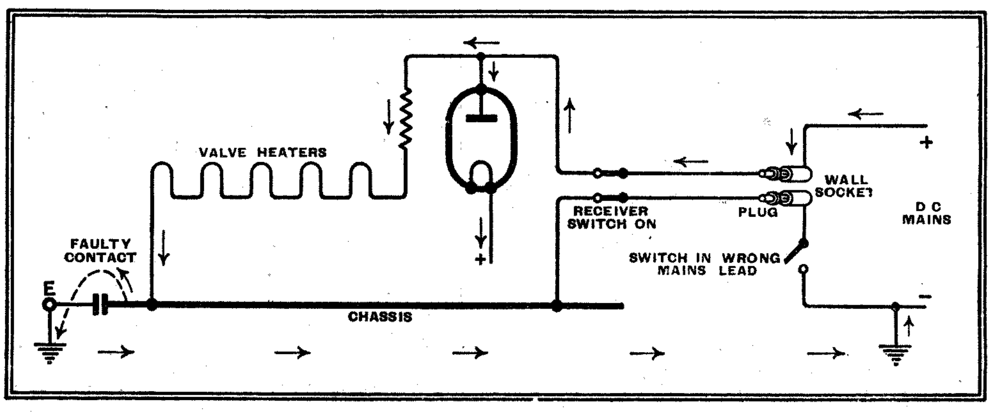
The next meeting of the Society will be on March 14th when a lecture-demonstration will be given by a representative of Voigt Patents, Ltd.
At a recent junk sale £8 was realised for the hospital radio fund.

HENRY FARRAD'S SOLUTION

(See page 223)

As one of the two mains leads is interrupted by the wall switch, the only way the circuit through the set can be completed is by an earth return. This, incidentally, means that the switch must have been wired in the "neutral" instead of the "live" main—not an uncommon fault in some houses. The receiver, being obviously an AC/DC type, almost certainly has the chassis, valve and coil screen, etc., connected to one side of mains, and the earth terminal and probably the loud speaker frame and external speaker leads connected to earth. If the condenser joining the two has broken down, or contact made in any other of a number of possible places, the mains circuit is completed, as shown in the diagram, but can be broken by means of the receiver switch.

Although it is possible that this arrangement might go on indefinitely without unpleasant incident, it is very desirable to trace and remove the chassis-to-earth contact, not only because the electricity supply authority objects to earth returns, but because if at any time the receiver had to be unplugged there would be an even chance when it was put back that it would be the wrong way round, which would cause a dead short-circuit and blow the fuses.



The arrows show the path of the current through the receiver, notwithstanding the wall switch being "off."

The Storage Principle

WHY IT IS IMPORTANT IN TELEVISION

By "CATHODE RAY"

TO those readers who follow the technical side of television the word "storage" as applied to that art will convey a definite meaning; but the others might take many more than the regulation three guesses before hitting on its significance. In these days, when the Government is talking about "short-term" and "long-term" schemes of food storage, it may be appropriate to refer to the television storage principle as an ultra-short-term scheme. It spreads over one-twenty-fifth of a second, at most. Yet this is a relatively long time compared with the consumption period. That, in fact, is the crux of the whole affair.

But to get down to the facts.

At any given moment a television picture consists of one small spot of light. Persons who rely on outworn phrases such as "seeing is believing" may, perhaps, refuse to accept this statement, but if necessary its truth can be demonstrated. If it were not for the sluggish response of the eye, which continues to see a thing for a short time after it has passed on, television, like the cinema, would be impossible.

Assuming the British system of television, with its 405 lines, of which 385 actually appear (the rest being used for synchronising), for every part of the receiver screen to be traversed once during the scanning process, it is necessary for the diameter of the luminous spot projected by the cathode ray tube to be 1/385th of the picture height. And as the picture width is 25 per cent. greater than the height it is equal to 482 spot diameters. So if the screen is imagined to be divided into tiny squares, each just large enough to contain the spot, the number of squares would be 385×482, which is equal to 185,570. These squares can be referred to as picture elements.

How the Spot Travels

Now if the reception of television were made the subject of a B.B.C. running commentary it might go something like this: "The spot has just come on to the field at the top left hand ("Square 1!") and is moving to the right very fast ("Square 2!"). It seems to be getting a bit brighter now ("Square 3!"). . . .

. . . and has reached the middle of the field ("Square 241!") travelling slightly diagonally ("Square 724!"). . .

. . . reached the extreme right and a little way down the field ("Square 964!"). It's gone! No! there it is again at the extreme left ("Square 965!"); now moving to the right again ("Square 966!"). . .

. . . very dark now and almost at the foot of the field, centre (Square 185,329!"). I can't see it at all now, can you? Oh! there it is at the top centre ("Square 242!"). . .

And so on.

But the commentator would have to be a rapid talker, for all 185,570 squares are successively occupied within one twenty-fifth of a second. Deducting from this the time spent behind the scenes changing from the end of one line to the start of the next, we are left with 1/31 sec., during which the speed of the spot is constant. Therefore the time taken to move from one square to the next is $\frac{1}{31 \times 185{,}570}$ of a second, or 0.174 of a microsecond (as a millionth of a second is called). During that unimaginably short time the cathode ray by its impact on the screen has to generate enough light to represent anything up to the brightest part of the picture—say a lamp in the scene. The problem seems to have been pretty well solved for the ordinary small domestic screens, but it is a different matter for large screens.

However, leaving that for the moment and going to the transmitter, the problem there is to pick up from an area smaller than a pinhole, during that fleeting fraction of a microsecond, enough energy, due to the light reflected from, perhaps, a grey November scene, to stand out strongly above the inevitable fluctuations that occur in valves and circuits as a result of the restless movements of the tiny particles that make up all matter (Fig. 2). Working the thing out, it seems impossible.

Photography has made wonderful strides, and pictures can be got with exposures of less than a thousandth of a second without exceptional demands on the lighting. But ask a photographer to take a picture in 0.000000174 of a second and hear what he says!

Accumulating Light

A reaper does not have to sow the seed and reap what has time to grow while he is actually on the spot; the seed throughout the field can be growing for quite a long time while he is busy elsewhere. And although any one picture element is touched by the scanning beam for only a sixth of a microsecond, it receives the light from the scene for 40,000 microseconds between visits. If it can be persuaded to draw electrical energy from the light during all that time, and save it up until the moment when the scanning ray comes to collect, there should be quite a useful harvest.

This was the idea of the "Emitron" used in this country, and the "Iconoscope" of America, which work extremely well and have made modern television possible. I say "was" the idea because although the explanation I have given was the generally accepted one until recently,

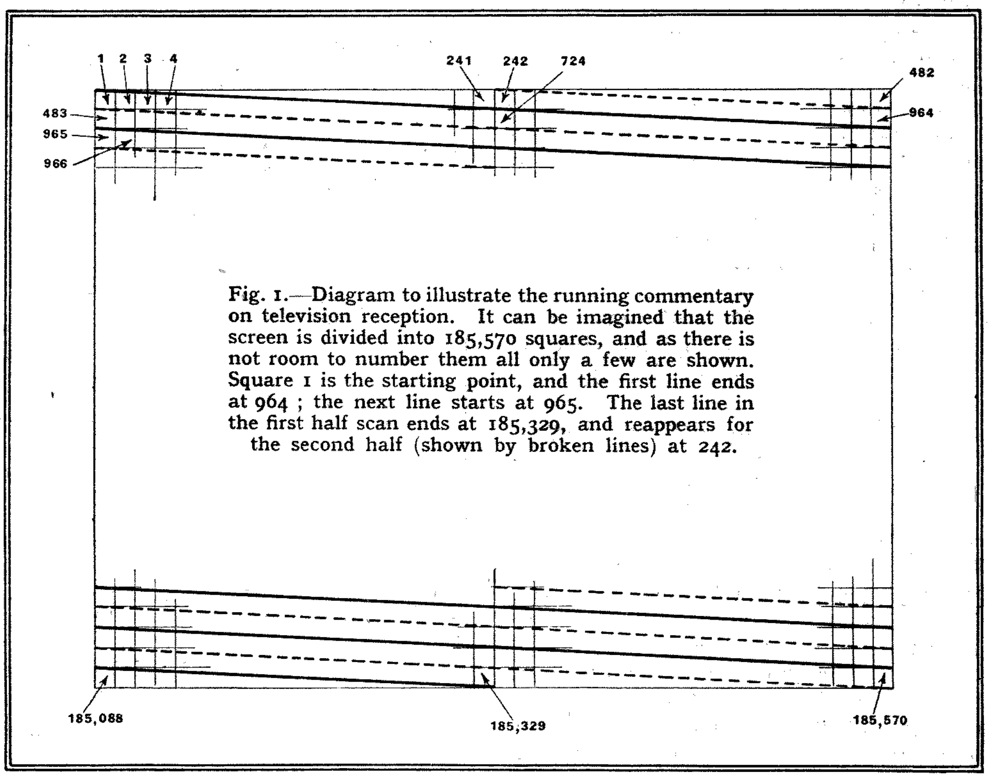


Fig. 1.—Diagram to illustrate the running commentary on television reception. It can be imagined that the screen is divided into 185,570 squares, and as there is not room to number them all only a few are shown. Square 1 is the starting point, and the first line ends at 964; the next line starts at 965. The last line in the first half scan ends at 185,329, and reappears for the second half (shown by broken lines) at 242.

The Storage Principle—

the people who are always doing research on these things for improving them have come to the conclusion that very little of the action described actually takes place, and that the beneficial results are really due to a much more involved process, in which secondary emission plays an important part. If it were not for the possibility of improving the equipment it would be rather mean of these investigators to upset the old explanation, which was so much easier to understand. However, the new theory still seems to allow the process to be described as a *storage* action, for the energy obtained from each picture element is not produced solely during the moment of visitation by the scanning beam but is stored by it during at least part of the comparatively long intervals, ready to be released.

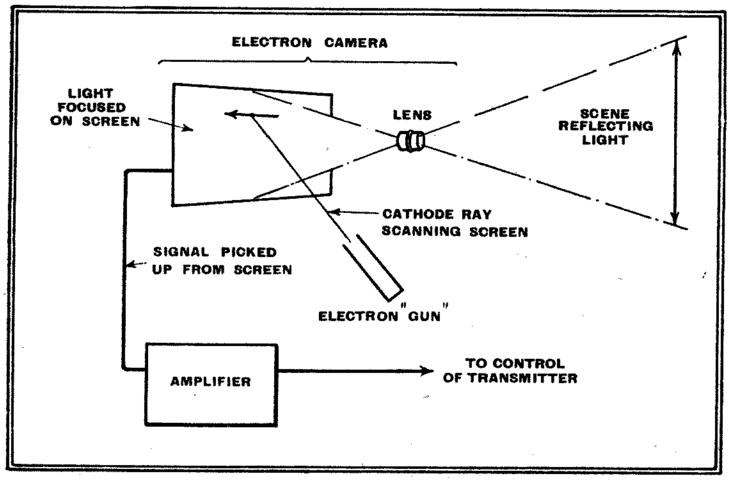


Fig. 2.—Very diagrammatic view of what goes on at the transmitting end. The light on the screen releases electrons according to its brightness, and when touched by the scanning ray a signal is obtained; but to be any good it must at least be much stronger than the amplifier "noise."

Big-screen Reception

Coming back now to the receiver, you will remember that as long as the screen is kept fairly small—not much over a foot across—it seems to get along very well without any storage (unless you include the tendency of the screen to remain glowing for a little while after the scanning ray has left it). Large screens are not at quite such a satisfactory stage. One system is to increase the power of the cathode-ray tube, such as by increasing the voltage from the usual 5,000 up to perhaps 25,000, so producing a dazzlingly bright picture; and then enlarging it by means of lenses. The brightness, of course, goes down in proportion as the size goes up—one can't have it both ways. So there is a limit to what can be done along these lines. Then 25,000 is not an ideal voltage for domestic appliances, because even if it is made safe it is undoubtedly expensive. And the life of the tube is at the moment rather problematical.

Another, and entirely different system is Scophony. I tried to explain the basis of it some time ago (Jan. 1st, 1937), and it is rather too much to repeat as a digression here, but I believe the Scophony Company has produced a very good booklet describing the working of the system. One of the most important features is an ingenious storage method, in which light from a powerful source is caused to light up not only the picture element being scanned at the moment but also a whole string of other elements in its train. The total amount of controlled light is thus multiplied many times. The clever part of the scheme is the way in which the vision signal belonging to any part of the picture is stored for a while so as to continue to control the brightness of the light falling there, even while the scanning passes on (Fig. 3).

More recently there is news of promising experiments by von Ardenne with a new cathode-ray receiver operating on a storage principle. In the familiar television cathode-ray tube, the impact of the ray itself produces the light that makes the picture. Von Ardenne has been looking for a way of causing the cathode ray to control the *transparency* of a screen, so that the picture can be projected to any convenient size, in the same way that the varying transparency of a cinema film can be used in projecting a large bright picture. But whereas a long time is occupied in producing a cinema film from the original scene or from another film, the cathode ray must do it practically instantaneously. The effect has to last for as long as possible up to a twenty-fifth of a second, and anything remaining then must be extinguished ready for the next picture.

It is too early to decide whether or not this system is going to be successful in practice, but it looks quite promising. In principle its merit depends on the vision signal being stored during the intervals between visits by the scanning ray, so that the whole picture is illuminated simultaneously instead of only one minute spot of it. Theoretically there is scope for getting 240,000 times as much light. Even a small fraction of that gain is worth having!

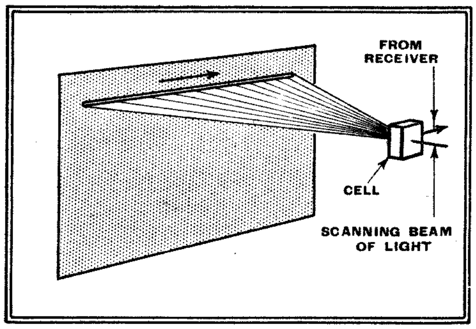


Fig. 3.—In the Scophony system not only is the spot corresponding to the transmitter scan position illuminated, but also a whole strip of the screen in its train. The cell has to store or "remember" the signals just past so as to keep the right distribution of light over the whole strip.

Television Programmes

Sound 41.5 Mc/s   Vision 45 Mc/s

An hour's special film transmission intended for demonstration purposes will be given from 11 a.m. to 12 noon each weekday. The National or Regional programme will be radiated on 41.5 Mc/s from approximately 7.45 till 9 p.m. every day.

THURSDAY, MARCH 9th.

3, Ray Ventura et ses Collegiens. **3.30,** British Movietonews. **3.40,** 223rd edition of Picture Page.

9, "Oleograph," an instructive entertainment as presented at the Oleographic Hall in 1880. **9.30,** Gaumont-British News. **9.45,** Cartoon Film. **9.50,** 224th edition of Picture Page. **10.20,** News.

FRIDAY, MARCH 10th.

3, Richard Hearne, Lily Palmer and George Nelson in "Bath h. and c." **3.15,** Gaumont-British News. **3.25,** Daisy Guth, pianoforte. **3.35,** Cartoon Film. **3.40,** "Condemned to be Shot," a play in the first person by R. E. J. Brooke.

9, Western Cabaret, including Big Bill Campbell and the Hill-Billy Band. **9.50,** Film: "Under Water." **10,** Animal First Aid. A veterinary surgeon demonstrates how to treat a sick or injured dog. **10.10,** British Movietonews. **10.20,** Spring Hats Display. **10.35,** News.

SATURDAY, MARCH 11th.

3, Intimate Interlude. **3.15,** Cartoon Film. **3.20,** Wyndham Goldie as Prince Charles Edward Stuart in "Count Albany," an historical invention by Donald Carswell.

9, Ray Ventura et ses Collegiens. **9.30,** Gaumont-British News. **9.40,** "The Gamblers," a farce adapted by Harold Bowen from the Russian by N. V. Gogol. **10.30,** News.

SUNDAY, MARCH 12th.

3, Television Surveys VI, Life on the Canal. O.B. from Clitheroe Lock on the Grand Union Canal. **3.20,** Film. **3.30,** The Jacquard Puppets. **3.45,** Cartoon Film. **3.50,** Otto Fassel, tenor.

8.50, News. **9.5-11,** "Goodness, How Sad," a play by Robert Morley.

MONDAY, MARCH 13th.

3-4.30, Ernest Milton in "Rope," a thriller by Patrick Hamilton.

9, "The Immortal Hour," the famous music drama by Rutland Boughton. Cast includes Irene Eisinger and Arthur Fear, supported by B.B.C. Singers and the Television Orchestra. **10.30,** News.

TUESDAY, MARCH 14th.

3, Gaumont-British News. **3.10-4,** "The Gamblers" (as on Saturday at 9.40 p.m.).

9, Coliseum Night. An O.B. from the stage of the London Coliseum. **10,** British Movietonews. **10.10,** "This Golfing"—not to be taken too seriously. **10.20,** News.

WEDNESDAY, MARCH 15th.

3, Coffee Stall. **3.15,** Cartoon Film. **3.20,** British Movietonews. **3.30,** Jack Hylton and his Band.

9, Leon M. Lion in "Libel" by Edward Wooll. **10.30,** News.

The Amateur Transmitting Station

SHORT-WAVE transmitters operate with aerials differing radically from those commonly employed for broadcast reception. This series of articles, which has covered, stage by stage, the complete design of an amateur transmitter, is fittingly rounded off by a description of suitable radiating systems.

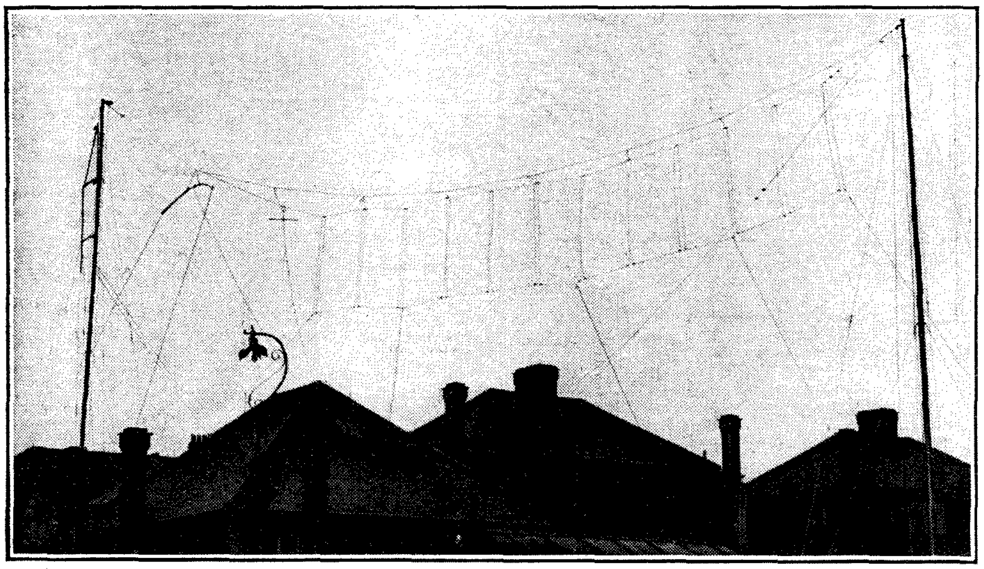
Part IX.—Planning the Aerial and Feeder System

By H. B. DENT (G2MC)

ALL the adjustments of the transmitter, including matching the modulator to the RF amplifier, can, and should, be carried out with the power dissipated in a dummy aerial.

When everything is working satisfactorily, but not before, the transmitter can be coupled up to an aerial. Just as much care has to be given to this part of the equipment as to the transmitter itself, for all one's work will be wasted unless as much as possible of the RF output actually finds its way into the aerial, because it is the aerial that is responsible for radiating; the transmitter is merely the generator.

As there are so many different kinds of aerial and coupling systems that can be used for short-wave transmission, only a few of the more commonly used varieties can be dealt with here.



The imposing array of aerials at G6OT. A multi-element directional system for five-metre transmission can be seen suspended between the two masts.

It is probably well known that any piece of wire suspended well away from earthy objects resonates at a wavelength equal to twice its length. It is thus referred to as a half-wave aerial, or dipole. The potential gradient of a wave at resonant frequency on this wire takes the form as shown in Fig. 24 by the dotted line A. At

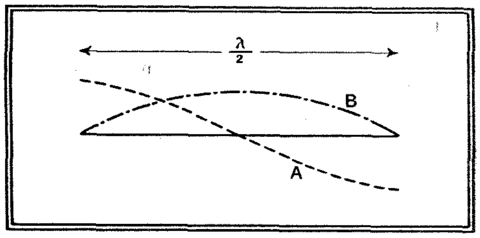


Fig. 24.—Voltage and current distribution on a half-wave aerial are shown by curves A and B respectively.

the two extreme ends the potential is high, while as the centre is approached it falls to a very low value. On the other hand, the current distribution along the wire rises from a low value at the ends to a high value at the centre, as indicated by curve B. Another way of expressing it would be to say that the centre of a half-wave aerial has a low impedance and approximates its radiation resistance, being for practical purposes 72 ohms, while the ends are at high impedance and may be as much as 5,000 ohms, though, owing to the influence of adjacent objects, is nearer 2,500 ohms for an ordinary aerial.

These characteristics of the aerial are important, as the varying impedance along its length has to be taken into account when deciding how and where to feed in the RF output from the transmitter.

The simplest arrangement is possibly a half-wave aerial fed in the centre by a low-impedance feeder, as shown in Fig. 25. By using a transmission line that is designed to have a surge impedance of 72 ohms (suitable cable is obtainable commercially), matching is automatically effected at the aerial end, and only the matching at the transmitter has to be considered.

Non-radiating Feeder

It might be mentioned that the idea of matching a transmission line to the aerial, and also to the source of supply of energy, is that by so doing the transmission line does not form a part of the radiating system, but only serves to convey energy to the aerial with the minimum of loss. Thus it can be any reasonable length and need not bear any relation to the wavelength.

So far as matching at the transmitter is concerned, it is generally sufficient to vary the coupling until the maximum RF current is obtained in the feeder, which can be ascertained by including a hot-wire ammeter or a thermo couple. At the same time, the anode current of the RF amplifier, which, as previously explained, increases when power is drawn from the anode circuit, must not be allowed to exceed the predetermined value. If it does do so with optimum coupling, i.e., maximum power output, then the input to the amplifier must be reduced.

The only disadvantage of this aerial system is that it is applicable to one wavelength only. For example, a half-wave aerial for 42 metres will be 66 feet long,

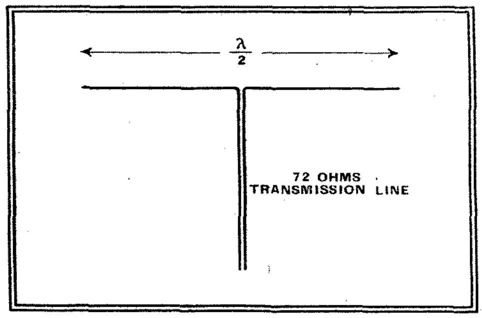


Fig. 25.—The centre of a half-wave aerial is the correct point of connection for a 72-ohm transmission line.

while for 21 metres 33 feet only are required. Now the centre of the 42-metre aerial is low impedance at resonance, but becomes a high-impedance point on

The Amateur Transmitting Station—

21 metres, since this aerial is two half-waves long, and the centre of each half-wave portion would be 16.5 feet from either end. Obviously, the 72-ohm feeder no longer matches to the aerial when the frequency is doubled.

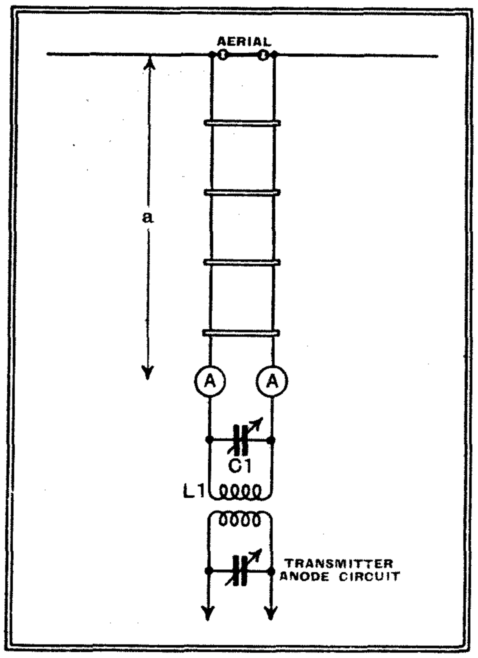


Fig. 26.—Tuned feeder system for a centre-fed half-wave aerial where a is an odd number of quarter-waves long.

A system of feeding that enables an aerial to be used on the fundamental frequency, or any harmonic frequency of the aerial, is that which is known as a resonant-line or tuned feeder. It is sometimes also called a Zepp feeder. The 72-ohm line and feeders of this kind, which can be any convenient length, are described as untuned or non-resonant lines.

With the tuned system there are standing waves on the feeders, and by suitably adjusting their length it is possible to arrange for a high impedance at the aerial end and a low impedance at the transmitter, or vice versa, or low or high impedance at both ends. Adjustment of length need not necessarily involve an actual change in the physical dimensions of the line, as it can be arranged electrically by tuning the line at the transmitter end either by means of a parallel tuned circuit or by a series tuned circuit. This then provides a flexible transmission line that enables the one aerial to be used on several harmonically related wavebands.

Latitude in Feeder Length

If the feeders terminate at a parallel tuned circuit, as shown in Fig. 26, and the aerial is low impedance at the centre at the working frequency, the length *a* of the feeder should be any odd number of quarter waves, i.e., one quarter, three quarters, five quarters, and so on.

The reason for this is that in the case of a feeder—or aerial, for that matter—the impedance is high at one end of a quarter-wave portion and low at the other. Parallel wires are used in order to prevent radiation from the feeders, as the voltage and current at any point are equal but of opposite sign.

Now by halving the wavelength the centre of the aerial becomes a high-impedance point, and with the feeder an odd number of quarter waves long the tuned circuit end is low impedance, but we require it to be high impedance for connecting across a tuned circuit.

In this case the length of the feeders ought to be an even number of quarter waves, but if the transmitter end is re-arranged as shown in Fig. 27 the desired impedance relationship can be preserved with feeders an odd multiple of a quarter wave long.

Voltage- and Current-fed Feeders

The parallel tuned arrangement can be termed a voltage-fed and the other a current-fed feeder, since at the input of the system the RF voltage is high and the current low in the one case, while in the other the current is high and the voltage low. RF ammeters are usually joined in each feeder line, as shown in Fig. 26 and Fig. 27, as an aid to tuning the line for resonance.

With parallel tuning, as in Fig. 26, C1 is set first to minimum capacity and the coil L1 coupled loosely to the anode circuit of the transmitter. Condenser C1 is then slowly increased, and when L1 C1 is in resonance the anode current of the RF amplifier will rise to a maximum. Slight adjustment of the anode circuit condenser may also be necessary. The coupling is then adjusted to give the required anode current in the RF amplifier.

It is possible that only a very small reading will be noticed on the line ammeters with parallel tuning, but it does not mean there is no current in the line, as they are located at a high-voltage point, and the RF current is extremely small.

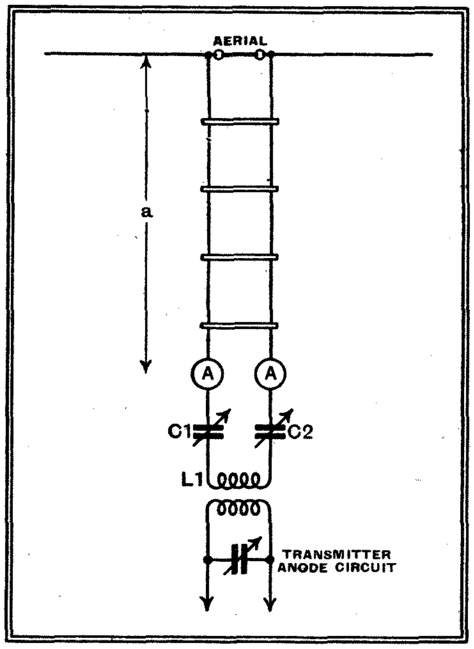


Fig. 27.—If the tuned feeders are an even number of quarter-waves long, a half-wave aerial should be arranged in this way.

Now in the case of series tuning, Fig. 27, the same procedure is adopted, but C1 and C2 are now adjusted simultaneously, and the same amount of capacity should be included in each line. Being a current-fed system, the meters will register a moderately high current, which should be the same in both lines. Generally, it is quite sufficient to fit a meter in one line only, though in the case of the series condenser feed, if the currents in each line were not equal they could be balanced by increasing the capacity of one and decreasing that of the other. However, this is hardly necessary in practice.

A simple switching arrangement that changes over the condensers from series to parallel tuning is shown in Fig. 28. In the parallel position one condenser only, i.e., C1, is in circuit.

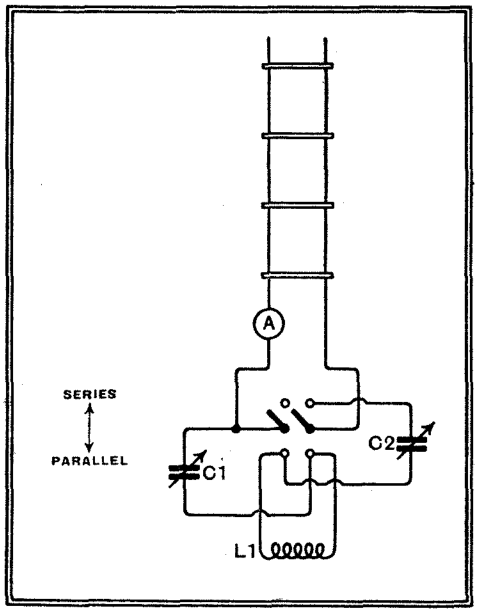


Fig. 28.—Series-parallel switching for operation on fundamental and even harmonic frequencies of the aerial.

It is advisable whenever possible to terminate tuned feeders just inside the building and so avoid any appreciable length after the point of entry. If the transmitter cannot conveniently be placed at this point, an intermediate coupling system, such as that shown in Fig. 29, may be employed.

Minimising Harmonic Radiation

By centre-tapping the two coupling coils, L2 and L3, and earthing those points, harmonic radiation is materially reduced. Tuning can be carried out by placing C1 in parallel with L4, disconnecting the feeders, and using this circuit as a temporary dummy aerial for approximate adjustment of the coupling coils, but the final positioning must be done with the feeders connected, as without them the circuit is not correctly loaded. We have spoken about aerials being a half-wave long, and mentioned quarter-wave lengths in connection with the feeders. The true length of a resonant aerial is actually slightly less than a half-wave, and its length can be ascertained for any fre-

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quency from the following formula:—
Length half-wave aerial (feet) =

$$\frac{468}{\text{Frequency in Mc/s}}$$

while for finding the length of open-wire feeders, such as the tuned variety mentioned, the formula is:—
Length quarter-wave tuned feeder (feet) =

$$\frac{240}{\text{Frequency in Mc/s}}$$

In order to prevent radiation from the feeder, the two wires must be reasonably close together, and about 6 inches is a satisfactory spacing. The spacing insulators must be loss free at the frequency used, for at certain points the RF voltages are quite high, and any leakage will mean a reduction in aerial power. Spacers two to four feet apart will ensure that the two wires remain equidistant even when the line is swaying in the wind.

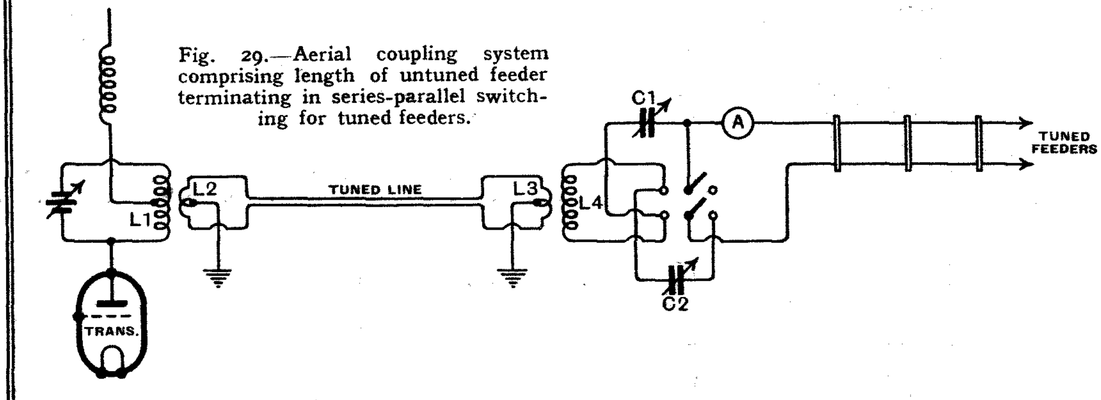


Fig. 29.—Aerial coupling system comprising length of untuned feeder terminating in series-parallel switching for tuned feeders.

The Marconi Aerial

Of the many other types of aerial used by amateur transmitters, only one will be mentioned here, and that is what is known as a Marconi aerial. The aerial can be about a quarter wave in length and then tuned by means of an inductance if shorter, or by a series condenser if longer, than a quarter wave to resonate at the transmitting frequency. The length of the earth lead has to be taken into account, as it must be considered an essential part of the aerial.

A quarter wave, or odd multiples of a quarter wave, are used, as the aerial is grounded at one end, and there is an image in the earth that simulates the other quarter-wave portions that would otherwise be needed.

Another variation of this would be a random length aerial tapped into a tuned circuit coupled to the transmitter, as shown in Fig. 30. An earthed screen, consisting of a series of stout parallel wire joined together at one end only and interposed between the PA anode circuit and the aerial tuning circuit as shown will reduce harmonic radiation to a minimum.

If the aerial is earthed as shown, the system will have to be tuned by varying the tapping to resonate at the transmitter frequency. Transmission can be effected on harmonic frequencies of the aerial so that it is a useful system for operating on several different wavelengths.

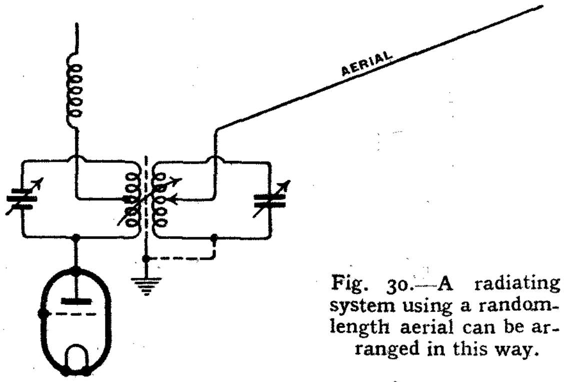


Fig. 30.—A radiating system using a random-length aerial can be arranged in this way.

Random Radiations By "DIALLIST"

Auroral Pranks

SITTING down to the controls of my short-wave receiver on the afternoon of February 24th, I got the impression that the set had gone entirely mad. Lots of usually good stations couldn't be heard at all; others were fading in odd ways and many were suffering from the most rapid and violent type of flutter. Clearly some big magnetic disturbance was afoot, and a little later on I had further direct evidence on the subject. Going out to take my dog for a short run, I looked up at the sky and all was explained. Overhead there were dense clouds, but to the north-west there was an area of clear sky between them and the horizon. The aurora was giving a brilliant display and I wished that there weren't those overhanging clouds, so that the full glory might have been visible. Even as it was it was a wonderful spectacle, for the edges of the clouds looked as if they were red hot and flashes of light could be seen every now and then through any rifts that appeared in them. Later on the clouds covered the whole of the sky and nothing of the display was to be seen. The effects of the magnetic disturbance, though, could be heard on the wireless set for the next twenty-four hours.

Radiolympia

THE Radio Exhibition at Olympia is to open this year on Wednesday, August 23rd, and to last until Saturday, September 2nd. The period thus corresponds exactly with that of 1938, when the Exhibition ran from August 24th to September 3rd. For many reasons I have always been in favour of a rather later date for Radiolympia. The chief of these is that August is the holiday month, when all the world and his wife and family are at the seaside or in the country, if they can possibly manage it. Another objection that I have to the period chosen is that in most years the last part of August and the first week of September are a time of very hot weather. Olympia, with its vast glass roof, is hardly the place that you'd choose for comfort when the thermometer is hovering about the eighties. Still, there must be excellent reasons for the R.M.A.'s choice of dates.

A Better Exhibition

It's good to see that there's a movement on foot for improving the Wireless Exhibition and making it altogether more attractive. It's some years since I first suggested the advisability of getting rid of stunts and having in their stead interesting and informative sideshows, such as that which the National Physical Laboratory once ran to show the working of the cathode-ray oscillograph. Something of the kind is quite likely to be done this year. An excellent suggestion is that the Navy, the Army, the Air Force and the A.R.P. authorities should each have an exhibit showing the practical applications of radio to their particular branches. That's the stuff to give 'em. The Exhibition has for some time tended to become too much a display of boxes, knobs and valves.

Home-made Interference

TALKING the other day to a service man who has cleared up many cases of home-made interference with wireless reception, I learnt that he had found that a single earth for the electric wiring system of the house is seldom sufficient, no matter how good it may prove to be when tested by measuring instruments. He had come across instance after instance of properly bonded wiring which was earthed only at one point being responsible for noisiness. He told me that he now makes a practice of earthing every lighting system's lead sheathing at two points at least; often additional earthing points are needed to give complete freedom from interference. I have never had any trouble in this way myself, but I find on examining it that the sheathing of my wiring is earthed at half a dozen different points to the water mains.

Recent Inventions

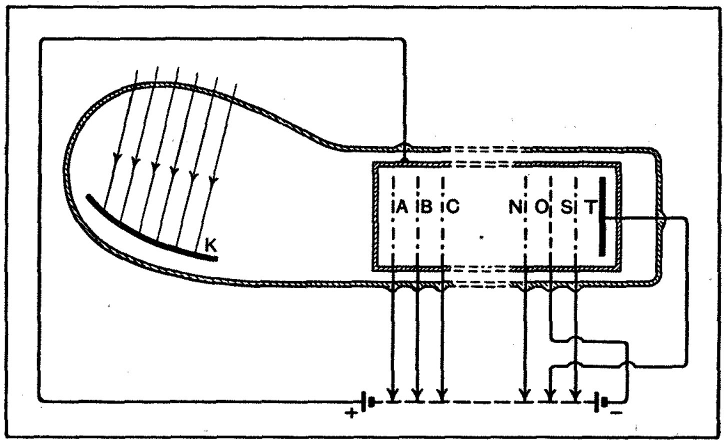
The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

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

ELECTRON MULTIPLIERS

THE figure shows an electron multiplier in which certain of the electrodes accelerate, whilst others retard, the main electron stream, the object being to secure maximum amplification for a given grading of the biasing potentials.

Light falling upon a photo-electric cathode K releases primary electrons, which then pass through a succession of perforated secondary-emission electrodes A, B, C . . . . N, O, all of which carry progressively increasing positive potentials, with, say, 200 volts difference between each. The stream is thus drawn forward and is amplified by secondary emission



Electron multiplier with both accelerating and retarding electrodes.

at each electrode until it reaches the output stage O.

Situated beyond this point are two retarding electrodes S, T, each carrying a lower potential than the electrode O. If, for instance, O is biased to 1,800 volts positive, S carries 1,700 and T carries 1,100 volts. This biasing causes extra secondary electrons to be emitted from both S and T and to be collected by the electrode O. The overall amplification of the device only rises to a maximum when the voltages on the two retarding electrodes are given definite values of the order stated.

Fernseh Akt. Convention date (Germany), May 30th, 1936. No. 496564.

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LUMINESCENT SCREENS

A MOSAIC of thin tungsten metal is deposited on a cellular surface to make a screen which is used for reproducing televised pictures by incandescence. Such a screen must have two properties. In the first place, it must cool from "white" to "dark" heat in less than one-twentieth of a second, and in the second place the heat from one "cell" or elemental point must not spread laterally to the surrounding cells.

The cellular foundation for the screen is made either by carbonising a velvet-like fabric, or by first chemically treating a natural organic tissue (such as elder pith) with sodium tungstate and then slowly burning it until only an ash skeleton is left.

The incandescing layer of tungsten is then deposited on the upper surface, whilst the side walls of the cells are covered with carbon to prevent heat from spreading laterally from one to another. The screen is finally mounted on a metal backing-plate.

F. Fischer and M. Lattmann. Convention date (Switzerland), June 4th, 1936. No. 496662.

TELEVISION RECEIVERS

INSTEAD of using the scanning stream of a cathode-ray tube to produce an image in fluorescent light, it is applied to vary the transparency of a specially prepared screen in accordance with the light-and-shade values of the received picture. For instance, the screen may be a thin glass casing filled with smoke, the effect of the scanning stream being to cause the smoke particles to condense in proportion to its intensity.

The invention is concerned with a cathode-ray receiver of this type and discloses means whereby the screen, after its transparency has been modified so as to correspond with the details of the received picture, is exposed to the rays of light from a lamp so that it throws an image of the picture on to a viewing screen mounted outside the tube. It is necessary for the scanning stream of electrons and the rays of light from the lamp both to be applied to the same surface of the transparent screen, and various ways are described for doing this without allowing one to interfere with the other.

Fernseh Akt. Convention date (Germany), May 2nd, 1936. No. 494967.

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PRECISION TUNING

TO secure greater precision in tuning, it has already been proposed to provide, in addition to the usual tuning knob, a button which, when the knob is set to zero, can be adjusted against any desired one of a list of stations. Here it co-operates with a corresponding notched disc on the spindle of the tuning knob, so that when the latter is subsequently turned it is automatically arrested at a point where the circuits are correctly tuned to the selected station.

The invention is designed to simplify the existing arrangement by making it possible, whatever the position of the tuning knob, to free the selecting button and align it with the name of the desired station on the indicator scale. As before, the control knob is then rotated until it is automatically brought to rest at a point where the receiver is precisely tuned to the pre-selected station.

Murphy Radio, Ltd., and J. D. A. Boyd. Application date, May 26th, 1937. No. 496275.

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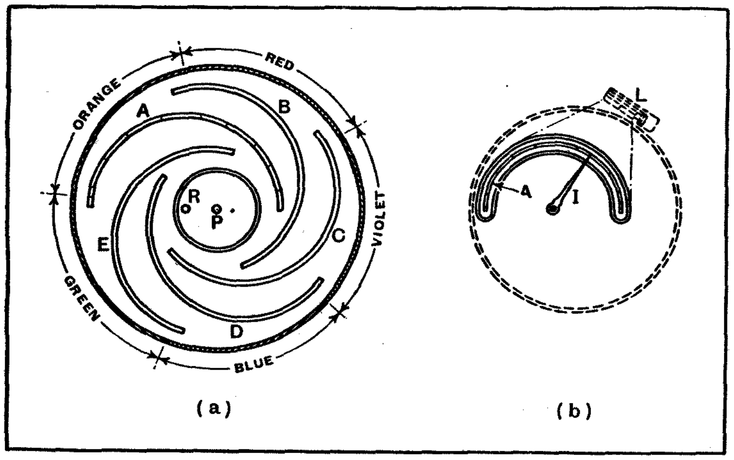
TUNING INDICATORS

THE diagram (a) shows the back-plate of a station indicator designed for a set covering five separate wavebands, each represented by one of the five semi-circular slots marked A to E respectively. The plate is of transparent glass, and different segments of its edge are variously coloured, as shown by the arrows, so that each tuning-slot, as it is brought into position by the wave-change switch, is lit up in a distinctive colour by the internally reflected light from a fixed lamp L, diagram (b), placed at the side of the indicator.

The back-plate is rotated about a centre P, which is offset from the shaft R which carries the indicator needle I, the drive for the plate being effected through a cam movement from the wave-change switch. Fig. (b) shows the slot A as it appears through the escutcheon from the front of the set. Since the illumination is from the side, instead of from the rear of the plate, the lamp L can be placed where it is easily accessible and where it does not occupy otherwise valuable space.



Tuning dial in which the various wavebands are indicated by different colours.

Marconi's Wireless Telegraph Co., Ltd. Convention date (U.S.A.) June 30th, 1936. No. 497854.

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THE indicator needle is mounted on a carriage which is driven by a cord-and-pulley gear from the tuning-knob, so as to move bodily across a wavelength or station scale, when making the initial adjustment. Fine tuning on the short-wave band is then completed by transferring attention to a disc, which is mounted at the foot of the pointer and co-operates with markings made at the foot of the carriage. The disc is driven through a pinion which gears with a rack formed on the carriage, the arrangement being such that a small movement of the carriage produces a comparatively large angular rotation of the disc.

The General Electric Co., Ltd.; R. G. S. Godwin and E. L. Mercer. Application dates, April 7th and November 15th, 1937. No. 496874.

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LOUD SPEAKERS

INSTEAD of mounting the loudspeaker diaphragm parallel with the grille or opening in the cabinet of a console receiver or radio-gramophone, it may advantageously be tilted back slightly, so as to throw the sound upwards, where it is more on a level with the listener's ears, and is less liable to be absorbed by the carpet.

But it is found, when the speaker is so tilted, that cabinet resonance comes into play and gives an unpleasant "coloration" to the emitted sounds. This is remedied, according to the invention, by closing in the space left between the backwardly inclined diaphragm and the grille opening by means of wooden strips which are lined with sound-absorbing material.

Murphy Radio, Ltd., and G. S. Brayshaw. Application date, June 25th, 1937. No. 496504.

The Wireless World

THE PRACTICAL RADIO JOURNAL

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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

Electrical Interference

An Absurd Position

THOSE who have optimistically hoped for early legislation which would bring about a reduction in electrical interference with broadcast reception and with television will have been sadly disappointed with the reply given in the House the other day by the Assistant Postmaster-General, when he said that—Inquiries regarding the possible scope and operation of a new Wireless Telegraphy Bill to deal *inter alia* with the question of electrical interference with wireless reception were being actively pursued. The problem, was, however, one of great complexity involving consultation with many commercial and other interests which would be affected, and he could not give any assurance that it would be possible to introduce a Bill during the current session.

Waiting for Finality?

If there had been a desire on the part of the Post Office to procrastinate in this matter of introducing legislation then it would be a matter on which to congratulate them on their success, but seeing that, as far as we are aware, the Post Office has throughout recognised the necessity for legislation and has gone so far as to accept responsibility for promoting a Bill to bring it about, we can only marvel at the delay which has occurred.

Legislation to control interference could have been hurried through at the time that the I.E.E. Committee two or three years ago recommended it, and the principle of control would then have been established. But delay has only contributed to complicating the issue. Television has developed since that time and has brought with it its own difficulties in the matter of interference, including interference of a type which was not experienced to any serious extent on ordinary broadcast receivers. At the same time the uses of electricity for all sorts of purposes has progressed apace and with it interference has grown proportionately.

A great deal can be done by voluntary action to suppress interference, but it is unreasonable to leave some to incur the trouble and expense involved when others do nothing because they are not under compulsion

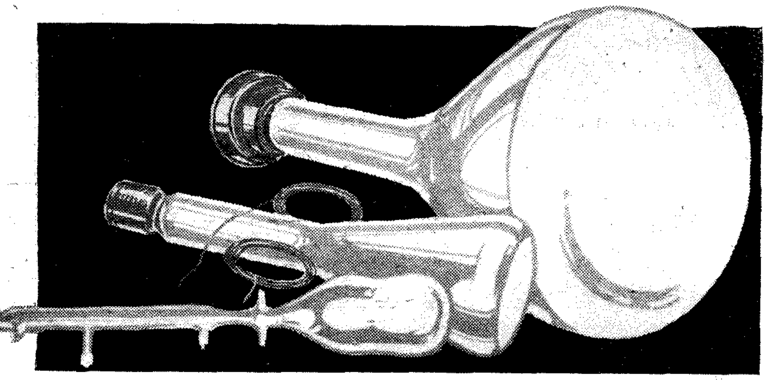
Sanity and Simplicity

The Wireless World has repeatedly urged that rather than wait for finality simple regulations framed in a spirit of reasonableness should be formulated, if only as a stop-gap. During the years that have been spent in attempting to reach an agreement, new problems have arisen, one after another, and if we are going to pursue the idea of water-tight legislation to cover every eventuality, then we may just as well sit back and postpone the effort until electrical, radio and television development have reached finality. Nothing to our mind is more absurd than for those who are to promote this legislation to try to cover all eventualities, when they are in the midst of continuously changing conditions.

It is surely yet possible to return to sanity and simplicity and evolve some form of general regulation giving the Postmaster-General authority to suppress interference, subject to reasonableness which could be attained by a small permanent advisory committee representing the various commercial and other interests affected.

Cathode-Ray Tubes

STORY OF THEIR DEVELOPMENT FOR TELEVISION RECEPTION



By O. S. PUCKLE, A.M.I.E.E.

THE cathode-ray tube is one of the most remarkable and certainly the most versatile of instruments used for the measurement and portrayal of events which are generally unintelligible to our senses, and which, in the great majority of cases, cannot be measured or portrayed in any other way.

Cathode-ray tubes which have been specially designed for television reception may be used for many other purposes, and the development of these tubes, although resulting in television tubes, was not carried out with that end in view. For this reason the present article cannot avoid mentioning many tubes which were developed with no thought of television, except perhaps as a speculative possibility, in the mind of the research workers and designers concerned with each particular development.

ALTHOUGH it is only in recent years that the cathode - ray tube has become widely known, development has proceeded for a long time. In this article the history of the tube is traced from its beginning, about 1859, to the present time.

Cathode rays were known as long ago as 1859, when they were investigated and named as such by Plücker. It was not, however, until 1890 that Johnstone Stoney discovered that the fluorescence produced when cathode rays strike the glass wall of the vessel in which they are generated was due to particles of electricity, of which the ray is comprised, bombarding the walls. He first discovered that cathode rays were composed of particles, and he used the word "electron" (Greek word meaning "amber") to describe such a particle.

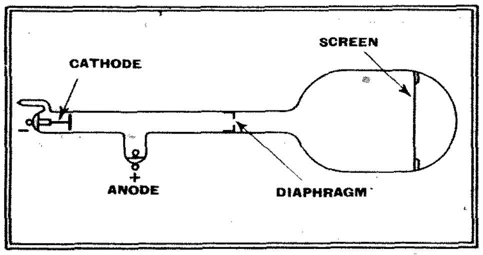


Fig. 1.—The Braun Tube of 1897. Reproduced from "Television" Science Museum Publication, 1937.

Apparently the first suggestion that these cathode rays might be used to depict a waveform was made by Hess,[1] a Frenchman, in 1890, who mentioned that they might be employed for tracing curves. This led to the development of a tube by F. Braun[7] (pronounced Brown), which was the first application of the cathode-ray tube to any useful purpose. Braun's tube was, of course, a very simple affair (see Fig. 1), operated from a Wimshurst or similar machine, and the beam was deflected by means of coils placed about the neck of the tube. In the same year, 1897, Sir J. J. Thomson,[4] of Trinity College, Cambridge, and Kaufmann, in Germany, independently employed a cathode-ray tube to measure e/m, the ratio between the charge on the electron and its mass. An illustration of Sir J. J. Thomson's tube is shown in Fig. 2, from which it will be noted that deflector plates were used for the first time, and, moreover, this was apparently also the first tube in which the fluorescent screen was coated on the end of the bulb instead of being mounted on a plate fixed inside the tube. Kaufmann[9] appears to have been the first to use electrostatic and electromagnetic deflection simultaneously.

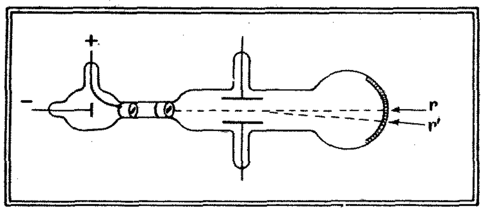


Fig. 2.—Sir J. J. Thomson's Tube for Measuring e/m. Date 1897. Reproduced from "Conduction of Electricity Through Gases."

It should be noted that, until 1898, when Wiechert[8] used a coil for focusing the beam, no attempt had been made to limit the size of the spot except by the insertion of diaphragms to cut down the diameter of the beam. In this connection it must, however, be remembered that the Maltese cross shadow produced in a Crookes' tube had been reduced in size by means of a coil wound round the neck of the tube and through which a direct current was passed. When the cross was reduced in size it was noticed that it was also rotated, but it is possible that the reason for this was not understood until later. This experiment was carried out by Fleming and his assistant Morris[6] (now Sir Ambrose Fleming and Prof. MacGregor-Morris) in 1897, and the effect is shown in Fig. 3. However, Campbell-Swinton[2] referred to the subject of magnetic focusing in an article in the *Electrician* even earlier than this, viz., in 1896. An early tube made for Prof. MacGregor-Morris by A. C. Cossor, Ltd., in 1902, is shown in Fig. 4.

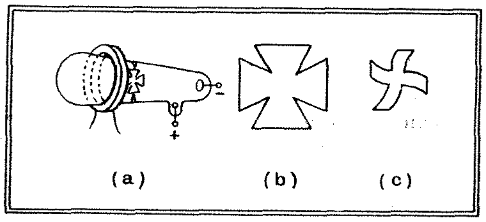


Fig. 3.—Crookes' Tube, (a) with focusing coil, (b) image without a field, (c) image with field. Reproduced from "Electrician."

The Hot Cathode

In 1903 Wehnelt[12] found that a coating of lime on a hot filament used as a cathode gave a more intense emission of electrons than was possible with a plain metal cathode, and, in 1905, he made a tube incorporating this idea, and found that it would operate on less than 1,000 volts instead of requiring 50 to 80 thousand volts (Fig. 5). Apparently the first hot cathode tube to be made in this country was manufactured by A. C. Cossor, Ltd., at the end of the year 1922, when they made an experimental high-vacuum tube for the Telegraph Construction and Maintenance Company. This tube was used chiefly for making tests on magnetic materials, and was operated at an anode potential of 600 to 800 volts. A photograph and a draw-

[1-16] The references throughout this instalment refer to a Bibliography which will be included in the continuation of the article.

Cathode-Ray Tubes—

ing of this tube are shown in Fig. 6, from which it will be seen that it was fitted with deflector plates and that the fluorescent screen was mounted on a sheet of mica fitted inside the tube. It is most interesting to note that, on the reverse side of the mica supporting the screen, there is graticule made of crossed lines 0.1in. apart. As can be seen in the photograph, the anode connection is broken, and a joint has been made to a wire by means of a metallic paste, and the whole joint then covered with insulating tape.

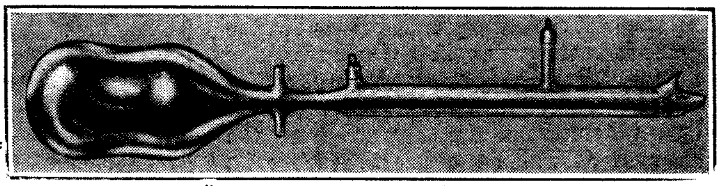
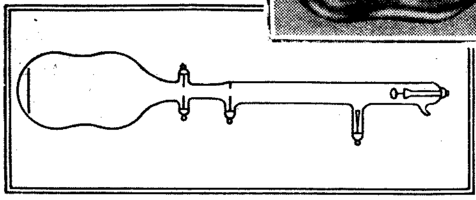


Fig. 4.—An early Cossor Tube of 1902.



The author is indebted to Mr. G. Sowter for information regarding the tube and to the Telegraph Construction and Maintenance Co., who have been good enough to present the tube to him.

Wehnelt's application of the hot coated filament to the cathode-ray tube was a real advance, but it was not until 1911 that any further development occurred, when Roschansky,[14] although he reverted to the original high-voltage form of the tube, seems to have constructed a more practicable form of tube than any which had preceded it. Roschansky's tube employed magnetic focusing and electrostatic deflection, and is shown in Fig. 7.

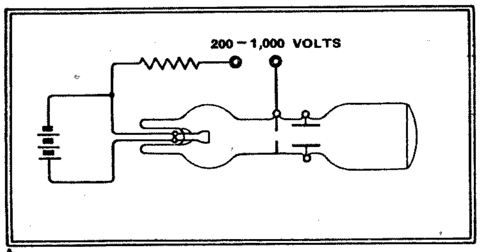
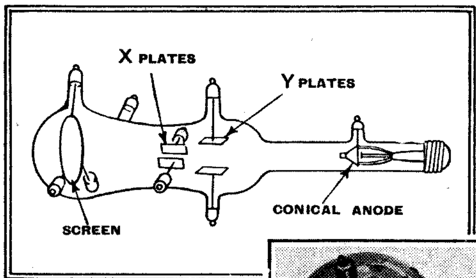


Fig. 5.—The Wehnelt Tube of 1905. Reproduced from "Bell System Technical Journal."

These early tubes, in their later forms, were generally focused electromagnetically by passing current through a coil wound round the neck of the tube. Such a coil was known as a "striction coil," and, although the same method is in use to-day, the original name seems to have been discarded in favour of "focusing coil." The word "striction" was employed to describe the means by which the coil obtained its effect rather than, as is common to-day, the effect itself. The effect of the coil (when a suitable current is made to flow through it) is, of course, to constrain the electrons to flow in convergent helical paths.

Deflection systems were either electrostatic or electromagnetic, and deflector plates were sometimes built into the tubes. The fluorescent screens were, in some cases, mounted on the end of the tube itself and, in others, supported on a sheet of mica mounted inside the tube.

In spite of the fact that these tubes required some 80 kV for their operation, and that they were both dangerous and bulky, some very useful work was carried out with their aid, notably by Sir J. J. Thomson[11] in England and Braun[7] and Zenneck in Germany. However, these disadvantages were sufficient to preclude the use of the tube outside one or two specially equipped laboratories. Even as early as 1908 Campbell-Swinton[13] pointed out the possibilities of the cathode-ray tube as a transmitter and receiver of television images. His scheme, although described in greater detail in 1911 (Fig. 8) during a presidential lecture[15] to the Röntgen Society in London, was quite impossible of being brought to a successful conclusion at the time due to several causes, amongst which may be mentioned the following facts:—



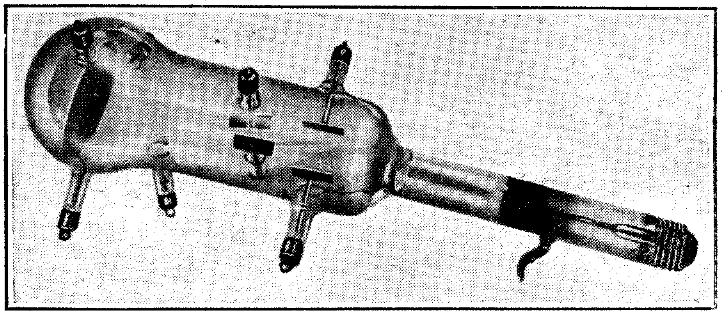


Fig. 6.—Hot coated-filament Tube made by A. C. Cossor for the Telegraph Construction and Maintenance Company in 1922.

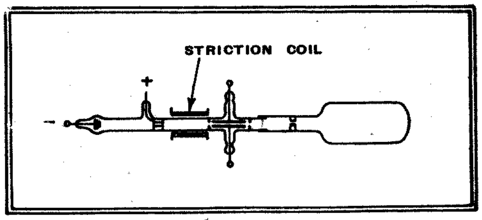


Fig. 7.—Roschansky's Tube of 1911. Reproduced from "Bell System Technical Journal."

(*a*) The three-electrode valve, although it had been invented, was but imperfectly understood, and, so far as the author is aware, no amplifying circuits had been developed. It was certainly impossible at the time to make high-gain stable amplifiers having the necessary band-width to reproduce even crude images.

(*b*) The fundamental principles governing the transmission of signals along cables had been defined by Oliver Heaviside, but they were too new to be thoroughly appreciated and put into practice for wide band-widths by engineers, partly because the necessary loss-free insulating materials had not been developed.

(*c*) The principles of photo-electric surfaces and the methods of their production and use had not been sufficiently developed.

No one appreciated the difficulties of putting Campbell-Swinton's idea into practice more than Campbell-Swinton himself, and, indeed, he pointed out in a letter to *Nature* that it was "an idea only." Had he lived till the present day he would probably have been amazed to find out how accurate a forecast he had made of the system at present used in all countries where television has advanced to any reasonable degree. However, apart from theories and speculations, television was still as far from being a practical reality as

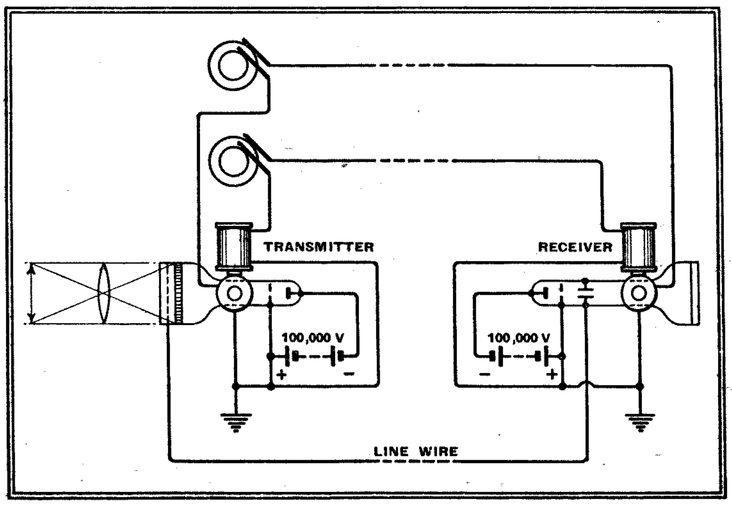


Fig. 8.—Campbell-Swinton's suggestion for a complete television system in 1911. Note that this system in its essential details is the same as that used at Alexandra Palace to-day. Reproduced from the Journal of the Röntgen Society.

Cathode-Ray Tubes—

it had been when the first suggestions for the transmission of vision were made about sixty years ago.

The next step towards the goal of television as we know it to-day was the development of the hot-cathode gas-filled tube (Fig. 9) by Van der Bijl and Johnson,[16] American engineers in the Western Electric Company. They eliminated the striction coil and brought about the focusing of their tube by the admission of a small amount of one of the rare gases, argon. The effect of the gas, although it is not now used for television tubes, is of the utmost importance, since it is still used for a very large number of special-purpose cathode-ray tubes; its effect in focusing the electron beam will, therefore, be described.

The principle of operation of a gas-focused cathode-ray tube is as follows:—

When electrons are emitted from a cathode they are projected into the

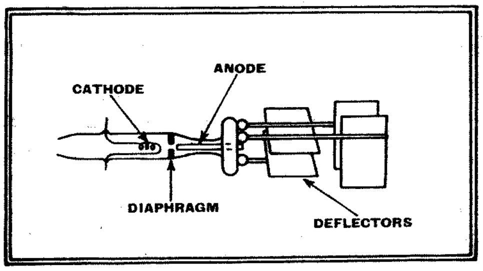


Fig. 9.—Electron gun and deflection system of Van der Bijl-Johnson Tube (1922). Reproduced from "Bell System Technical Journal."

enlarged end of an evacuated cathode-ray tube in the form of a divergent stream unless a striction coil or some other means (to be described later) is used to cause the electrons to converge. If the tube is, however, filled with a small quantity of inert gas, the gas becomes "ionised by collision." The process of ionisation takes place in the following way: the electrons, which are fast-moving particles of extremely small size, would continue to diverge were it not for the fact that the gas molecules, which are some thousand times

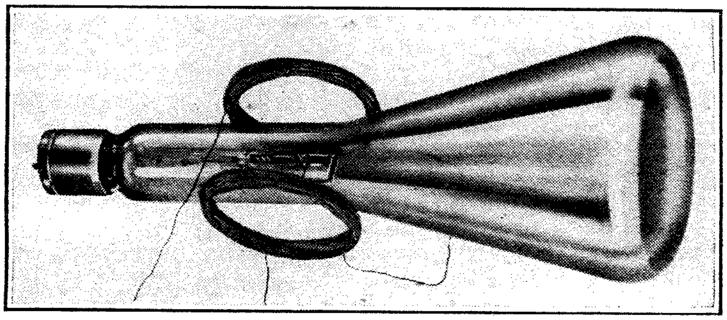


Fig. 10.—Van der Bijl-Johnson Tube made by Standard Telephones and Cables, Ltd., and incorporating electromagnetic deflecting coils.

more massive than the electrons, are sufficiently numerous to ensure that the electrons can travel only a small distance before they approach a molecule of gas. When this occurs, an electron is ejected from the molecule, which is left with a positive charge. Thus, a large number of positively charged bodies having large mass and, therefore, moving relatively extremely slowly, are left in the path of the electrons, and form a sort of core down the centre of the beam. The positive bodies, or ions, as they are called, attract the negative electrons and cause them to converge. It will be obvious that if the amount of ionisation, i.e., the number of positive ions so formed, can be controlled, we have a means of determining the amount by which the electron stream is caused to converge. Van der Bijl and Johnson caused the amount of ionisation to be controlled by altering the rate of emission of electrons from the heated cathode of the tube. This they did by controlling the temperature of the cathode by means of a series resistance inserted in the cathode-heating circuit. Obviously, the amount of ionisation, or the amount of convergence of the electron stream, or beam, determines the distance from the cathode at which the beam reaches its smallest diameter, so that, by adjustment of the heating current, the beam can be brought to a focus at the point where it strikes the fluorescent screen. Fig. 10 shows a tube made by Standard Telephones and Cables, Ltd., incorporating the ideas of Van der Bijl and Johnson.

(To be concluded.)

PROBLEM CORNER—11

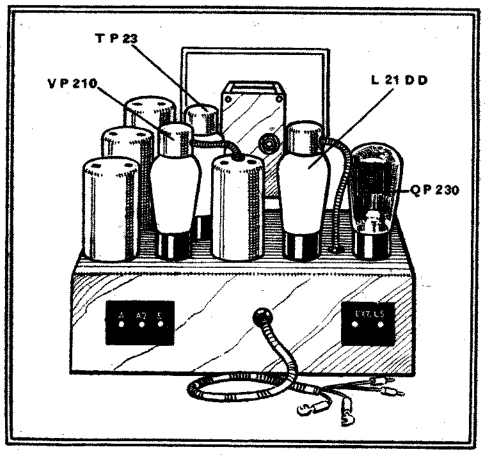
Test Your Powers of Deduction

ANOTHER sample of Henry Farrad's correspondence is published below. As regular readers are aware, Henry Farrad's skill in deducing the causes of troubles brings him many such letters, and an opportunity is given of testing one's own ability in this direction before turning to the solution on p. 246.

All Hallows School,
Berkhamsted.

Dear Henry,

Thanks awfully for working out that potentiometer problem for me. Now I have struck something else that has got me down absolutely. I have been making a battery superhet, and last Saturday got it all ready, started connecting the batteries, LT first for safety, and there was a dickens of a flash when I brought the second lead to the accumulator terminal. Obviously a dead short-circuit somewhere. It is a good thing I happened to have had the set switched on as I was connecting the battery, as otherwise I might not have noticed it until too late. After a lot of messing about I found that it was perfectly all right so long as the double-diode-triode valve was left out. So I tested this valve—a L21DD—for shorted filament and everything else I could think of, but as a valve it was perfectly O.K. Directly it was put back in the set there was a shorted LT battery. I don't see how you can spot the snag without seeing it, but here is some of the constructional information, for what



Sketch indicating the position of the various valves in Tony's receiver.

it is worth. The fellows are keen to hear the set working, so I do hope you will be able to spot what's wrong.

Yours ever,
Tony.

Well, what was wrong?

The Amplification and Distribution of Sound. By A. E. Greenlees, A.M.I.E.E. Pp. 254 and 82 figs. Published by Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2.

THE art of public address has grown by the accumulated experience of many firms large and small, and at the present time is badly in need of rationalisation from the technical point of view. The decibel is freely bandied about without thought of its true significance, and microphones and amplifiers are rated by a host of different methods. As a result, the individual practitioner, who may show great skill in handling his own particular equipment, encounters difficulties when comparing notes with other workers or when he wishes to buy a new component for incorporation in his installation.

No such confusion could have arisen had this book been put in the hands of every PA engineer at the beginning of his career. It starts from first principles and deals in orderly fashion with every aspect of PA work including the design and rating of amplifiers, microphones and loud speakers, the calculation of distribution lines and matching transformers, indoor and outdoor acoustics and the planning of central installations. Chapters are devoted to record reproduction and the use of radio receivers, and there is useful advice on the preparation of specifications and the maintenance of permanent installations.

The treatment of the decibel is particularly good and the relative merits of microphones are clearly set out in tabular form, together with their average sensitivities on the two most commonly used scales.

The treatment is unusually complete and, if some aspects of the subject are treated briefly, the information is always to the point. The illustrations, apart from the circuit diagrams, are somewhat rudimentary, but the text is always clear, concise and informative. This is a book which will serve as a work of reference for the established PA engineer as well as an admirable introduction for the beginner. F. L. D.

Stabilising Condensers

AMERICAN COMPONENTS FOR PRESS-BUTTON TUNING

Of the various methods employed to ensure high frequency stability the most interesting are probably those involving the use of parallel condensers having an opposite temperature/capacity characteristic to that of the main tuning condensers.

By Our New York Correspondent

PRESS-BUTTON tuning has demanded better stabilisation of receiving circuits against the effects of time, temperature, moisture and vibration. In America the problem is acute because there are many broadcasting stations in the United States and Canada. In addition, we in America have our own short-wave problem. At all hours of the day and night hundreds of short-wave and ultra-short-wave police radio stations transmit to fixed-tune receivers in patrol cars. At night the signals often "come down" in distant cities with great strength. We all know that police cars are not always driven gently, but only experience showed the true severity of the demands imposed on a receiver fitted in what we call a "prowl-car." Its sensitivity must be high as motor car receivers go, or else calls are missed in shielded areas. The selectivity must be high, for there is little separation between channels. Finally, the receiver must be very stable or the wrong station is heard. All these things must hold true despite constant use and occasional violence. Sad experience was acquired in the early days, and much equipment was replaced. The American aircraft situation is also severe but not unique.

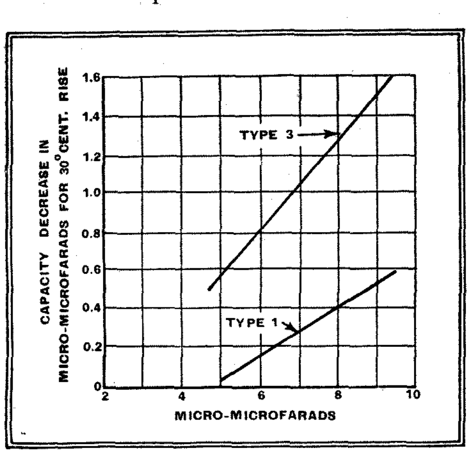


Fig. 1.—Curves showing performance of Sprague Types 1 and 3 liquid compensators.

In fixed-station commercial receivers such problems are met by massive construction and the use of air condensers. Whatever the merits of such construction, it is not adapted to mobile use, nor is it cheap enough for household receivers. Thus, at present, manufacturers tend to make the circuits primarily stable against vibration and moisture, accepting some temperature drift which is then compensated by means of a small shunting condenser with an opposite temperature drift. The necessary adjustability of the tuning to permit trimming is attained by normal means. The movable iron coil core is in fairly common use, as is the variable capacity trimmer. The latter differs from the older sort in that it forms only a small portion of the total capacity, and is more stable by virtue of a larger airgap and better material. In a few cases it is an outright air condenser of small capacity.

Among the condensers intended to form the bulk of the tuning capacity, and therefore requiring good constancy, one naturally finds the silver-on-mica type well in the foreground. The performance of the types now available is illustrated by Table 1, made up from manufacturer's data.

Among the condensers intended to effect compensation there are the familiar ceramic types and the liquid compensators. In both cases the compensation is effected by changes in the dielectric constant of the insulation as the temperature is changed. No differential expansion or other motion is involved. However, the two types cannot be tossed into one basket, since there is an essential difference between them. The nature of this difference appears in Table II and the following explanatory paragraph.

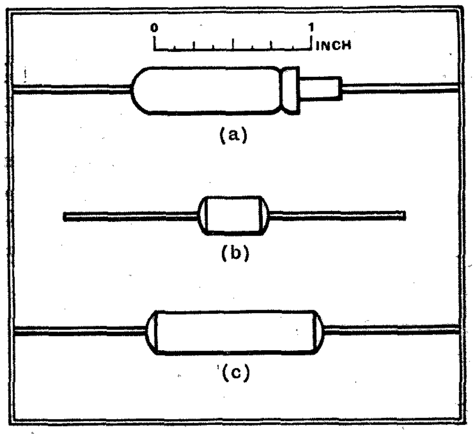


Fig. 2.—Sketch showing external appearance and sizes of Sprague (a) and Erie (b and c) compensating condensers.

Offhand, this seems to suggest that the characteristics of the liquid compensator are of an unpredictable nature, but actually these condensers are quite rational, as may be seen when their performance is presented in the form of curves (see Fig. 1). The difficulty of the worded statement in the table is that it does not give a proper understanding of the effect of the shunt capacity due to those strain lines which pass directly between the terminals without encountering the special

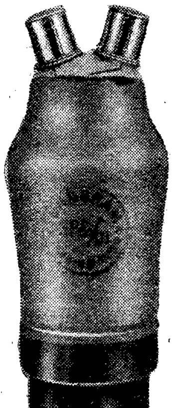
TABLE I.—PERFORMANCE FACTORS.

Maker	Sprague Specialities Co., North Adams, Massachusetts.	Erie Resistor Co., Erie, Pennsylvania.
Seal	Wax	Wax.
Base	Ceramic or bakelite	Ceramic.
Capacity tolerances...	± 20, 10, 5, 2.5, also ± 1% or ½ micro-microfarad, whichever is greater.	± 10, 5, 3, 2, 1% but in no case less than ¼ micro-microfarad.
Range available ...	5 to 500 m-mfds....	40 to 120 m-mfds. (type F); 15 to 2,500 m-mfds. (type A).
Drift with time ...	0.1% max.	0.1% max.
Capacity/frequency characteristics.	Better than usual measuring equipment.	———
Capacity/temperature characteristics.	Essentially constant	+ 0.00004 per degree C. for type A, 0.000025 for type F.
Losses	In vacuum, Q exceeds 10,000. In commercial form Q exceeds 1,500.	Power factor under 0.05, leakage R above 1,000 megohms after 100 hours at 40 degrees C, 100% humidity.
Physical form ...	Rectangular with leads at the ends ...	Rectangular with leads at the ends.
Dimensions	1 1/16″ × 9/16″ × 1/8″	1 5/16″ × ⅝″ × 3/16″, also midget size ¾″ × ½″ × 5/32″.

TABLE II.—COMPENSATING CONDENSERS (FIXED).

Maker	Sprague Specialities Co., North Adams, Massachusetts.	Erie Resistor Co., Erie, Pennsylvania.
Type	Liquid in cartridge	Ceramic and silver.
Capacity change for 30 degrees C. rise.	Type 1, decrease 0.4 m-mfd. for 8 m-mfd. size. Type 3, decrease 1.25 m-mfd. for 8 m-mfd. size (5% and 15.6%). In the 5 m-mfd. size the decreases are 0.03 and 0.55 respectively for types 1 and 3 (0.6% and 11%).	Type P, increase 0.36%; Type N, decrease 2% for all sizes.

Stabilising Condensers—
dielectric. Such a fixed by-pass does no actual harm, as it is merely added to the other capacities of the circuit. The magnitude of this fixed by-pass obviously depends on the physical form of the condenser. In the case of the Erie "Ceramicon" condensers of the above table, the electrodes are of silver-plate, and the ceramic insulator extends some distance beyond; hence nearly all the capacity is through the ceramic material, and the statement in the table is sufficiently correct. The Sprague liquid compensators, on the other hand, take the form of a small but deep metallic cup enclosing the dielectric altogether and extending higher to hold the insulating seal through which the other (central) electrode enters. Thus the relation is reversed; the electrodes extend beyond the special dielectric, and it is necessary to take into account the capacity beyond the special dielectric. This is done when the performance is stated in the form of the curves. It is seen that the performance is quite straightforward. From a designer's point of view the chart is very useful, since it describes the compensators in terms of the micro-microfarads of variation, which is also the significant factor when measuring the drift in a receiver.



The valve has two top caps; one is for grid the other for cathode.

New UHF Pentode

VALVE WITH THREE CATHODE LEADS FOR ULTRA-SHORT WAVES

By I. ZAKARIÁS (TUNGSRAM RESEARCH LABORATORY, HUNGARY)

In this new valve three leads are provided for the cathode in order to reduce common coupling to a minimum and so increase the input impedance. Two of them are used for the grid and anode return circuits, the third for earthing.

THE conventionally built RF pentode fails at high frequencies for two reasons: the mutual conductance of about 2 mA/v. is too low to suit the circuit impedances practically obtainable at frequencies of over 20 Mc/s, and the inductance of the connecting leads of the electrodes is high. This is particularly important in the case of the cathode lead because it increases the damping effect of the valve on the input circuit and also feedback in general. The conventional circuits used at radio frequencies are, therefore, seriously affected. According to which effect predominates, neutralisation or regeneration must be used.

This is a serious drawback of the conventional RF pentode. Shortening the common cathode lead naturally reduces the undesired coupling, but does not completely eliminate it.

Neutralisation and regeneration can be avoided by using the new UHF pentode. With a normal anode current of 10 mA a mutual conductance of 9 mA/v. is obtained. The input grid loss due to the transit time of the electrons is greatly reduced because of the very small cathode-control grid, and control grid-screen grid electrode spacings; 0.15 and 0.25 mm. respectively. The input damping, due to the common cathode lead, is completely avoided. The result is that the input resistance at the normal operating conditions is as high as some 60,000 ohms at 40 Mc/s.

Preliminary investigation showed that the input grid damping can be easily diminished to a negligibly small value through the use of at least two cathode leads. Further tests seemed to destroy the hope that the feedback of the anode circuit to the grid circuit could be also reduced in this way. The cause of the apparent failure of a UHF pentode with three cathode leads was found to be due to the inductance of the cathode lead which connects the cathode to earth. The anode-earth and the grid-earth capacities in conjunction with the cathode-lead inductance provide the unwanted coupling between input and output. The next step, therefore, was to arrange separate shielding boxes for the grid and for the anode circuits. In this way, the direct anode-earth and grid-earth capacities were reduced to a negligibly small value. The feedback arises now only from the grid-anode capacity of the valve. With high circuit impedances, this residual feedback may cause regeneration, and eventually oscillation may occur. According to investigations, this residual feedback can be still further reduced in a simple manner. For this purpose the separate shielding boxes are connected to the common earth by means of leads outside the valve also.

The cathode connection for the grid circuit is arranged on the top of the bulb in the vicinity of the grid cap as a second cap. The product LC is thus made a minimum; L is the inductance of the grid and cathode leads, and C the input capacity of the valve. The grid circuit shielding box, otherwise insulated from earth, must be connected to the cathode cap on the bulb top. The suppressor-grid is connected to the cathode by means of a short lead inside the valve. In the valve base two cathode connections are arranged. One of them must be connected to the anode circuit shielding box, otherwise insulated from earth. The other must be connected to earth. The screen-grid bypass condenser must also be connected to earth.

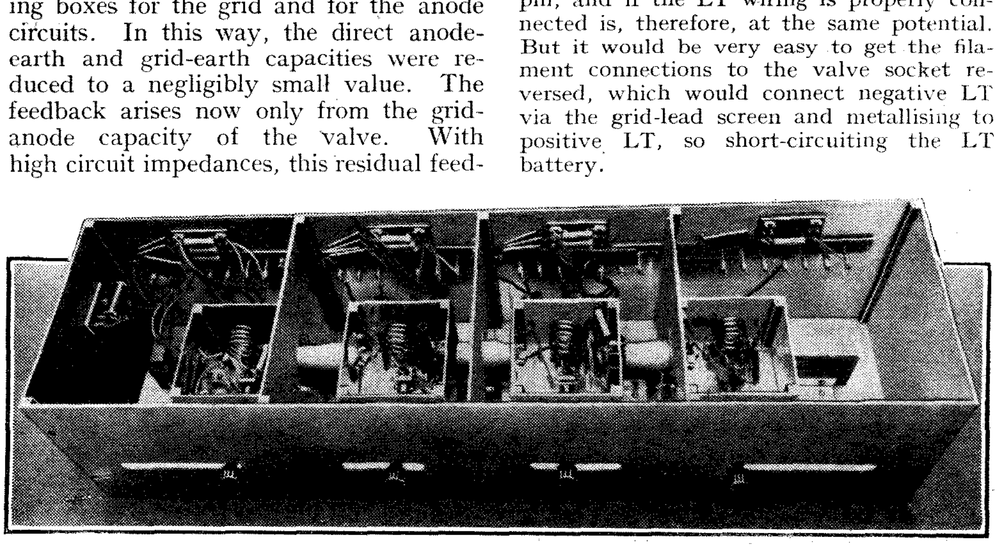
The photograph shows a three-stage amplifier for the frequency of 40 Mc/s with the new UHF pentodes. The amplification amounts to about 50,000 times. The method of mounting the valves is clearly shown. The valve has the type number SP4/U1 and has a heater consumption of 0.7A at 4 volts. The anode and screen supplies should be 250 and 150 volts, and the currents are 10 mA and 2.5 mA respectively.

Frequency-changer and secondary emission valves in which the same principles are applied, are in development.

HENRY FARRAD'S SOLUTION

(See page 244)

THE sketch of the set shows that the double-diode-triode valve has a close-fitting "hat" for maintaining continuous screening of the grid lead right up to the metallising of the valve. The "hat" is, of course, earthed to chassis, and so normally is negative LT. The metallising of the valve is common to the filament negative pin, and if the LT wiring is properly connected is, therefore, at the same potential. But it would be very easy to get the filament connections to the valve socket reversed, which would connect negative LT via the grid-lead screen and metallising to positive LT, so short-circuiting the LT battery.



A receiver embodying the new valves and designed for operation at 40 Mc/s is shown here.

Receiver Noise

FACTORS LIMITING THE USEFUL GAIN OF RECEIVERS AND AMPLIFIERS

By D. A. BELL, M.A.

THE background noises that are inseparable from high sensitivity in a wireless receiver are analysed in this article; then the various causes are examined and it is shown that often by taking certain precautions the inherent noise can be reduced to a minimum.

IN an article describing the developments in the Post Office wireless communication system[1] it was mentioned that the cost of one of the short-wave receiving stations is comparable with that of the transmitter with which it works. Can we then balance the cost of adding stages of amplification to the receiver, so as to increase its sensitivity measured in microvolts input for standard output, against the cost of increasing transmitting power to give a corresponding increase of field strength (microvolts per metre) at the receiving station, and from these costs alone determine the optimum transmitting power? Actually, of course, much of the cost of an elaborate receiving station goes on devices for mitigating fading; but this does not affect the argument, for the depth of fading (i.e., ratio of minimum to normal field strength) is presumably independent of the absolute value of the normal field strength.

A corresponding problem arises in landline working, whether it be for telegraphy, telephony or television. In this case the maximum strength of the transmitted signal is usually fixed by other considerations, but the problem remains of how weak the signal may be allowed to become before an amplifier ("repeater") is inserted in the line.

Background Noise

In every case, the limit of usable signal strength is set by the necessity for the signal to be appreciably greater in strength than the general level of background noise, the noise including components both internal and external to the receiver or amplifier. It is important to realise that both classes of noise, internal and external, may be divided into inherent noise and noise due to imperfect apparatus. For example, the inherent external noise in radio reception consists of natural atmospherics, while the remaining external noise due to electrical machinery of all kinds, commonly known as "man-made static," is due to defective apparatus outside the receiver. Similarly, while the noise within the receiver may be partly due to imperfect apparatus, such as a noisy volume control or imperfect valve insulation, there are two sources of inherent noise within any valve amplifier, and these are known as "shot noise" and "thermal noise." It is then the business of the engineer to design his communication system so that as far as possible the noise due to imperfections is below the inherent noise, and the signal strength always remains above the level of the total noise due to all these causes. This article is devoted to a consideration of the two kinds of inherent noise within the receiver.

The simpler of the two is "thermal noise," so called because it is proportional to the temperature of the resistance in which it arises. Those who have read "Which Way Does the Current Flow?" (*Wireless World*, December 15th and 22nd, 1938) will realise that in the ordinary metallic conductor the electron forms the link between the electric current and the material of which the conductor is made; and it shares in one of the most important properties of all matter, namely, temperature. Now the temperature of a body is really a measure of the energy which the constituent molecules possess in the form of random vibrations in a solid or random movements in a fluid; it is then only natural that the electrons in a metal should also share in the random motions, but since the movement of an electron constitutes an electric current,

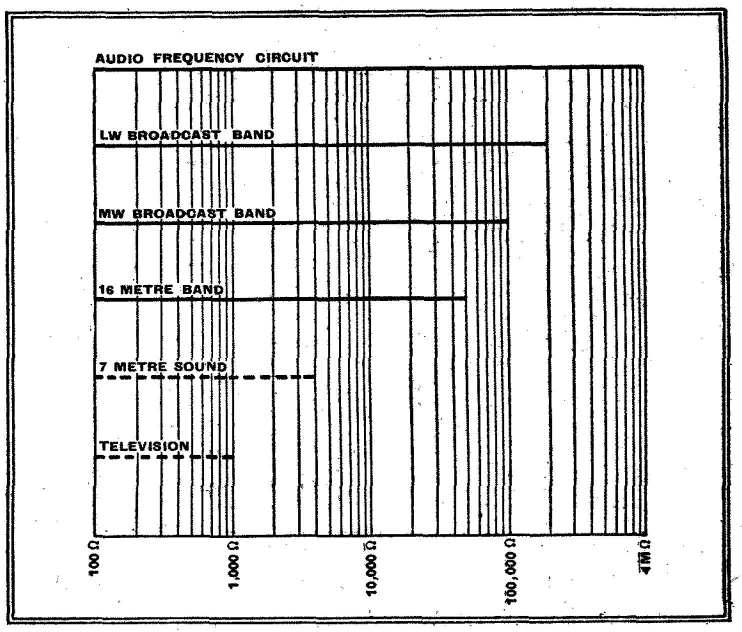


Fig. 1.—Impedance of circuits in a broadcast receiver with approximate values for the television sound and vision frequencies.

we immediately have a vast number of minute electric currents in random directions in every conductor. Actually, the random current component due to any single movement of one electron is much too small—both in the length of path and the time for which it lasts—to be directly perceptible; so that the noise current which we observe is the resultant effect of innumerable electrons which are moving in all directions, but those moving in one direction do not exactly balance those moving in the other direction, since the distribution of velocities is not uniform but irregular.

Computing Noise Voltage

This can be illustrated by the analogy of a tube-station subway in the rush hour. On the average, the number of people leaving the subway must be equal to the number entering it; but owing to the different speeds of travel of different individuals, it is quite possible for the number of people leaving at any particular instant to be either greater or less than the number entering at that same instant. Similarly, the electrons within a conductor free from any applied EMF will on the average be uniformly distributed, but at any instant the random motions may result in a greater electron density towards one end than at the other; the momentary voltage which results at the terminals of the conductor is then called a noise voltage, or fluctuation voltage.

Owing to its irregular nature it is impossible to predict the instantaneous amplitude of this fluctuation voltage (or current), but its mean square value can be calculated. It was originally shown by Nyquist that a resistance behaves as though it had in series with it a source of fluctuation voltage according to the equation

$$V^2_{af} = 4RkT.df \quad \ldots\ldots\ldots\ldots (1)$$

where V^2_{af} is the mean square of the com-

[1] "Post Office Wireless," *The Wireless World*, November 17th, 1938.

Receiver Noise—

components of noise voltage in a narrow band of frequencies *df* c/s, *R* is the resistance in ohms, *T* the temperature in degrees absolute of the resistance, and *k* an important constant of atomic physics known as Boltzman's constant.

It is interesting to examine the factors on the right-hand side of equation (1) individually. First, the width of the frequency band appears because the noise is of irregular waveform—a "transient"—and therefore has components of all frequencies; as the band-width of the receiver is increased, so more of these components are brought in. Then the absolute scale of temperature is one on which the measure of the temperature is directly proportional to the molecular energy of the material; it is then only natural that the energy of the free electrons, and hence the electrical noise energy V^2_{df}, should be proportional to the same factor. Boltzman's constant is a factor which relates the magnitude of molecular energy to absolute temperature; it is necessary because, although the absolute scale of temperature starts from the correct zero, the size of its degrees was made equal to those of the Centigrade scale, without any relation to molecular magnitudes.

The resistance of a conductor gives the relation between the passage of an electric current and the consequent generation of heat, so it is not unreasonable that this same resistance should also be an important factor in the spontaneous transfer of energy from thermal to electrical form. Thus on quite elementary grounds equation (1) has been shown to be of reasonable form; anything approaching a proof of this equation, such as the reasoning used originally by Nyquist, is too involved to be presented here.

Source of Inherent Receiver Noise

Although the explanation has been given in terms of a simple metallic resistance, the *R* of equation (1) may equally stand for the resistance of a complex circuit, for example, the dynamic resistance of a tuned circuit at resonance, provided that the value of resistance *R* is the value appropriate to the frequency band *df* over which the noise voltage is to be measured. Since noise is most serious where the signal is weakest, i.e., at the input of a receiver, and most receivers have a tuned input circuit, the application to tuned circuits is the most important use of equation (1) in radio receivers. Ordinary room temperature is, roughly, 290° absolute, and on inserting the value of *k* in electrical units, equation (1) becomes

$$V^2 = 1.56 \times 10^{-5} R.df \quad \ldots\ldots\ldots \quad (2)$$

where V^2 is now in microvolts squared and *df* in kc/s, but *R* still in ohms. On the medium-wave broadcast band a good tuned circuit may have a dynamic resistance of 100,000 ohms, and with a selective receiver *df* will be perhaps 10 kc/s; we then find $V^2 = 15.6$ (microvolts)^2. Taking the square root of this, one would expect it to correspond in strength to a signal of just under 4 microvolts with 100 per cent. modulation.

The other important source of noise is "shot" noise in the valves of the receiver, which is due to the fact that the current arriving at the valve anode is not a continuous stream but a succession of individual electrons. This effect may be illustrated by a crude acoustic analogy. A stream of sand falling on a gong would set up a certain amount of continual ringing in the gong, whereas a perfectly steady stream of water (i.e., free from turbulence and splashing) would not have any audible effect.

The amount of noise would depend upon the resonant properties of the gong, the rate of flow of the stream of sand, and the size of sand particles. For example, a stream of shot would make more noise than a stream of sand for equal weights per second of falling material. Similarly, the equation for the "shot" noise voltage in the anode circuit of a valve includes the impedance of the anode circuit and slope resistance of the valve, the magnitude of the anode current, and the charge on an electron. Although it is not perhaps the most used formula, the "shot" effect in a saturated diode (i.e., a diode with no space-charge, the anode current being limited by the filament emission) can be shown to be equivalent to the flow of a certain fluctuation current whose mean square value is

$$i^2_{df} = 2Ie.df \quad \ldots \quad (3)$$

where i^2_{df} represents the components of fluctuation current in the frequency band *df*, *I* is the mean anode current (direct current) and *e* the charge on an electron. From the acoustic analogy of the sand and shot, it is natural to find the noise proportional both to the magnitude of current flowing *I*, and to the size of each article of the current stream, i.e., to the charge *e* on each electron.

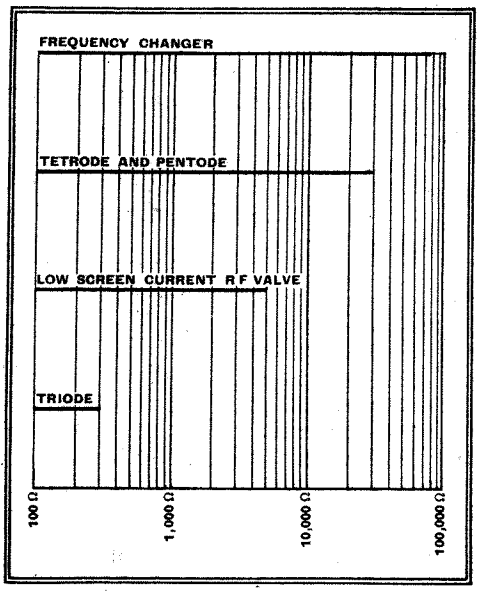


Fig. 2.—Valve noise expressed in terms of "equivalent grid resistance."

Unfortunately, this simple formula is only true of a saturated diode, and is not applicable to the amplifying valves in a radio receiver, all of which work with space charge. The first correction required in an amplifying valve is that the fluctuation current given by equation (3) must be assumed to flow in the anode load circuit and the internal resistance of the valve in *parallel*, so reducing the amount of noise in the load circuit.

Although the noise does vary with valve resistance in this way, it is reduced still further by some additional factor. One argument is that a valve which has a definite slope resistance ought to produce thermal noise like any other resistance, rather than "shot" noise, and various theories show that the temperature of the internal resistance of the valve should be taken as half the temperature of the cathode, measured in degrees absolute. The theory of the amplifying valve with space charge is far too involved to be discussed here,[2] but in practice the noise actually found falls somewhere between the values predicted by the two elementary theories. Thus for triodes the observed noise may be 10 to 20 times *less* than that predicted by the equation (3) with correction for valve resistance, but 10 to 20 times *more* than that predicted as thermal noise in the valve's internal resistance.

In radio receivers the important valves are not as a rule triodes, but the screened-grid or RF pentode valves in the first stages. Until recently these valves were much worse than triodes, and showed a level of noise energy from 60 to 100 per cent. of that which would be generated by a saturated diode passing the same anode current. A rough representation of this weakness of the screened valves may be obtained by regarding the screen to anode space as a diode with the screen as a virtual cathode; the resemblance of the static characteristic to that of a saturated diode is obvious.

Recently, however, special screened valves have been developed in which a great reduction of noise is obtained by focusing the anode current into definite beams which pass through the openings of the screen without interference by the screen wires.[3]

"Silent" Valves

In this case the screen does not behave as a virtual cathode, since there is negligible flow of current into the screen wires, and the anode current stress may be regarded as coming uninterruptedly from the space charge outside the actual cathode. The valve is in effect almost a triode in which the effective distance of the anode from the cathode is extremely great. Valves of this type may be recognised in *The Wireless World* Valve Data lists by the small value of screen current compared with anode current; about 1/30 to 1/50, in place of the usual proportion of screen to anode current of 1/6 to 1/12. As far as one can judge from published data, the mean

[2] For a serious study of noise phenomena, readers are referred to *Spontaneous Fluctuations of Voltage*, by E. B. Moullin, Oxford University Press.

[3] A typical valve of this type is the Mullard EF 8, described in *The Wireless World* of May 26th, 1938, p. 474.

Receiver Noise—

square noise output is reduced about seven times by this means, as compared with a screened grid or pentode valve of normal construction.

The noise value of a valve is most conveniently specified in the terms of an "equivalent grid resistance," i.e., the value of resistance whose thermal noise voltage at room temperature if applied to the grid of the valve would produce a noise output in the anode circuit equal to that already produced by the valve's anode current. This method of specification is useful because one can say immediately that if the "equivalent grid resistance" of the valve is less than the impedance of the grid circuit with which the valve is to be used, the valve noise will be unimportant, and vice versa.

The value of "equivalent grid resistance" depends, amongst other things, upon the factor G^2/I, where G is the mutual conductance of an amplifying valve or conversion conductance of a frequency-changing valve, and I the mean anode current; this factor alone has also been used as a sort of figure of merit for signal to noise ratio of valves.

Valve and Circuit Noise Values

Typical values of "equivalent grid resistance" for different classes of valves are: triodes, 200 to 500 ohms; normal screened valves, 20,000 to 50,000 ohms; low-screen-current screened valves, 4,000 to 5,000 ohms; frequency-changing valves, 50,000 to 100,000 ohms. This is one of the reasons why a frequency-changing valve should never be the first stage in a highly sensitive receiver; selectivity is the other consideration favouring the interposition of signal-frequency amplification between the aerial input circuit and the frequency-changer.

It only remains now to compare the magnitudes of the two sources of noise, valve and circuit. The ratio of the two depends, of course, upon the exact design of any given piece of apparatus, but Figures 1 and 2 have been constructed to show typical values for the impedances of circuits used at various frequencies and the "equivalent grid resistances" of different types of valve. Comparison of these two will show whether valve noise or circuit thermal noise will predominate in any particular combination of circuit and valve. The values for television frequencies must be treated with some reserve, and are therefore shown dotted; the difficulty is that at these frequencies the valve has a comparatively low effective resistance from grid to cathode, and the amount of noise arising from this cause is not known.

It will be noticed that the diagrams have been drawn to a logarithmic scale. This was necessary in order to allow the inclusion of a very wide range of values in a single legible Figure; it has the additional advantage that the differences in lengths of line in the Figures are proportional to the differences in noise level expressed in decibels.

Remote Frequency Changer

TWO-UNIT RECEIVER FOR DISTANT CONTROL

By E. MARTIN

(Engineering Dept., Philco Radio and Television Corp. of Gt. Britain, Ltd.)

ALTHOUGH somewhat less spectacular than the Philco "wireless" remote control system described in our issue of January 19th, the method described in this article provides an interesting solution of the problem.

IN the last few years much knowledge on the subject of remote control has been gained; many improvements have been made; and more suitable components have appeared. Now, with the present-day use of mechanical and electrical push-button tuning devices, a fixed radio installation, controllable from any room, becomes a practicable commercial proposition. In this direction, an interesting method of remote control which has been developed by Philco Radio, lends itself admirably to this new system.

The Philco Model D-732 is the result of a new approach to the problem of remote control. This receiver is built in two sections, one the remote unit which is portable, and the other the receiver proper which is installed in the most suitable position adjacent to the aerial and earth installation. These two units are connected by means of a special shielded multi-cored cable.

Comprised in this cable are four insulated wires which together are covered with tinned copper braiding. One of these wires forms the low-impedance transmission line for the intermediate frequency signal; another is used for the volume control; while the other two are for AVC feed and heater LT supply respectively. The metal braiding provides an earth return. Around this metal braiding, an insulated wire is wound in a special manner so as to form a feeder connection from the aerial to the tuning unit. Two additional insulated wires are provided for the mains operating switch, and the complete cable is covered with a cotton braiding. For the connection of extension speakers, a further wire is needed, and this may conveniently be included in the cable.

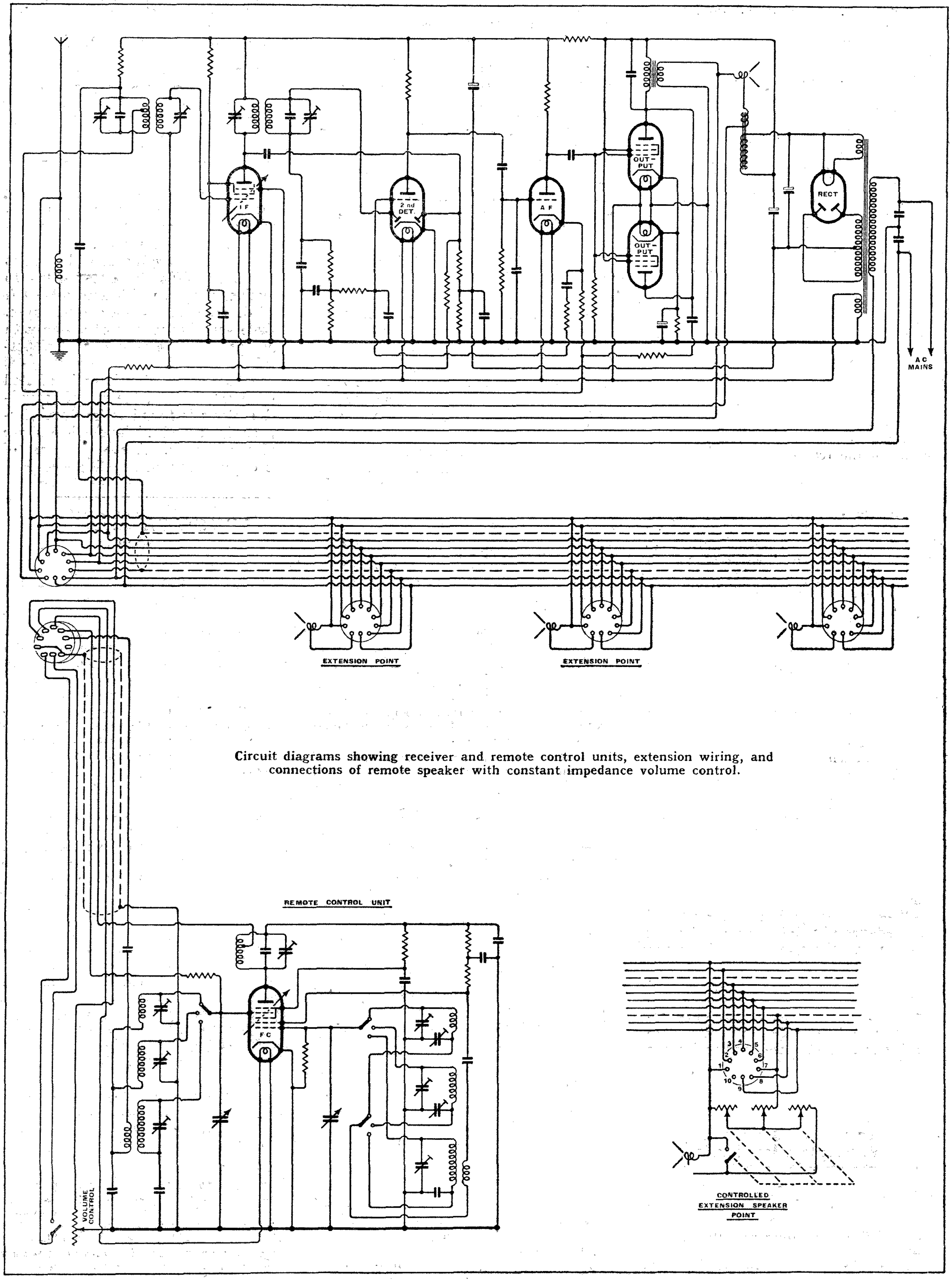
Control unit and speaker at the remote point.

The remote unit comprises the frequency-changer valve, aerial and oscillator coils, associated small components, and the gang condenser with mechanical push-button tuning arrangement. The frequency-changer valve is coupled by means of the low-impedance transmission line to the receiver proper, which houses the IF, second detector, audio and output stages. All these are of conventional design with the exception of the volume control portion of the circuit.

Since the control of volume is effected from the remote unit, the use of conventional systems is found to be unsatisfactory, as hum and high-note losses are introduced thereby. A special system of audio degeneration or negative feed-back is used, in which the amount of feed-back and consequently audio gain are remotely controlled by the single variable resistance in the remote unit. Automatic tone compensation is thus effected.

Briefly, the remote unit provides mains on-off switching, wave-changing, manual tuning of short, medium and long wave stations, automatic tuning of eight medium- and long-wave stations by means of six mechanical push-buttons, and volume control, all these operations to be carried out at a position some distance from the actual receiver.

A similar form of remote control is used in the Philco Model M-522 car radio receivers. For this type of receiver especially, the use of a single electrical cable, instead of the more usual Bowden type steel cables connecting the control unit to the receiver, provides a definite improve-



Circuit diagrams showing receiver and remote control units, extension wiring, and connections of remote speaker with constant impedance volume control.

Remote Frequency Changer—

ment in simplicity of installation and ease of operation.

By using this system of remote control for a domestic installation, and wiring each room with an extension speaker, remote unit connecting socket, and multicored cable to the receiver, it is possible to operate the receiver from any room merely by connecting the remote unit to the socket in the particular room in which reception is required. Insertion of the connecting plug switches the local speaker only into circuit, but provision may be made for connecting any of the other speakers in circuit also, if desired.

For the latter arrangement, pin and socket numbered 10 (see accompanying diagram) are dispensed with, and the speakers, each of which is fitted with a constant impedance volume control and an on-off switch which is arranged to short-circuit the speech coil in the "off" position, are connected in parallel across sockets numbered 1 and 7. This arrangement is shown in the inset of the main diagram, which illustrates the circuit wiring of the remote control system.

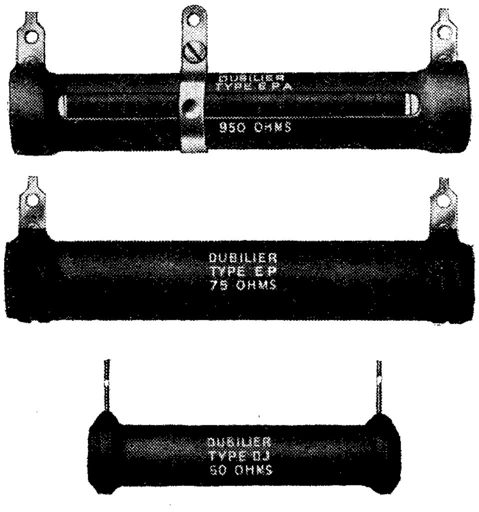
For the Manufacturer

Power Wire-wound Resistances by Dubilier

DESIGNED for use in situations where they may be required to withstand a high degree of temperature and humidity, these new Dubilier resistances are wire-wound with spaced turns on cylindrical ceramic formers and coated with a cement which is processed at a relatively low temperature.

Nickel-chrome or nickel-copper alloy is used for the wire and connection to the ends may be either die-cast or by means of terminal clips. No fewer than ten different terminal arrangements are available.

The range of resistance values is from 0.5 to 340,000 ohms, with tolerances of ±5 per cent. above 50 ohms and ±10 per cent.



Dubilier fixed, tapped and adjustable power wire-wound resistances on ceramic formers.

below. Working ratings vary from 5 to 200 watts.

In addition to the standard fixed type, resistances may be supplied with one or more tappings or with continuously adjustable clips making contact to a bared track on the winding.

For particulars of prices application should be made to the Dubilier Condenser Co., Ltd., Victoria Road, North Acton, London, W.3.

Television Programmes

Sound 41.5 Mc/s. Vision 45 Mc/s

An hour's special film transmission intended for demonstration purposes will be given from 11 a.m. to 12 noon each weekday. The National or Regional programme will be radiated on 41.5 Mc/s from approximately 7.45 to 9 p.m. daily.

THURSDAY, MARCH 16th.

3, Elizabeth Welch in songs. **3.10,** Cartoon Film. **3.15,** "Tee for Two"; tales told at the nineteenth hole by Reginald Arkell, illustrated by Harry Rutherford. **3.25,** Gaumont-British News. **3.35,** 225th edition of Picture Page.

8.40, "A Ship in the Bay," a nautical comedy by David Yates Mason, with music by Geoffrey Wright. **9.30,** Boxing O.B. from Harringay Arena, Len Harvey *v.* Larry Gains for the British Empire Heavyweight Championship. **10.30,** 226th edition of Picture Page. **10.45,** News.

FRIDAY, MARCH 17th.

3, Vanity Fair. A fashion display of wool for all occasions. **3.15,** Cartoon Film. **3.20,** British Movietonews. **3.30-4,** "Oleograph," amusement with moral improvement!

9, Jack Hylton and his Band. **9.30,** Gaumont-British News. **9.40,** "Animals, Anatomy, Artists," John Skeaping and James Fisher. **10,** Cartoon Film. **10.5,** Vanity Fair (as at 3 p.m.). **10.20,** Sports Film. **10.30,** Eilund Davies, pianoforte. **10.40,** News.

SATURDAY, MARCH 18th.

2.15, Head of the River Race. Cameras mounted on Mortlake Brewery will televise the start of the 133 competing crews. **2.40,** Cartoon Film. **2.45,** Gaumont-British News. **2.55,** Inter-Varsity Sports. O.B. from the White City. **3.10,** Cabaret with Leonard Henry. **3.25,** Inter-Varsity Sports O.B., continued. **3.30,** Film. **3.45-4.20,** Inter-Varsity Sports O.B. continued.

9, "Grandfather's Further Follies" from Grosvenor House. **9.30,** British Movietonews. **9.40,** "Seconds Out"; boxing, fencing and wrestling from the studio. **10.30,** News

SUNDAY, MARCH 19th.

3-4.30, "The Immortal Hour," the famous music drama by Rutland Boughton. The cast includes Irene Eisinger and David Franklin.

8.50, News. **9.5-10.40,** Gwen Ffrangcon-Davies in "Gaslight," a play by Patrick Hamilton, from the Apollo Theatre.

MONDAY, MARCH 20th.

3-4.30, Leon M. Lion in "Libel," a play by Edward Wooll.

9, Speaking Personally: M. Pertinax, the French journalist. **9.10,** La Chauve Souris. **9.40,** British Movietonews. **9.50,** "Les Jeux d'Eaux," a programme of French music and dances. **10.20,** Entienne Amyot, piano. **10.30,** News.

TUESDAY, MARCH 21st.

3, British Movietonews. **3.10,** "Joie de Vivre"—French Cartoon Film. **3.15,** O.B. from Victoria Station of the arrival of President Lebrun. **3.30,** "Les Jeux d'Eaux," (as on Monday at 9.50 p.m.).

9, News Map: France. **9.20,** "L'Avare" by Molière, adapted from Lady Gregory's version, "The Miser." **10.30,** News.

WEDNESDAY, MARCH 22nd.

3, Friends from the Zoo. **3.15-4,** "A Ship in the Bay" (as on Thursday at 8.40 p.m.).

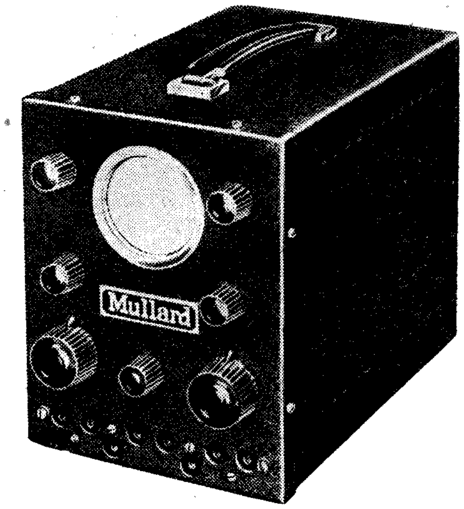
9, Friends from the Zoo. **9.15,** "In the Barber's Chair"—Charles Heslop. **9.25,** "The Edge of the World"—Film. **10.35,** News.

The New Mullard Oscillograph

Technical Details of the Model 3155

FIGURES are now available of the characteristics of the oscillograph which the Mullard Wireless Service Co., Ltd., have introduced for servicing. It is a compact instrument weighing 17 lb.—about the same as a baby portable—and measuring 8⅝in. × 6¾in. × 10⅝in. overall.

The 3-inch tube has a practically flat screen, which is an advantage when using a calibrated graticule scale. Incidentally,



All controls and input connections are mounted on the front panel of the Mullard GM3155 oscillograph.

the escutcheon shown in the accompanying photograph has been modified to accommodate a transparent scale in contact with the end of the tube. Three degrees of sensitivity are available in the vertical amplifier of 100 mV, 285 mV, and 830 mV per centimetre, and with direct connection to the plates the sensitivity is 16.5 volts/cm. A variable gain control is available on all three ranges. A high-gain pentode amplifier stage is also provided for the linear time base, which has a frequency range of 15 c/s to 25 kc/s. There is provision for external or internal synchronising, and the grid may also be modulated for time-marking purposes. With the gain control (10,000 ohms) switched out, the input impedance is of the order of 1 megohm. It is emphasised that the amplifier is free from phase distortion and that the frequency response is unaffected by the setting of the gain control.

All circuit changes are controlled by two knobs, which with the input sockets and the usual beam controls are situated on the front of the instrument.

An interesting manual dealing with the applications of this instrument to servicing problems has been prepared, and we hope to deal with it in our next issue.

TRANSMITTING VALVES

CONCISE technical data relating to twenty-six valves suitable for use in amateur transmitters together with current prices are contained in a brochure just issued by The Mullard Service Co., Ltd.

Many of the valves mentioned can be used in place of American types and when the characteristics are similar the American equivalent is stated. Particulars are also given of Mullard CR tubes, oscilloscopes, AF oscillators and signal generators, and it is obtainable from 225, Tottenham Court Road, London, W.1.

UNBIASED

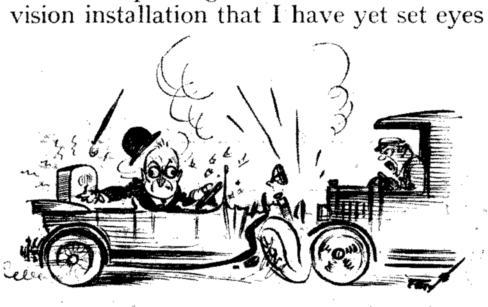
By FREE GRID

A Question of Ethics

I WAS telling you the other week of my proposed visit to Denmark in search of the death ray, particulars of which had been sent me by a correspondent in that country, who alleged that cars had been mysteriously stopped by a wireless experimenter using one of these elusive engine-stopping rays. I am sorry to say that I learned nothing of technical value concerning the ray, but I am not at all surprised at cars getting into trouble, and, indeed, until these Scandinavian countries agree among themselves which side of the road is the proper one to drive on, these so-called mysterious happenings to cars are likely to continue.

As a result of the mutually contradictory policy of these northern countries in the matter of the "rule of the road," I had a bad smash up and nearly came to an untimely end, as after searching vainly for the ray in Denmark, I took my car across in the ferry to Sweden with the idea of running through to Norway and catching a boat from Bergen, as for a certain reason I wished to avoid the Danish port authorities at Esbjerg. Owing, however, to this tomfoolery of the rule of the road suddenly changing wherever two Scandinavian countries meet, I had a nasty accident.

It is an ill wind that blows nobody any good, however, and had it not been for an enforced sojourn in hospital I should not have been privileged to see the finest television installation that I have yet set eyes



"It is an ill wind . . ."

upon, and this, mark you, in a country where a television service is not yet started. The installation in question, which is not quite completed, is in a large private school and is intended for internal educational purposes only.

The headmaster of the school has had a complete two-way television system fitted in each class-room and connecting to a similar installation in his private sanctum, and he will be able, by means of a large switchboard, to switch himself into televisionic communication with any class-room he chooses. His idea, he tells me, is solely one of economy, as he hopes, by means of this arrangement, to be able to dispense with all his high-salaried assistants, and conduct each class himself, dodging from one class to another as necessity dictates by means of his switchboard.

Although I found the installation absorbingly interesting, from a scientific point of view, I cannot say that I approve of it from the point of view of ethics, more especially as I learn that transmitters are to be installed in the boys' studies and elsewhere, so that a watchful eye can be kept on them, even in their leisure hours. This sort of underhand espionage leaves a nasty taste in the mouth, and I frankly told the headmaster so and said that I should not be surprised if the boys retaliated by equipping themselves with pocket-size ultra-short-wave oscillators and similar interference-causing gear. The headmaster rather discomfited me, however, by saying that he had already thought of that and so was using concentric cables instead of an etheric link.

Shocks Short-circuited

A LOT of unnecessary fuss is being made in certain quarters about the possibilitiy of severe shocks being received by people who persist in messing about with the innards of their television sets while the juice is still on. After all, nobody wastes much sympathy on the man who goes looking for a gas leak with a lighted candle, or who attempts to stop an electric fan by sticking his finger into the blades. The moral of all this is that practically every piece of apparatus in our homes, including even the poker, is dangerous if improperly used, and if this fact were a legitimate argument against them we should still be living in caves like our ancestors.

Nevertheless, in spite of these sentiments, I always welcome any and every effort towards raising the margin of safety still further in our wireless sets and other domestic apparatus. We must protect even the fool from his folly, if we can, and although I don't see what the gas industry can do in this respect, the electrical industry, with which is included wireless, is not so trammelled, and I have recently been privileged to inspect the work of an inventor who plans to make the household mains, and the appliances which run from them, as innocuous as a pocket flash-lamp.

The inventor explained to me that, human nature being what it is, it is impossible to prevent people tinkering with the "innards" of wireless sets while the juice is on or similarly misusing other electrical appliances. This remark is, of course, very true, and even in my own case I received a nasty shock the other day, although I am willing to confess that it was all my own fault. I happened to be feeling particularly peckish as I climbed out of my bath the other morning and, after wrapping myself in a towel, I foolishly proceeded to toast my morning kipper at the bars of a portable electric fire which I had in the bathroom. In my haste I pushed the prongs of the metal toasting fork into contact with the glowing element and as I was effectively "earthed" through the damp towel and the edge of the bath on which I was sitting, the result can be imagined.

All these little annoyances will be swept away if my friend's invention is adopted, and we shall be able to solder our tele-

"Effectively 'earthed.'"

vision sets without bothering about switching off first. Briefly, his idea is to supply AC at a million cycles per second instead of the customary fifty. As you all know, owing to the "skin effect" at these very high frequencies no shock can be obtained, as any one of you can prove by catching hold of the aerial of a broadcasting station while it is in action. As for the method of generating power at these very high frequencies, I need hardly say that once more the ubiquitous oscillating valve is to be used, but I shudder to think how many banks of them will have to be connected in parallel to provide light and heat for the average-size town.

Motor or Solenoids?

THE two main systems of push-button tuning, namely, a motor driving the main tuning control and the switching-in of pre-tuned auxiliary circuits, each has its merits and demerits. Speaking personally, I have a strong liking for the second method, but a great many makers are, in their new sets, adopting remote control by putting the tuning buttons in a small unit coupled to the set by a few yards of multi-wire "flex" and a tuning motor is, I am told, absolutely essential for this purpose; indeed, one maker, whose new sets have already been announced, has gone so far as to include the "instantaneous" pre-tuned system in his receivers, but has included a tuning motor to switch in the pre-tuned circuits when the remote control unit is employed. What I want to know is just this: why on earth can't the "instantaneous" feature be retained in the case of remote control by using a simple solenoid to switch in each pre-tuned circuit as required? Apart from anything else, it seems a lot simpler. There must be a snag somewhere, but I should be glad to know just what it is.

NEWS OF THE WEEK

ASPECTS OF CINEMA TELEVISION

London Cinemas and the Harvey-Gains Fight

THE fight between Len Harvey and Larry Gains for the British Empire Heavyweight Championship will be televised and broadcast by the B.B.C. direct from the Harringay Arena at 9.30 this evening.

The B.B.C. is permitting the promoters to sanction the reproduction of the television transmission in places of public entertainment, so for the second time the onus of exhibiting a television programme to a paying audience rests entirely between the theatre managements and the boxing promoters.

Although it was expected that Gaumont British would relay the transmission in a number of its London cinemas it was decided last week-end that as the installation of the Baird big-screen television apparatus in the London Gaumont-British circuit necessitates intensive operations, rediffusion of the Harvey-Gains fight would not be undertaken.

At the time of going to press, the Monseigneur News Theatre, Marble Arch, which is equipped with Scophony big-screen television, in the only cinema which proposes to relay this particular transmission.

Harvey and Gains will fight at Harringay to-night in a ring specially coloured yellow and brilliantly lighted for the benefit of television viewers. This change has been introduced in order to prevent blur and halation, and, for the same reason, the ropes have been dyed blue. This colour scheme, combined with the fact that the relay will be effected by cable to Alexandra Palace, is expected to result in even better pictures than those of the recent Boon-Danahar contest.

Sir Stephen Tallents, B.B.C. Controller of Public Relations, speaking to the Radio Manufacturers' Association at their luncheon last week, gave an indication of the B.B.C.'s attitude regarding this type of transmission, when he said that the Corporation believes in concentrating on the developments of home television and at the same time co-operating, as real and promising opportunities occur, in experiments which may shed light on the possibilities of the exhibition to a paying public of big-screen television.

QUESTIONS IN THE HOUSE

Electrical Interference : Television for the Provinces : Free Licences

REPLYING to a question in the House of Commons last week Sir Walter Womersley, Assistant Postmaster-General, said that enquiries regarding the possible scope and operation of a new Wireless Telegraphy Bill to deal, *inter alia*, with the question of electrical interference with wireless reception were being actively pursued. The problem was, however, one of great complexity involving consultation with many commercial and other interests which would be affected. He regretted that he could not give any assurance that it would be possible to introduce a Bill during the current Session.

In replying to another question the Assistant P.M.G. said that on the advice of the Television Advisory Committee, technical research is being undertaken in regard to possible methods of relaying television programmes from London to other centres, but the research work is likely to occupy considerable time, and it is feared that no decision concerning the extension of the service to other centres can be reached in the near future.

A further question dealt with by Sir Walter Womersley related to the issue of free wireless licences, which is at present restricted to blind persons under the Wireless Telegraphy (Blind Persons Facilities) Act, 1926. The question of extending the concession to other classes deserving of sympathy was considered by the Broadcasting Committee of 1935, who reported against any extension.

STUDIO ACOUSTICS

New German Measurements

THE task of ascertaining the reverberation time of a studio has until now been a lengthy procedure for engineers, but a piece of apparatus has now been designed by Telefunken with which the task can be carried out in an hour or so.

A round of blank cartridges, fitted in a disc firing mechanism, is fired at prearranged intervals; it has been found that a shot includes all audible frequencies at approximately the same amplitude.

By preselecting any one of a range of filters incorporated in the recording apparatus the reverberation period of the studio at the corresponding frequency is recorded.

It was in this way that Telefunken engineers worked out the reverberation period of the ultra-modern gramophone recording studio illustrated on the right, which has just been opened by the German H.M.V. Company, Polydor, in the old Central Theatre, Berlin. Recordings in this studio are made simultaneously on two wax discs. After each session one of these discs is played back for the artiste to hear his own work, the other record being left untouched for printing if the recording is accepted.

NEW B.B.C. CHAIRMAN

Successor to Mr. R. C. Norman

THE Prime Minister announced in the House of Commons on Monday that Sir Allan Powell had been appointed chairman of the B.B.C. Board of Governors in succession to Mr. Ronald Collet Norman, who had asked to be relieved of his post. Mr. Norman, who is sixty-six and the brother of Mr. Montagu Norman, Governor of the Bank of England, was appointed chairman in 1935 in succession to Mr. J. H. Whitley.

Sir Allan Powell, whose appointment is for five years from April 19th, is a barrister and has been Mayor of Kensington since 1937. He was created a Knight in 1927.

B.B.C. CELEBRATES A BIRTHDAY

Growth of the Recording Department During Six Years

TO mark the sixth anniversary of the inauguration of a regular service of recorded matter to the various programme departments, the B.B.C. gave on March 7th a demonstration at a Press Conference of the latest developments in the technique and applications of recorded sound.

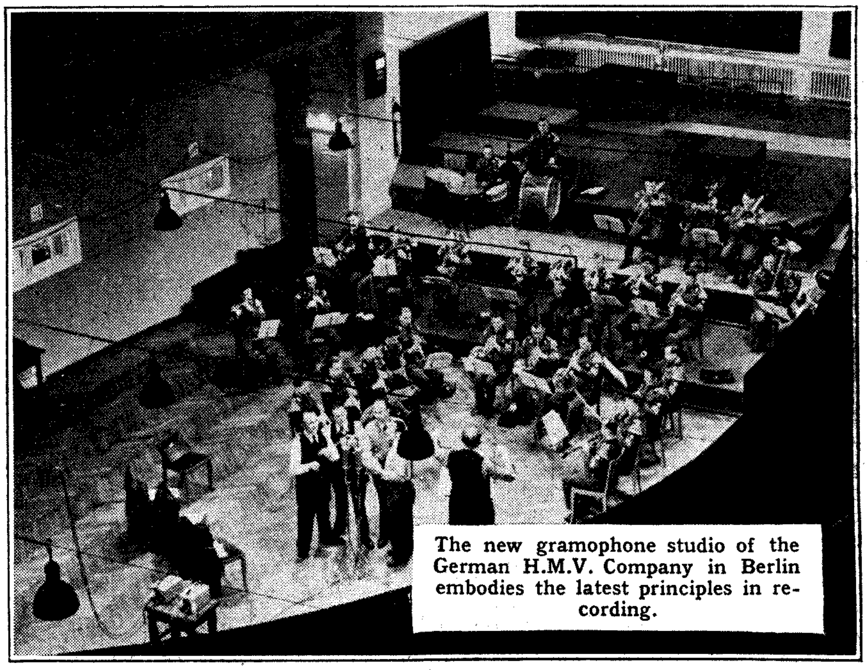
It was emphasised that records are used only as a means of providing material that would otherwise be unavailable to listeners at a given time, and it is a method which is invaluable in the Empire service.

Recording Headquarters

The recording section is housed at Maida Vale, where there are three duplicated Marconi-Stille steel-tape recording channels, a similar number of disc-recording units, and a single duplicated channel employing the Philips-Miller film recording system. This permanently installed plant is supplemented by two mobile vans each with two disc machines and a private saloon car fitted with a single recording unit.

In general the steel tape system is confined to material not of permanent interest which must be rebroadcast after a short time interval, the Philips-Miller system for certain special broadcasts, and the disc method where permanent records are required or when it is necessary to carry out editing or "dubbing" for sound illustration purposes.

During the afternoon members of the party were able to make records simultaneously on all



The new gramophone studio of the German H.M.V. Company in Berlin embodies the latest principles in recording.

News of the Week—

three systems and to hear their voices played back from each for comparison. It was evident that a vast improvement in high-frequency response in relation to background noise has recently been effected.

Exchanges of records of historical interest have been made with broadcasting authorities in other countries and a library of over 5,000 of these special records, many of which have not yet been heard by the public, has already been collected

In 1933 the individual responsible for records made on the average two a week. Now there is an administrative staff of twenty-three and recording commitments run to three hundred a week.

INTERFERENCE WITH DAVENTRY

Deliberate or Accidental?

As a result of the watch maintained at the B.B.C.'s listening station at Tatsfield, Kent, it can be said that no cases of deliberate interference with any of Daventry's transmissions have been observed. It is pointed out, however, by the Engineering Division of the B.B.C. that a certain amount of interference is almost inevitable with so many broadcasting and commercial stations working on wavelengths below 50 metres, many of which have less than the necessary 10 kc/s separation from their immediate neighbours.

A common cause of interference is the operation of transmitters on frequencies other than their correct ones. Another cause of interference, although not so common, is the radiation of strong harmonics. Serious morse interference may have been noticed recently by listeners in Oceania to GSI on 15.26 Mc/s. This was found by the Tatsfield listening station to be due to a commercial station working on its correct frequency of 7.63 Mc/s radiating a strong second harmonic on 15.26 Mc/s. The station was identified, and on the interference being pointed out to the authorities concerned the necessary transmitter alterations were effected.

PRIVATE HOUSE AS SEMI-PERMANENT STUDIO

"To get away from the studio atmosphere" the B.B.C. is wiring-up a private house in London for broadcasting purposes. The house is Howard Marshall's, and in his drawing-room well-known sportsmen will congregate as "guests" to discuss forthcoming sporting events. The first "at home" will be at 6.20 on April 12th, and National listeners will hear all that goes on. A series of six broadcasts is scheduled.

BOAT RACE INNOVATION

A Short-wave Commentary to be Given from the Air

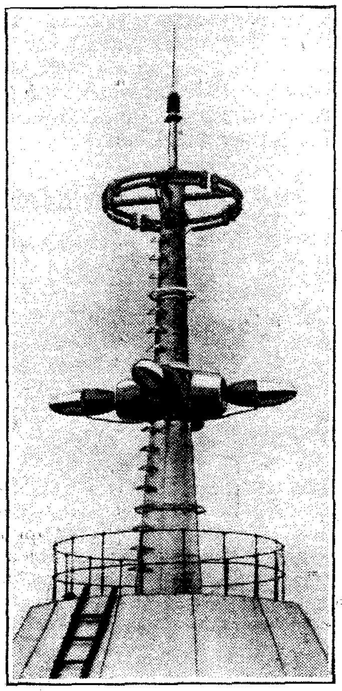
For the first time the University Boat Race on April 1st is to be the subject of a commentary from the air. As usual, John Snagge will give his vigorous description of the race as seen from a following launch, but in addition Joly de Lotbinière, Director of Outside Broadcasts, will provide a commentary from a 'plane cruising at a minimum height of 2,000 ft.

The object of this interesting experiment is to overcome the difficulty of estimating the distance between the two boats.

This year John Snagge will be on the launch *Consuta*, not the *Magician* as in previous years, and the bulk of the commentary will be his. But when the boats begin to draw apart he will put in a radio appeal to his colleague above, who will be able to form a fairly accurate estimate of the distance between the boats. Both launch and 'plane will keep in radio contact with a receiving station on the roof of Harrods' Depository.

NEW TELEVISION AERIAL

Erected on the Empire State Building, New York, is an unusual aerial system to be used by the N.B.C. for its



ELECTRICAL DE-ICING equipment is included in the N.B.C.'s television aerial in New York.

television transmissions. It has four torpedo-shaped radiators, which are the elements of two dipoles having a transmission characteristic which is flat over a band of 30 Mc/s, for the vision channel. Above them are four horizontal dipole elements arranged in the form of a loop; these radiate the sound signals.

The physical dimensions of the various elements are so important that electrical de-icing equipment has been included.

VISIT OF PRESIDENT LEBRUN

The State visit of President and Madame Lebrun to London will be covered in all its phases by the B.B.C. The visitors' reception by the King and Queen at Victoria Station will be televised at 3.15 p.m. on Tuesday, March 21st.

PLANS FOR BETTER RADIOLYMPIA

Sir Stephen Tallents, B.B.C. Controller of Public Relations, was the guest of honour and the principal speaker at the monthly luncheon of the Radio Manufacturers' Association held at the Savoy Hotel last Thursday. At this luncheon plans were revealed for making this year's Radiolympia, which will open on August 23rd, the finest and most attractive radio show ever staged in the world.

As well as being the focal point of radio interest throughout the country the show will have something to interest everybody, both technical and non-technical, and it is proposed to design the show to bring home to listeners a fuller realisation of what they are missing by continuing to use old and out-of-date receivers which cannot possibly do justice to the realism of modern broadcasting.

BROADCASTING CORPORATION OF NEWFOUNDLAND

On Monday, Mr. F. W. Ogilvie, Director-General of the B.B.C., and Sir Thomas Inskip, M.P., Secretary of State for Dominion Affairs, speaking from a London studio, took part in the inaugural ceremony of the Broadcasting Corporation of Newfoundland.

There are six broadcasting stations in Newfoundland, none of which have a power of more than 0.5 kW. These stations have been owned by various bodies, including newspapers, a church, and business houses. It is understood that the B.B.C. have been consulted by the Newfoundland Government on the economic and technical aspects of the Corporation.

The ceremony on Monday marked the end of private enterprise in broadcasting in Newfoundland when the Corporation took over all the broadcasting activities in the island. We learn, however, that there will still be a certain percentage of commercial programmes.

Up-to-date receiving apparatus will be installed to enable the Corporation to relay the Canadian and B.B.C. programmes by its new 10-kW station.

VALVE CHANGING RECORD

Two C.B.S. engineers set up a record of 1 minute 11 seconds for changing a water-cooled power amplifier valve at WABC-W2XE transmitters at Wayne.

When informed of this American feat the B.B.C. were impressed, but pointed out the variation in the sizes of such valves and the ensuing difficulties which were involved. To perform the operation with a big valve at Droitwich would take about four minutes from the time of the "bang," but the same job on a Regional transmitter could be done in something under two minutes.

FROM ALL QUARTERS

R.C.A. Television Research

In the nineteenth annual report to the shareholders of the Radio Corporation of America it was stated that means must be developed for the interconnection of television stations either by radio or cable. The possibility of relaying television by wireless was said to hold interesting promise, as shown by experiments conducted in the R.C.A. laboratories during 1938.

South Africa's Short Waves

The South African Broadcasting Corporation's two 5-kW short-wave stations now use a different call sign for each of the four wavelengths employed. The station at Roberts Heights, near Pretoria, uses ZRG (31.5 metres and ZRH (49.94 metres), and that at Klipheuval, near Cape Town, uses ZRL (31.23 metres) and ZRK (49.2 metres).

H.M.V. Form C.W.R. Unit

Under the leadership of Mr. W. S. Purser, manager of the H.M.V. recording studios at Abbey Wood and one of the earliest workers in the field of radio communication, members of the staff of E.M.I. can join the Civilian Wireless Reserve (R.A.F.) and take a training course as one unit.

Baird Television

The adjourned ninth ordinary General Meeting of Baird Television will be held on Friday, March 31st, in the Caxton Hall, Westminster, London, S.W.1. Later on the same day will be held the General Meetings of the holders of Preferred and Deferred Ordinary Shares and an extraordinary General Meeting.

The C.B.C. in London

The Canadian Broadcasting Corporation has appointed Mr. Graham Spry as its London representative.

R.C.A. Income

Preliminary figures of the Radio Corporation of America's net income for 1938 show that this has dropped from the previous year's figure of $9,024,858 to $7,412,072.

High-Voltage Smoothing

AN ALTERNATIVE TO THE CHOKE-CAPACITY FILTER

IF the voltage of an HT supply is so high that the price and size of the smoothing condensers exceed those of a triode, it may be preferable to economise in condenser capacity by using a valve bridge circuit. The principle of the circuit is to insert the cathode-anode path of a grid-controlled vacuum valve in series with the load, and to feed to the grid of this valve ripple voltage of opposite phase to that on its plate, and in the inverse amplitude ratio to the magnification factor of the valve. The effective control voltage of the valve is then neutralised for the ripple and its plate current becomes pure direct current.

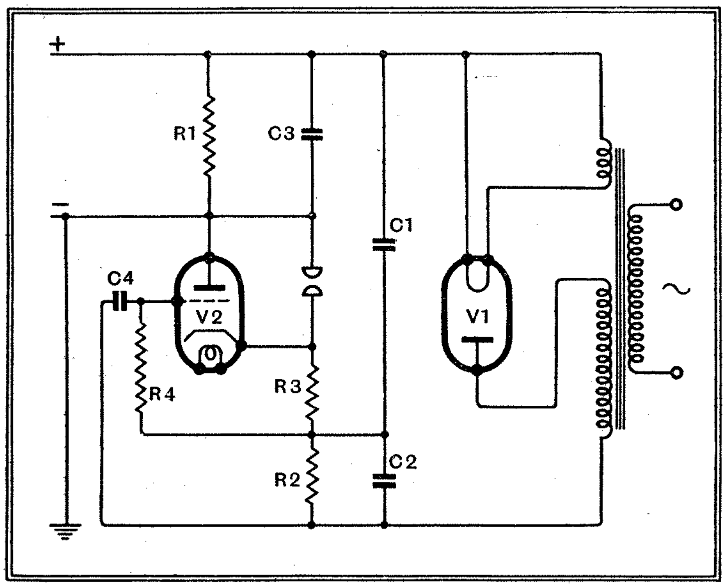
This principle is exemplified in the accompanying circuit diagram. The mains transformer together with the rectifier V1 produces an unsmoothed voltage of several thousand volts on the charging condenser C1, which may be of unusually small capacity. Parallel to this condenser is the load potentiometer R1 in series with which is the smoothing valve V2. In series with the charging condenser C1 is a parallel circuit consisting of the condenser C2 and the resistance R2, on which the unsmoothed current produces a voltage drop. The AC component of this voltage drop is fed via the grid condenser C4 and the grid leak resistance R4 to the grid of the smoothing valve V2. The plate current of the smoothing valve, being by assumption pure DC, produces a small constant grid bias voltage on the cathode dropper resistance R3. The rectified DC then passes through the circuit from the transformer via the resistances R2 and R3, the cathode-anode path of the smoothing valve, the load R1 and the rectifier V1.

The condensers C2 and C1 are chosen in the capacity ratio equal to the amplification factor of the valve V2, C2 being the much larger capacity but designed for a DC voltage smaller by about the same proportion. The cathode point of the valve V2 is at the AC potential of the junction between the condensers C1 and C2; plate and grid are fed from the outer ends of this capacitive voltage divider in opposite phase and in proportion to the amplification factor. The plate current of the valve V2 is then free from all frequencies which suffer no attenuation or phase distortion in the grid condenser C4 and leak R4, the time constant of which, therefore, must be large compared with the lowest ripple frequency. The resistance R2 is needed not only to pass the DC component of the current but also to correct the phase conditions of the bridge, which are upset by the plate leakage impedance of the smoothing valve V2. The capacity C3 parallel to the load is hardly needed for smoothing, but, if added from other reasons, greatly reduces the residual traces of ripple.

If the valve V2 heats up slowly compared with the rectifier V1, it has to stand the full voltage so long as it is not conducting. A breakdown due to this voltage has to be prevented; a small spark gap parallel to the cathode-plate path of the valve V2 has proved a simple and adequate protection.

The circuit was tested in a power supply for 5,000 volts, 1 mA, using a Marconi or Osram Type MH41 as the smoothing valve V2. The ripple—observed on a cathode ray oscillograph—was ±6-volt peak for 5,000 v. DC, i.e., three times better than in the usual arrangement with two smoothing condensers of 0.2 mfd. each in cascade, separated by a series resistance of 0.2 megohm.

A better bridge minimum was not found, but the setting seemed to be stable and by no means critical.



Ripple neutralisation by means of a smoothing valve. Values of components used were: C1, 0.01 mfd. ± 5%; C2, 0.8 mfd. ± 5%; C3, omitted (see text); C4, 0.25 mfd. ± 20%; R1, 5 megohms ± 20%; R2, 0.2 megohm ± 5%; R3, 3,000 ohms ± 20%; R4, 5 megohms ± 20%.

The Wireless Industry

THE business of the Portable Electric Light Co., Ltd., of Shaftesbury Avenue, London, W.1, has been transferred to The Ever Ready Co. (Great Britain), Ltd., Hercules Place, Holloway, London, N.7.

◇ ◇ ◇

Eleven firms are now members of the National Radio Trade Service Association, which has for its object the pooling of technical resources and various other arrangements to promote increased efficiency. Firms coming within the definition implied in the association's title are invited to ask for particulars from the Hon. Sec., c/o Specialised Radio Service Co., Ltd., Tanners Lane, High Street, Lincoln.

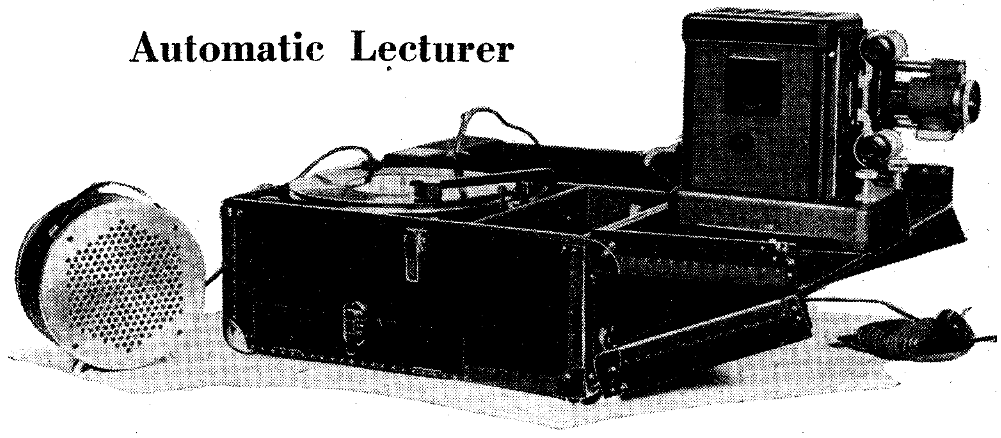
◇ ◇ ◇

Claude Lyons, Ltd., 180/182a, Tottenham Court Road, London, W.1, have just issued a comprehensive catalogue (No. 10) of "Hickok" radio service equipment. The range includes signal generators, oscillographs, valve testers and universal meters, and prices are quoted in sterling. All essential electrical characteristics are given for each instrument.

◇ ◇ ◇

A complete technical specification of the Model 3339 double-beam CR oscillograph, including amplifier and tube characteristics, is given in a leaflet just issued by A. C. Cossor, Ltd., Highbury Grove, London, N.5.

Automatic Lecturer



Portable equipment is being demonstrated by the Telefunken Company which enables talks previously recorded on slow-motion 15-minute discs to be amplified and, where necessary, illustrated by means of short films or lantern slides from a projector incorporated in the unit. The necessary breaks in the recording to permit the showing of particular slides can be timed during the recording. It is claimed that a satisfactory "lecture tour" can be carried out by anyone able to operate the gear.

The Modern Receiver Stage by Stage

Part III.—RADIO-FREQUENCY AMPLIFICATION

Following on the discussion of the aerial tuning system, the RF amplifier is dealt with in this article. The problems associated with the intervalve coupling are treated, and also the advantages to be gained through the use of an RF stage.

SUPERHETERODYNES often have the frequency-changer for the first valve and the output of the aerial tuning system described last week is then applied straight to its grid. The disadvantages of this arrangement are that valve hiss is likely to be more troublesome, and that superheterodyne whistles are not improbable. This is because there is only one circuit tuned to the wanted signal, and the amount of selectivity before the frequency-changer is too low.

Experience shows that, while good results can often be secured with only one circuit, the use of two is highly desirable. It is not, however, essential to use an RF amplifier with two tuned circuits; they can be coupled together and used without a valve. This arrangement is shown in Fig. 5, which should be compared with the single circuit of Fig. 4.

There are a primary tuned circuit L1 C1 and a secondary circuit L2 C2 coupled together by the condenser C3, which is common to both. The aerial is coupled to the primary coil L1 by L3.

Compared with the single circuit of Fig. 4, this arrangement gives much better selectivity and a broader response close to resonance, which is desirable. The efficiency, however, cannot exceed 50 per cent. of that of the single circuit. This means not only a reduction in the sensitivity, but, more important, a poorer signal-noise ratio.

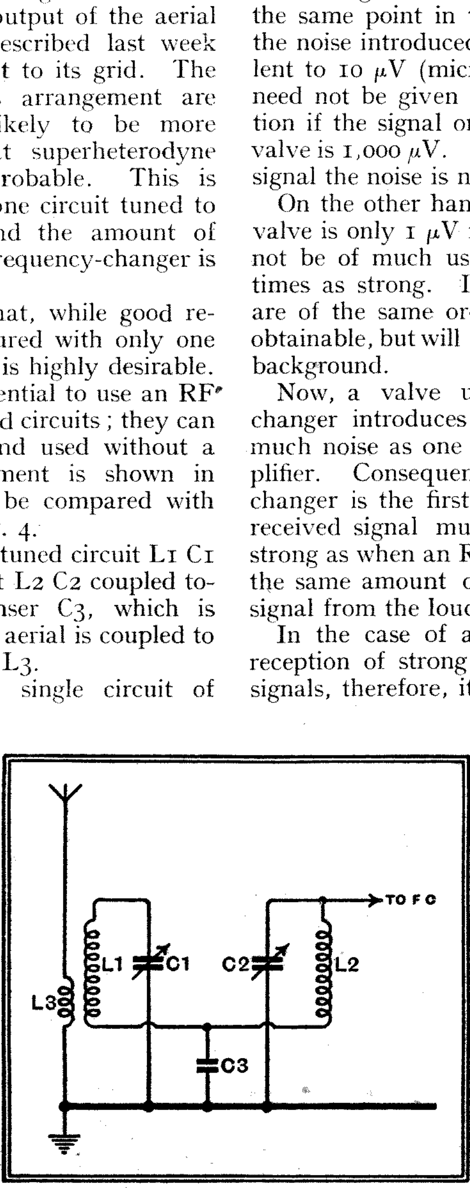


Fig. 5.—This diagram shows a pair of tuned circuits coupled by the common capacity C3.

This question of valve and circuit noise is highly important, for it often determines the general arrangement of the early part of a receiver. Every valve introduces a certain amount of noise which in the final result is evident as a background hiss. The amount of noise depends on the type of valve, its construction, and how it is used.

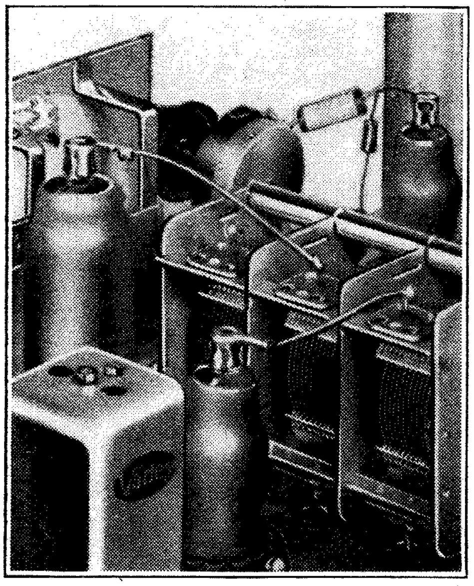
It is not so much the amount of noise introduced that is of importance, however, as its magnitude relative to the signal at the same point in the receiver. Thus, if the noise introduced by a valve is equivalent to 10 μV (micro-volts) on its grid, it need not be given a moment's consideration if the signal on the grid of the same valve is 1,000 μV. In comparison with the signal the noise is negligible.

On the other hand, if the signal on this valve is only 1 μV it is clear that it would not be of much use, for the noise is ten times as strong. If the noise and signal are of the same order, the signal will be obtainable, but will have a very unpleasant background.

Now, a valve used as a frequency-changer introduces about three times as much noise as one functioning as an amplifier. Consequently, if the frequency-changer is the first valve in the set, the received signal must be three times as strong as when an RF amplifier is used for the same amount of background to the signal from the loud speaker.

In the case of a set intended for the reception of strong or moderately strong signals, therefore, it will be permissible to omit the RF amplifier and to start with the frequency-changer. But it will not be permissible to omit it when weak signals must be received. It should be noted that the term weak and strong signals is here used to indicate not the field strength but the voltage received.

If the aerial is poor enough, the local station can be a weak signal, and if it is first class a Continental station may be strong. The writer has had good reception of foreign stations with negligible background and without RF amplification, but the aerial was good. He has also heard intolerable background hiss on the local station with the same set, but then the aerial was notable only for its inefficiency.



If it can be afforded, the RF stage is advisable, since it not only increases the amplification and improves the signal-noise ratio, but it makes the use of a poorer aerial permissible in cases where extreme range is not required. This is often a decided convenience.

It is not only valves that introduce noise, however; the circuits themselves do so. Again, it is only the circuits preceding the first valve which are normally important. The signal-noise ratio improves as the dynamic resistance ($=\omega LQ$) of the first circuit is raised, which means in practice that it improves with Q.

The relative importance of valve and circuit noise depends very largely upon the dynamic resistance obtainable in the tuned circuit. The higher the resistance the better, for it corresponds to low-series resistance and high Q. Efficiency, selectivity and signal-noise ratio are all improved by a high dynamic resistance.

The Intervalve Coupling

On the medium and long wavebands it is not difficult to make the dynamic resistance high enough for circuit noise to predominate over the noise introduced by an RF valve. On short waves, however, this can rarely be done, and valve noise is the limiting factor. It is necessary, therefore, to choose a valve which introduces a minimum of noise.

Other things being equal, a valve with a low-screen current is likely to introduce less noise than one taking a high current. For the Three-Band AC Super, therefore, the low-noise hexode EF8 was chosen for the RF stage; the valve has the exceedingly low screen current of 0.25 mA.

For the coupling between the RF stage and the frequency-changer there are quite

The Modern Receiver Stage by Stage—
a number of possible alternatives. A tuned circuit will naturally always be involved because of the selectivity which it gives and of the impossibility of otherwise securing the necessary amplification, except perhaps on the long waveband.

The three main alternatives are tuned-anode, tuned-grid and tuned-transformer, and these are shown in Fig. 6. Tuned-anode (*a*) and tuned-grid are very similar and have about the same RF characteristics. With the former the resistance R1 is in shunt with the tuned circuit, and damps it somewhat, while in the latter the losses in the RF choke act similarly.

Tuned-grid is more expensive than tuned-anode, because a choke costs more than a resistance, but it is less susceptible to feed-back at audio-frequency. In the case of Fig. 6 (a) audio-frequency potentials on the HT supply can be transferred to the grid of the following valve through C2 at appreciable intensity. With tuned-grid, however, this is not so.

It should be remarked that the AVC connections may necessitate a modification to this statement, but with the circuit as shown it is true. The possibility of such feed-back proving troublesome is not very great in practice, but it is advisable to guard against it where possible.

The stage gain is equal to the product of mutual conductance and dynamic resistance, the latter including all sources of loss such as the AC resistance of the RF valve, the input resistance of the frequency-changer, and so on. In practice it may easily be 50-200 times on the medium and long wavebands. On short waves it is likely to be much lower because of the much heavier losses.

Transformer coupling, Fig. 6 (c), can give very similar results, but primary and secondary are completely isolated at audio-frequency. There is also much more scope for varying the characteristics of the stage. The performance does not now depend only on the valve and the tuned circuit but also on the primary inductance L1 and its coupling to the secondary.

If the primary winding is smaller than the secondary and very tightly coupled to it, the general performance is the same as with tuned anode or tuned grid, but the gain is lower by a factor which depends on the relation of primary and secondary. If the coupling were 100 per cent. the gain would be below that of tuned anode by the ratio of primary to secondary turns. Thus, with a 1 : 2 ratio transformer the gain would be half that with tuned anode.

As the coupling is never 100 per cent. the gain is always a little lower than this, but the same general characteristics remain. Now, the general tendency is for the dynamic resistance to fall as the resonant frequency of the tuned circuit is lowered by increasing C. This, in turn, makes the stage gain fall off.

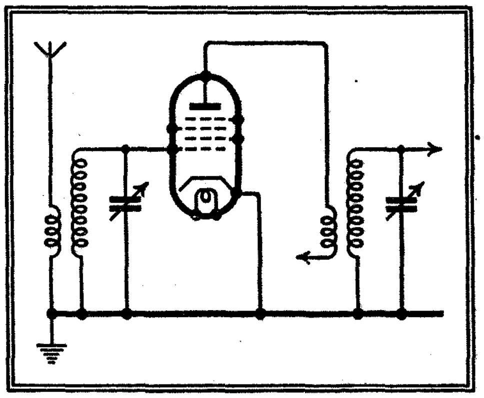


Fig. 7.—The basic circuit of the RF amplifier showing the aerial and intervalve circuits.

By using a larger primary winding more loosely coupled, the action becomes rather different. It is, in fact, possible to make the amplification higher at the low-frequency end of the tuning range than at the high. This is done by using a primary winding of such a large inductance that it resonates with the stray capacities at a frequency lower than any within the tuning range. On the medium waveband a suitable resonance frequency is of the order of 450 kc/s.

By winding the primary at the grid end of the tuned winding a certain amount of capacity coupling is introduced and the stage gain can be kept very nearly constant over the waveband. This is, of course, desirable, but it is unwise to adopt it for the RF stage of a superheterodyne.

If all the primaries are tuned in the neighbourhood of 450 kc/s, signals on this frequency can pass through the amplifier fairly easily in spite of the secondaries being mistuned. In the usual superheterodyne the intermediate frequency is about 450 kc/s and, consequently, such signals pass straight through the receiver and are liable to cause serious interference.

When an RF stage is used the high-inductance primary is very desirable for the aerial coupling system because it permits much better ganging to be secured than the old small primary. For the intervalve circuit, however, it is wise to use a small primary in order to reduce the possibility of interference from signals on the intermediate frequency.

In order to maintain some approximation to even amplification over the waveband, the primaries are wound at the earthy ends of the tuned coils. The aerial circuit is then most efficient at the low-frequency end of the band and the intervalve circuit at the high-frequency end. The greatest overall efficiency is then likely to be secured at the centre of the band and it falls off somewhat at each end.

On the long waveband there is no objection to large primaries for both circuits, and it is the use of small primaries in both circuits that may cause trouble. This is because the intermediate frequency is now higher than the signal frequency, and small primaries are likely to resonate near the intermediate frequency.

For ganging purposes a large primary is advisable in the case of the aerial circuit, but the intervalve circuit can have a large or small primary, as desired. As already indicated, the design of the coils will be different in the two cases but the performance will be very similar.

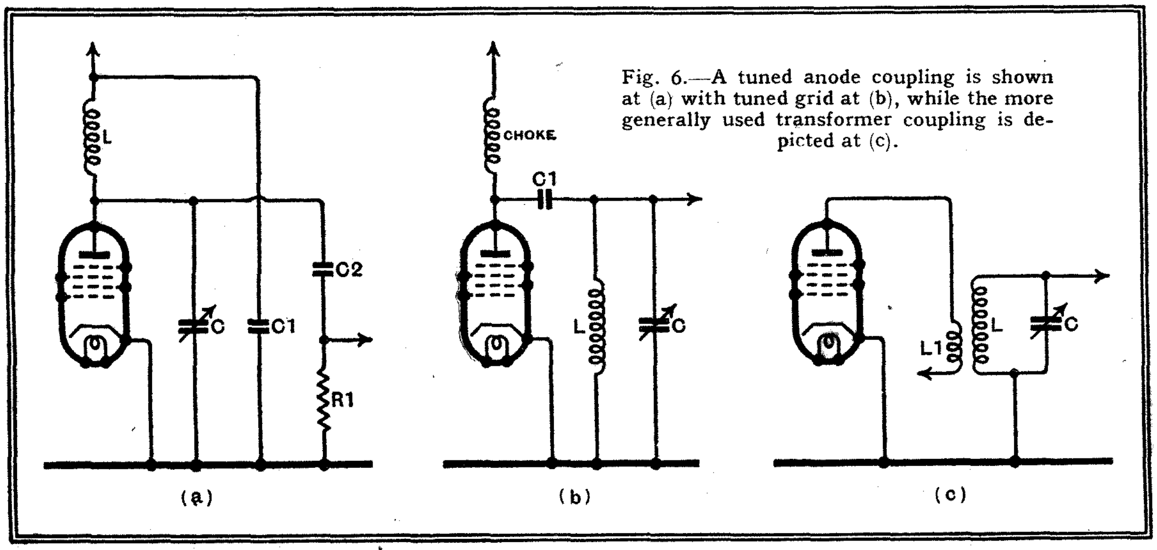


Fig. 6.—A tuned anode coupling is shown at (a) with tuned grid at (b), while the more generally used transformer coupling is depicted at (c).

The use of a small primary for the intervalve transformer is often advantageous, however, because the transformer characteristics are then rather less critical. With a large primary at the grid end of the secondary a small change in the spacing of the coils may have quite a large effect because it varies not only the mutual inductance but also the capacity coupling. With a small primary at the earthy end of the secondary the capacity coupling is very small indeed.

The primary is usually made fairly small on the medium and long wavebands. The turns used will generally be less than those on the secondary, but will depend on the degree of coupling. No attempt is made to secure maximum amplification and the gain obtained is usually well below that easily possible.

This is done because it is easy to make

The Modern Receiver Stage by Stage—
the gain of even one RF stage too high. On the medium and long wavebands there are many powerful stations which give quite a large signal on the first valve. With high RF gain the frequency-changer input then becomes too great and harmonics are produced which lead to "superheterodyne whistles."

Unless a manual RF gain control or a special AVC system is used it is much better to design the receiver for a moderate degree of RF amplification only. A gain of 10-30 times will normally be found sufficient.

On short waves conditions are different. It is there desirable that the gain should be as high as possible. Unfortunately it is much more difficult to secure high gain. A small primary for the intervalve transformer is almost invariably used. The tuned secondary is a single-layer coil with spaced turns and the primary is generally wound in the spaces between the secondary turns to obtain the tightest possible coupling. The primary turns are usually a few less than the secondary. This is done to ensure that the resonance frequency of the primary with the stray circuit capacities is higher than the highest frequency to which the secondary will tune.

The basic circuit of the RF amplifier thus takes the form shown in Fig. 7, where all the anode and grid DC supplies are omitted for simplicity. In the next article we shall consider the frequency-changer and we shall then be in a position to deal with some of the details of the tuning equipment.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

"What is a Valve?"

I THOROUGHLY agree with "Diallist's" remarks on the above subject in a recent issue of *The Wireless World*.

My own opinion is that the number of valves which amplify or rectify the signal between aerial and speaker should be known. This opinion was evidently that of the folks who, in the days when the pentode was the most complex valve, defined circuits by 2+1, 3+1, 4+1, etc., the first figure denoting actual receiving valves and the second the mains rectifier.

It is certainly an advantage for the number of "auxiliary" valves to be stated as well as the number of "receiving" valves. I think a solution of the present problem would be to denote a circuit of, say, FC, IF, DDT, tetrode output, mains rectifier and cathode-ray tuning indicator, by 4+2.

The first figure being the number of valves which directly contribute to signal strength, including valves in push-pull. The second would include mains rectifiers, tuning indicators of cathode-ray type, phase changers, diodes and amplifiers for AVC, AFC, ASC, etc.

Thus, a well-known console might conveniently be known as a 7+5 receiver instead of merely a 12-valve receiver.

If necessary, the number of stages could be stated. A stage to be any *amplifying* cathode-anode stream in the *receiving* chain.

P. BINNS, F.R.E.A.

Halifax, Yorks.

Short-wave Snobbery

RECENTLY listeners have been treated to another of Nature's firework displays—to wit, the "Northern Lights." Now, it is only too well known that the Aurora Borealis, besides providing people with a charming and free entertainment, also has the effect of interfering seriously with reception on the short waves. Even if one did not know this fact from one's own personal experience, one would gather as much from the inevitable note in the following morning's newspapers. There is, it seems, a certain amount of snobbery about short-wave listening. What I am getting at is that one seldom or never hears anything of the effect of sun-spots and the like on reception of *medium* waves, yet this band also is often badly affected at such times.

The medium-wave band concerns the average listener far more than do the short and ultra-short bands, so, as I have already said, it would appear that the only explanation of the conspiracy of silence on the subject of the effect on medium-wave reception of the "Northern Lights" and other electrical manifestations is that snobbery is afoot. It is the same with television. Now that it is becoming gradually more popular, we ordinary listeners to sound broadcasting may hope to witness the bringing into existence of legislation rendering all interference with reception illegal, and that before we lay our heads on our pillows for the last time. You see, television is "important" and must not be subject to the vagaries of man-made static, whereas sound broadcasting (or "blind listening," as some snob or other has described it) never has been considered important by our legislators—except, of course, at general elections!

T. J. EGERTON WARBURTON.

St. Leonards-on-Sea.

Short-wave Oscillator Problems

IN an article in *The Wireless World* of February 9th, 1939, entitled "Short-wave Oscillator Problems," Mr. Cocking gives several useful remedies for eliminating the trouble of parasitic oscillations, in particular those giving the appearance of numerous pseudo stations, a phenomenon which occurs mainly on the short-wave bands.

He admits that whereas he is aware that a contributory cause lies in the excessive heterodyne voltage, the explanation of the phenomenon is obscure and suggests that it may be in some way connected with a negative resistance portion of the hexode section viewed from the injector grid.

I would venture to suggest that the explanation of this trouble lies in an entirely different phenomenon which, though it gives rise to oscillations in an associated circuit as if due to negative resistance effects, is not really due to a negative resistance, *per se*, of any portion of the valve, and it is somewhat misleading to refer to it as such. It is due to a form of inverse space-charge coupling which appears to produce shock excitation of the input circuit.

Consideration of the paths of the primary electrons at voltage conditions such as prevail when the injector grid is very negative (equal to anode current cut-off value, or nearly so) show that besides the intended virtual cathode or second space-charge between grids 2 and 3, a spurious space-charge exists in between grids 1 and 2. Now if an excessive heterodyne voltage is applied to the injector grid from the triode which makes it very negative, the above-mentioned spurious space-charge occurs in the proximity of the signal grid on the negative peaks of the oscillator voltage. By the well-known influence effect, these periodically occurring space-charges transfer impulses on to the signal grid.

On short waves, where the difference between the resonance frequency of the signal grid circuit to the oscillator frequency is small, the shock excitation by these impulses of the signal grid circuit is an easy matter.

In my opinion, this inverse space-charge coupling produces the pseudo station signals referred to by Mr. W. T. Cocking. It is also more than likely that this same phenomenon is the cause of the discontinuity in amplification in a hexode referred to by Mr. H. Owen Walker, B.Sc., in *The Wireless Engineer* of August, 1937.

By restricting the heterodyne voltage to that recommended by the valve maker and taking all the necessary steps to avoid stray coupling, so ably described by Mr. Cocking, one can use modern mixer valves without even suspecting the possibility of the above spurious phenomenon.

London, W.C.1. J. A. SARGROVE.

Wireless and A.R.P.

I HAVE studied with interest your editorial article in the February 23rd issue and also the letter from your correspondent, Mr. C. R. Pinder.

The suggestions contained in each are that the B.B.C. should radiate a special warning note in time of emergency, to be received on ordinary broadcast receivers; in effect, a long-range "siren alarm." I agree with you that the public will be willing in time of crisis to keep their receivers in operation to learn any information available. I agree with Mr. Pinder that telephonic or personal communication is impracticable, and also that the sirens are not always efficient, even in built-up areas. The problem of covering effectively rural or semi-populated districts by siren warnings seems far from solution.

I cannot agree that the suggestion that the B.B.C. should radiate some kind of warning note is practicable. If we consider the area covered by any one broadcasting station, the fallacy of this method is at once apparent. Either a prearranged note is radiated as a warning or definite information is given as to danger in any particular locality. If the first method is adopted any danger anywhere within, say, the London Regional area, would mean that everyone in this area should take cover. If hostile aircraft were seen over Greenwich, residents of Greenford would take cover! It may be argued that the time taken for the aircraft to proceed from Greenwich to Greenford is a matter of minutes, and therefore the whole of London's millions should be warned in these circumstances. I suggest that if this plan were followed, the entire population might be demoralised within a few weeks by any enemy sending over one or two aircraft hourly each night and day with a constant state of alarm existing and hourly rushes to the air-raid shelters taking place.

The second possibility is that the B.B.C. could disseminate special information to individual areas. Even if this did not lead to chaos it is entirely dependent upon each area being able to communicate its requirements to the B.B.C. To be effective the information must be re-radiated within a very short period. And, of course, probably the telephone would again have to be used.

There may be advantages or disadvantages of this scheme which I have overlooked. The use of any broadcasting station in a time of air raid would undoubtedly provide an excellent means for enemy aircraft, equipped with DF apparatus, to be sure of their position.

May I suggest an alternative scheme for consideration? A number of vehicles should be equipped with low-power radio-telephone transmitters, radiating on some chosen frequency in the broadcast band. These would have a strictly limited range, so as to deal with their own area without undue interference over greater ranges. A limited frequency response, say, up to 2,500 c.p.s., would be adequate for intelligible speech, and would allow for several units to be operated within close distances of each other without the need for too wide a frequency allocation for this service. The equipments being mobile no direction-finding apparatus could be of any value to an enemy. The vehicle could be located where most suited for access to other means of communication and information. Most important of all, actual instructions, as they apply to each individual area, could be radiated.

D. T. BENNETT.
London, W.1. Film Industries, Ltd.

Stand-by Crystal Sets

IS it possible to procure a good crystal set these days?

I imagine that the majority of modern sets to-day derive power from the mains, and are therefore dependent on this source of outside supply. This might easily fail through air attack in time of war and millions of wireless sets suddenly become useless. The value of broadcasting was amply illustrated in the crisis last September, and I was informed by one well-known manufacturer that there was quite a "rush" on battery driven sets by many who visualised their mains sets being put out of commission. But even with this reserve it might be difficult to replenish batteries or valves in a real emergency.

Here, then, I suggest is an opportunity for some manufacturer to market a really good crystal set to act as a "stand-by" if the need arose, not forgetting also the demand there would likewise be for earphones. A ready customer would certainly be,

C. BERNARD HENNING.
Seaford.

Poor PA Systems

THE purpose of this letter is to register a vigorous protest against the ever-growing menace in theatres, cinemas and halls of the microphone(s)-amplifier-loud speaker(s) combination, generally referred to as a Public Address system.

Once again this is an instance where a legitimate use of a technical development has been turned into an abuse. For such conditions as speaking to large crowds of people in the open air or in auditoria with unsatisfactory acoustics, the assistance of a high-grade PA system is permissible, but to-day almost every theatre, music-hall and cinema (giving stage items) employs some sort of PA equipment. The description "some sort" is used advisedly, for the bad quality of the average system, coupled with its incompetent operation, comprises my chief complaint against this practice.

In the course of my work I have visited many cinemas and theatres in and around London, and such faults as (1) continuous overloading, (2) operation of the system in an incipient "howl-back" condition throughout the performance, and (3) a persistent high-level hum from the speakers, are commonly present. The significant point is that the public in general seem to have become so "conditioned" to PA, whether good or bad, that they expect it in every act, with the result that third-rate comedians (usually billed as "from the B.B.C.," after one broadcast on an Empire programme!) and singers without properly trained voices (sometimes called "crooners"), project their voices through a microphone. In the provinces, I understand, several "straight" theatres have recently been fitted with PA systems, which will undoubtedly result in the performers paying less attention to their diction and delivery of their lines by relying on the microphones to get their speeches over to the audience.

I shall refrain from mentioning all the other applications of PA apparatus, e.g., on railway stations, in churches, police cars, which assail our ears nowadays, but they might with advantage be borne in mind. For the ultimate conclusion of this spreading practice will be that the natural unamplified human voice will become a rarity.

The Wireless World must be read by many of the persons responsible for the design, sale, installation and operation of PA systems, and I, for one, hope that they will heed this warning and ensure that their systems conform to a high standard (one of the main requirements being that the system should be non-obtrusive) and be correctly operated and regularly serviced. If the systems fall short of this standard, the remedy lies in the hands of the public. Complain personally to the theatre managers and/or write letters to the local papers.

DONALD W. ALDOUS.
Ilford, Essex.

IMPERIAL AIRWAYS' WIRELESS

Stand-by Equipment on the Long-distance Flying Boats

A VERY interesting piece of wireless apparatus, now being tested for use as an auxiliary on board the Imperial Airways flying boats which are to operate the North Atlantic mail service this summer, is a lightweight portable transmitter-receiver. This is the Hermes Trans-receiver designed by Transreceivers, Ltd., in conjunction with Squadron-Leader E. F. Turner, the radio superintendent of Imperial Airways. It comprises a transmitter, receiver and rotary converter, all three units being housed in one container measuring 22in. × 12in. × 9in. and weighing 43 lb.

Lightweight stand-by equipment for Imperial Airways flying boats.

This apparatus has a waverange of from 5 to 1,000 metres and is crystal controlled on any required frequency. It can be used for CW, MCW or telephony, and feeds some 15 to 20 watts to the aerial. Optional AVC is included in the superhet receiver, and there is a BFO for CW reception. Either loud speaker or low-resistance headphones can be used.

Long-range Tests

With regard to range, tests have already been carried out on a flying boat on one of the Empire routes, and communication on short waves was maintained with London up to a distance of 3,300 miles. On wavelengths between 600 and 1,000 metres a telephony and MCW range of from 150-300 is expected, considerably greater distances up to 500 miles being anticipated in the case of CW. An additional feature of the apparatus is that it can be connected to the PA system of the aircraft so that broadcast programmes or announcements by the pilot can be "piped" to the passengers.

Standardisation has now been effected in the case of the "fixed" wireless installation on the Empire and Atlantic flying boats, apparatus for two-way communication on short and medium waves and for DF and "homing" work being fitted by the Marconi Co. In the case of the Atlantic route, two-way communication will be possible at all times from stations on both sides of the ocean, and DF bearings will be available throughout each flight.

Random Radiations

By "DIALLIST"

Writ Sarcastic ?

"ONE gathers," writes a Stratford-on-Avon reader, "that 'Diallist' finds fault with the lay journalist's definition of the term volt." (He has in mind a recent paragraph of mine in which I quoted a mention of an accident caused by "a current of 7,000 volts, sufficient to light a whole village.") "Accordingly, I enclose for his edification a cutting from *The Listener*, written under what appears to be high authority and published, presumably, with the blessing of the B.B.C. itself. Perhaps in connection with modern atomic physics we are intended to regard a 'volt of energy' in much the same light as an 'abstract shape' in modern art." The cutting that he encloses is from an article on splitting the uranium atom, by Mr. P. I. Dee, of the Cavendish Laboratory. In the course of his article Mr. Dee speaks of the emission of helium atoms by an atom of uranium. "In this successive ejection of small fragments," he writes, "about one hundred million volts of energy are liberated." But surely the use of the term volt in this connection is quite usual? Doesn't it stand for the energy a particle would acquire in passing through this difference of potential?

Will They Learn ?

WILL the wireless industry, I wonder, take to heart the lessons that are to be learnt from the recent statement by Philco? That company, whose prospects in the world of radio once seemed so bright, has unfortunately piled up a gigantic loss in the last few years' working. One point very strongly made in the statement is that, whereas the replacement market for radio sets should be well over 2,000,000 annually, the company's trading figures go to show that last year it probably didn't exceed 1,500,000. With the best part of 9,000,000 receiving licences current, there must be at least ten-and-a-half million receiving sets in the country; many people have two or more fixed receivers in their homes, whilst others have portables in addition to their fixed sets. If Philco's estimate is correct, that means that wireless sets are now being made to last about seven years.

A Nine-Year-Old

Things aren't quite so bad as that, I think; but there's no doubt that in hundreds of thousands of homes cranky old sets are being kept in service—and the chief reason is that it's not being brought home to the people that own them that they're missing something. Only a couple of nights before this note was written I went in to see a man who had recently moved to my part of the world. "Like to hear the news?" he said, just before nine o'clock. I said that I would and he went into the next room to switch on. I didn't see the set which lived there; all that I saw and heard was a funny old balanced-armature extension loud speaker. Weird, woolly speech came from this with a quite strong musical accompaniment from Turin; with an effort one could follow the words of the announcer, but that was about all. My new neighbour explained that the set was nine years old, but that it was still jolly good.

Action Needed

Now, though he's not one of those who must pinch and scrape, he had thought it worth while not only to bring that prehistoric set with him when he moved, but also to go to the trouble of wiring up its comic extension loud speaker. I made no comments, of course; but I gathered from what he let fall on the subject that he knew absolutely nothing about the advances made in the better wireless sets in the last seven or eight years. Don't you think that he's just typical of a very large percentage of the public? If the wireless industry is to prosper it must wake up and tell the public what it is doing. I have been told that it does so by means of advertisements: most of the advertisements that I see seem chiefly intent upon driving home the amazing cheapness of the sets with which they are concerned. I am told, too, that it is the business of the wireless dealer to keep the public up to date as regards improvements. He can do so only to a very limited extent. And, rightly or wrongly, the public can't rid itself of the idea that he has an axe to grind.

Where Are We ?

The position now is a curious one. Though enormous improvements have been made in the technique of reception, the medium-priced receiver remains year after year very much what it was in performance and even in appearance. The man-in-the-street is offered almost the same old works in a box not very much different from last year's or that of the year before. The price goes down a bit, and that's pretty well the only "improvement" that he hears of. In 1937 we had, in many instances, much the same old valve combinations, with a short-wave range added; the man-in-the-street was told that the world was now his. Last year medium-priced receivers showed little advance in performance, but he was given buttons to push. This year one can fairly safely prophesy that, whatever gadgets are added, such receivers will not put their predecessors in the shade as regards the number of stations that they can bring in, or the quality of their reproduction.

Let Them Know

And so, so far as one can see, there'll be no particular reason in years to come why sets of this class should ever be replaced until they blow up or fall to pieces. If only makers could abandon these silly price wars and rid themselves of the idea that they must bring out cheaper and cheaper sets each year, everyone would be a great deal better off. Cheap and moderately priced sets there must be, for there are huge numbers of people to whom nothing else could appeal. What must be done is to get rid of the idea that you can buy as good a set as anyone could possibly want for something under ten pounds. There should also be a real movement to bring home to the public that good quality of reproduction is to be had and that there are such things as sets on whose tuning dials the 19-metre and 25-metre wavebands occupy rather more than half an inch apiece. Short-wave reception is full of interest—but not with a noisy, creeping receiver of poor sensitivity and with coarse tuning.

The Valve Speaks

THE machine which can be made to utter words, and even sentences, when various combinations of its operating keys are pressed, is a remarkable achievement. It was evolved in the Bell Telephone laboratories, where so much valuable work in research into acoustic problems has been done. The keys control oscillating circuits and by combinations of the output of these, wonderful imitations not only of human speech but also of animal sounds can be produced. At a recent demonstration in Philadelphia the audience suggested a variety of difficult words in several languages, and most of these were successfully tackled. I wonder if there are rather extraordinary possibilities about that contrivance? Don't you think that it might conceivably be developed to provide the dumb with a means of speaking? The valve has already enabled the deaf to hear; how splendid it would be if it could round off its work by giving speech to the dumb.

Cinemas and Television

THE suggested partnership between the cinemas and television seems to be rather hanging fire at the moment and, no doubt, many people are much relieved that this should be so. Mr. Ostrer has hinted that he is ready to subsidise not only OBs, but also studio items which would be so costly that the B.B.C. could hardly give them a thought in the ordinary way. He has also made a noise rather like £5,000,000 when talking about the aid that the cinemas might give to the B.B.C. in extending the television service to centres outside London. To these overtures the B.B.C. has responded on we-are-not-amused lines. I don't think that that's the end of the matter. Proffered showers of gold are not lightly to be refused in these times. But I do believe that there's a pretty strong feeling in the country against any sort of direct advertising in our programmes, whether they be televised or of the "sound" order. Much is likely to depend upon the strength of that feeling and upon the proposals that the cinemas have to make if and when they are asked to come down to brass tacks.

The Television Committee

This is written just before the meeting of the Television Committee, from whom something may have been heard by the time that it appears in print. It's a pity, perhaps, that the Committee couldn't have met earlier, but its members seem to have been pretty widely scattered and couldn't, I suppose, be collected with greater despatch. In its famous original report, the Television Committee touched on the subject of subsidised television programmes, and by no means dismissed them as unthinkable. If some means can be found of avoiding any direct advertising and—most important of all—of any control of the programmes by cinemas, I shall be surprised if the Committee's statement on the subject doesn't at any rate leave the door open for further discussion. Before they come to a definite decision they will probably want to discover which way public opinion is leaning.

The B.B.C.'s Attitude

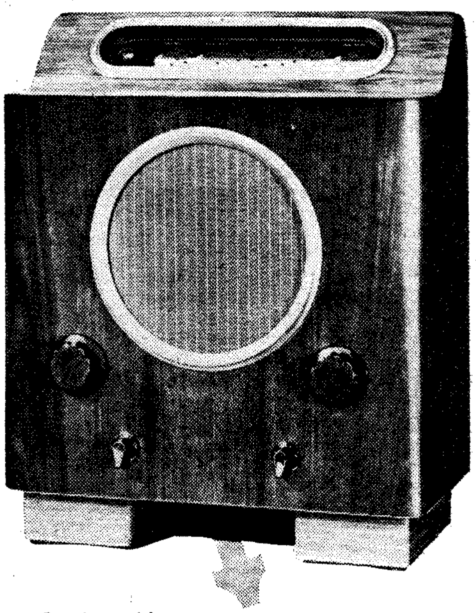
The B.B.C. is naturally nervous about any intrusion of the cinemas into the television world. Like the Trojans of old, who feared the Greeks when they came with gifts in their hands, the B.B.C. wonders what may be behind this sudden generosity on the part of the cinemas. It suspects that a plea for a policy of give and take may mean that those who give a lot are to take all that they can get. Another thing that is worrying the B.B.C. is this. So long as the television audience is not large, there isn't much difficulty in arranging OB's of all kinds. But if this were suddenly to jump from a few thousand to several million, those who promote entertainments, sporting or otherwise, would be faced with the unwelcome possibility of reduced receipts at gates and box offices. Obviously they wouldn't be so ready to give leave for OB's. Hence, the B.B.C. argues, television in the cinemas would be much to the disadvantage of the home viewer.

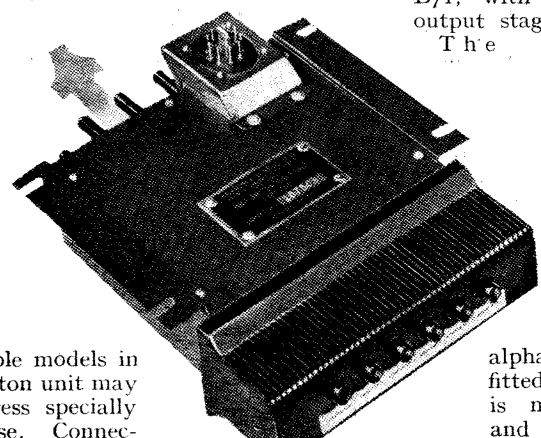
THE NEW MURPHY SETS

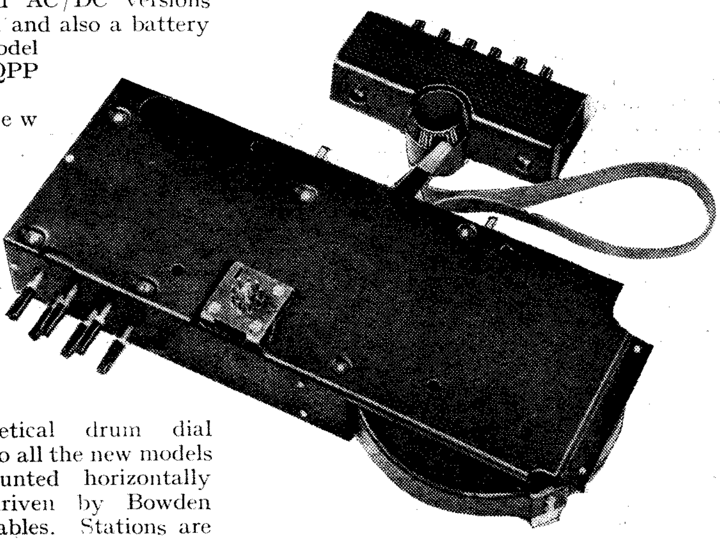
Optional Push-button and Remote Control Units

To take advantage of the improvements which have been made in the latest range of Murphy receivers the purchaser is not obliged to pay also for push buttons if he does not want them.

A cabinet design has been standardised







In the cabinet which has been standardised for the new "72" series either the push button or the remote control unit (right) may be plugged into a recess in the base.

for all the new table models in which the push-button unit may be added in a recess specially provided in the base. Connection is made to the chassis through a nine-way plug and socket and no modification to the main receiver is called for. One merely turns the waverange switch to a fourth position marked "B" for push-button operation.

Six ganged permeability tuned circuits are provided in the push-button unit, four on medium waves and two on long. Adjustment is made by screwed extension rods projecting from the back. An interesting detail is that AVC is changed from undelayed to delayed when the push-button circuits are in operation.

The remote control unit incorporates a volume control in addition to the six station buttons. The control gives a diminution of volume below the level to which the main receiver control is set. A small electric motor drives a selector switch for the permeability tuned circuits, and the 15ft. cable is housed in a drum with a spring-loaded rewinding mechanism.

The basic circuit of the new "72" series is a superheterodyne with four valves and a rectifier. A triode-hexode frequency changer is preceded by a single tuned circuit with suitable modifications to reduce whistles. There follow an IF stage, double-diode-triode signal and AVC rectifier and first AF stage and a beam tetrode output valve rated at 5 watts. Variable selectivity is provided in the IF stage and gives a response up to 6,500 cycles for local station reception. Quality is said to be comparable with that of the A50 receiver.

Radiogramophone and AC/DC versions of the A72 are available, and also a battery receiver, Model B71, with QPP output stage.

The new alphabetical drum dial fitted to all the new models is mounted horizontally and driven by Bowden wire cables. Stations are now grouped according to waverange, and the appropriate section of the dial is illuminated according to the position of the waverange switch.

The price of the A72 is £12 10s., and the push-button unit costs £1 15s. or £3 10s. with the addition of remote control.

News from the Clubs

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. DeGruchy, of Everett, Edgcumbe, Ltd., gave a lecture on "Radio Servicing Instruments."

At the next meeting, on March 21st, Mr. G. Parr, of the Edison Swan Electric Co., Ltd., will lecture on "Electro-encephalography."

Thames Valley Amateur Radio Transmitting Society

Headquarters: The Albany Hotel, Station Yard, Twickenham.
Meetings: Wednesdays at 8.15 p.m.
Hon. Sec.: Mr. D. R. Spearing, York House, Queen's Road, Teddington.

This society has been recently formed to succeed the Thames Valley Amateur Radio Television Society, which had to be disbanded through lack of enthusiasm. Membership of the new society is limited to holders of amateur transmitting licences and to B.R.S. members of the R.S.G.B. The big feature so far arranged by the new society is the running of the R.S.G.B. (District 15) 3.5 Mc/s N.F.D. station. The next meeting of the society is on March 22nd.

International Short-wave Club, London

Hon. Sec.: Mr. A. E. Bear, 100, Adams Gardens Estate, London, S.E.16.

The Club will hold its sixth annual dinner and dance at Maison Lyons, Shaftesbury Avenue, London, W.1, on Saturday, April 15th. The function will be attended by short-wave listeners and by representatives of the Radio Manufacturers' and Broadcasting organisations. Tickets, for which early applications should be made, are 7s. each.

Eastbourne and District Radio Society

Headquarters: The Science Room, Cavendish Senior School, Eastbourne.
Hon. Sec.: Mr. T. G. R. Dowsett, 48, Grove Road, Eastbourne.

At the last meeting Mr. J. H. Ayre gave a lecture entitled "Five-metre Amateur Communication."

Electron Optics.—By L. M. Myers. Pp. 618+xviii. Published by Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 42s.

ALTHOUGH electron optics is a new subject to many, in its beginnings it dates back many years. It is only recently that it has become generally known that there is such a subject, however, for attention has been focused on it by the development of cathode-ray tubes and some of the latest types of valves.

The treatment in this book is very thorough and there is an enormous amount of information contained in the 618 pages. The subject is developed from fundamentals and much of the treatment is mathematical.

Intended for the graduate student, the book should also be of great value to all who are engaged in work in which electron optics plays any part. W. T. C.

Recent Inventions

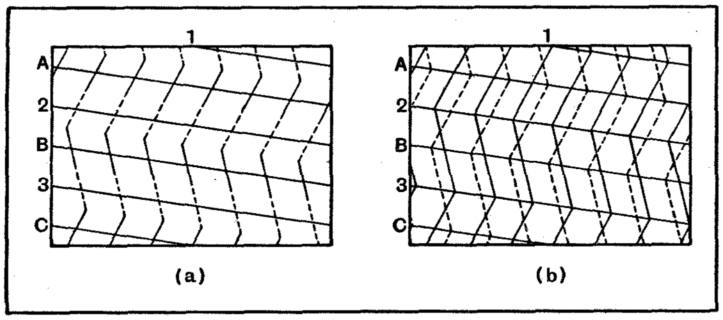
Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

LARGE-SCALE PICTURES

ALTHOUGH the use of interlaced scanning definitely reduces picture "flicker," it has a defect which is particularly noticeable in the case of a large-sized screen intended for a cinema theatre where some of the audience will be seated at comparatively close range. If the observer's attention is focused at one point on the picture, he gets the impression that the scanning lines are moving steadily upwards or downwards. If the lines are bright, the effect can be described colloquially as "dithery."

The object of the invention is to avoid this, the desired effect being attained by increasing the width of each set of interlaced lines. Diagram (a) shows the standard method where the lines 1, 2, 3, of one frame are interlaced with the lines A, B, C of the second frame. The width of each line is indicated by the cross-hatching shown dotted in the first frame and in full lines the second. Diagram (b) shows the arrangement according to the invention, where the width of both sets of lines is doubled, as shown by the dotted and full-line cross-hatching, so that each frame, in effect, covers the whole of the picture area instead of half of it.

A. D. Blumlein. Application date, June 7th, 1937. No. 495724.



The normal interlacing system (a) compared with a method (b) in which the width of both sets of lines is doubled.

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PUSH-BUTTON TUNING

IN most push-button or similar systems of automatic tuning, a driving motor, brought into action by operating a button or other selecting device, is stopped at the desired setting by the automatic opening of the driving circuit. In practice the difficulty is to stop the motor at the exact position required, and to prevent it from overrunning owing to inertia.

According to the invention, the problem is attacked by closing instead of opening a circuit in order to stop the motor. The circuit closed then creates an electrical braking force which stops the motor instantaneously.

The complete circuit is too complicated to reproduce here, but the essential feature is a driving-motor which, in addition to a main energising coil, is provided with two special groups of direction-control windings, one or other of which is closed or energised to brake the motor instantaneously at the selected tuning point.

W. W. Triggs (communicated by Operadio Mfg. Co.). Application date, June 24th, 1937. No. 497490.

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.

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TELEVISION "EFFECTS"

WHEN in the course of televising a scene it is desired to change from the normal size of picture to a "close-up," it is usually necessary to provide either a second television "camera" to handle the larger picture, or else a special turret containing a second set of lenses.

The invention discloses a method whereby the required change in magnification is effected by varying the focusing of the electron stream inside the cathode-ray transmitting tube.

The picture is first projected on to the photo-electric cathode of the tube, and the electrons liberated by the incident light are passed through an electron-optical focusing arrangement before reaching the point where they are scanned in order to produce the signalling currents. The magnification is then controlled along the electron stream by varying the strength of the current applied to the magnetic focusing coil outside the cathode-ray tube. The control rheostat is graded in steps so that any desired change in the size of the picture image can be produced on the screen prior to scanning.

H. Miller. Application date, April 1st, 1937. No. 496751.

CUTTING OUT INTERFERENCE

A KNOWN method of reducing the effect of sudden voltage surges, such as are produced by atmospheric interference, consists in interrupting the receiver circuits at a frequency which is sufficiently high not to affect the apparent continuity of the received signal. The intermittent breaking of the circuits serves, however, to cut out most of the undesired noise, since this is usually of a highly damped or impulsive type.

According to the invention the signal channel is interrupted, for this purpose, in the second detector stage of a superheterodyne, and the resulting signals are passed through a limiting device to restrict the amplitude of the interference, and also through a low-pass filter circuit having a cut-off frequency lower than the frequency of interruption. In this way the output signal is freed both from the interfering disturbances and from any effect due to the interruption frequency used to eliminate it.

Marconi's Wireless Telegraph Co., Ltd. Convention date (U.S.A.), May 28th, 1936. No. 496246.

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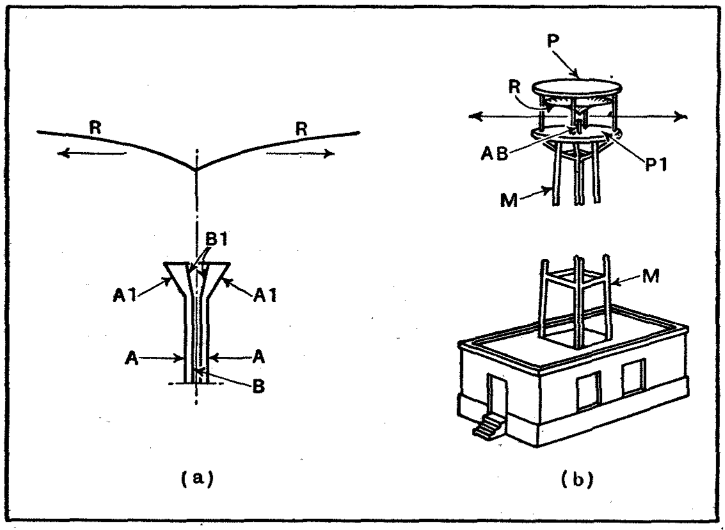
SHORT-WAVE AERIALS

IT is known that a certain amount of energy radiates away from the open end of a concentric feed-line carrying ultra-high-frequency currents. By flaring out the two ends of the inner and outer conductors A, B, so that they take the form shown at A1, B1 in diagram (a), and by suitably matching the diameter of each conductor to the working wavelength, this effect is, according to the invention, utilised to secure efficient radiation without using any other form of aerial. By backing the flared ends with a reflector R of the shape shown, the radiation takes the form of a substantially horizontal beam as indicated by the arrows.

Diagram (b) shows a complete aerial installation suitable for transmitting television programmes. Upper and lower platforms P, P1 are arranged to protect the flared ends of the feed-line AB, and the reflector R, from the weather, the feed-line passing from the power house at the base up through the centre of the mast M.

Standard Telephones and Cables, Ltd. (assignees of Le Materiel Telephonique Soc. Anon.). Convention date (France), July 21st, 1936. No. 495977.



Radiating system for ultra-short waves.

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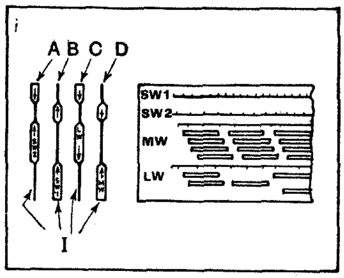
TUNING INDICATORS

INSTEAD of lighting up only the particular waveband to which the receiver is set, the whole tuning scale is equally illuminated and an indicator needle of special shape is used to distinguish the waveband in use from the others. The indicator needle I is made with facets stamped out at right angles to each other, so that its front appearance changes, as shown at A . . . D, as it is turned through successive angles of 90 deg. The facets are suitably coloured on each side, and also bear arrows to indicate the particular waveband with which the needle is to be used for a given setting.



Tuning scale with automatically registering cursor.

For instance, it presents the appearance shown at A for use with short waveband No. 2. As shown at B, it co-operates with SW band No. 1. At C it is working on the long waves, and at D on the medium-wave stations. The rotation of the needle is effected automatically through chain-and-pulley gearing from the wave-change switch.

L. F. Birdseye. Application date, May 26th, 1937. No. 495879.

PRINCIPAL BROADCASTING STATIONS OF EUROPE

Arranged in Order of Frequency and Wavelength (Stations with an Aerial Power of 50 kW and above in heavy type)

Station.	kc/s.	Tuning Positions.	Metres.	kW.
Istanbul (Turkey)	152		1973.5	5
Kaunas (Lithuania)	153		1961	7
Hilversum (No. 1) (Holland)	160		1875	10-150
Radio Romania (Romania)	160		1875	150
Lahti (Finland)	166		1807	150
Moscow (No. 1) (U.S.S.R.)	172		1744	500
Paris (Radio Paris) (France)	182		1648	80
Ankara (Turkey)	183		1639	120
Irkutsk (U.S.S.R.)	187.5		1600	20
Deutschlandsender (Germany)	191		1571	60
National (Droitwich)	200		1500	150
Minsk (U.S.S.R.)	208		1442	35
Reykjavik (Iceland)	208		1442	100
Motala (Sweden)	216		1389	150
Novosibirsk (U.S.S.R.)	217.5		1379	100
Warsaw (No. 1) (Poland)	224		1339	120
Luxembourg	232		1293	150
Moscow (No. 2) (U.S.S.R.)	232		1293	100
Kalundborg (Denmark)	240		1250	60
Kiev (No. 1) (U.S.S.R.)	248		1209.6	100
Tashkent (U.S.S.R.)	256.4		1170	25
Bergen (Norway)	260		1153.8	20
Oslo (Norway)	260		1153.8	60
Vigra (Aalesund) (Norway)	260		1153.8	10
Leningrad (No. 1) (U.S.S.R.)	271		1107	100
Tromsö (Norway)	282		1064	10
Tiflis (U.S.S.R.)	283		1060	35
Saratov (U.S.S.R.)	340		882.3	20
Finmark (Norway)	347		864.6	10
Bodö (Norway)	347		864.6	10
Archangel (U.S.S.R.)	350		857.1	10
Budapest (No. 2) (Hungary)	359.5		834.5	18
Sverdlovsk (U.S.S.R.)	375		800	40
Banská-Bystrica (Czechoslovakia)	392		765	15-30
Lulea (Sweden)	392		765	10
Rostov-on-Don (U.S.S.R.)	395		759	20
Voronezh (U.S.S.R.)	413.5		726	10
Oulu (Uleaborg) (Finland)	431		696	10
Baranowicze (Poland)	520		576	50
Ljubljana (Yugoslavia)	527		569.3	6.3
Viipuri (Finland)	527		569.3	10
Bolzano (Italy)	536		559.7	10
Wilno (Poland)	536		559.7	50
Budapest (No. 1) (Hungary)	546		549.5	120
Beromünster (Switzerland)	556		539.6	100
Klaipeda (Lithuania)	565		531	10
Catania (Italy)	565		531	3
Palermo (Italy)	565		531	3
Radio Eireann (Ireland)	565		531	100
Stuttgart (Germany)	574		522.6	100
Alpes-Grenoble (P.T.T.) (France)	583		514.6	20
Madona (Latvia)	583		514.6	50
Vienna (Germany)	592		506.8	100
Athens (Greece)	601		499.2	15
Rabat (Morocco)	601		499.2	20
Sundsvall (Sweden)	601		499.2	10
Florence (No. 1) (Italy)	610		491.8	20
Brussels (No. 1) (Belgium)	620		483.9	15
Cairo (No. 1) (Egypt)	620		483.9	20
Kouibyshev (U.S.S.R.)	625		480	10
Christiansand (Norway)	629		476.9	20
Lisbon (Emissora Nacional) (Portugal)	629		476.9	20
Tröndelag (Norway)	629		476.9	100
Prague (No. 1) (Czechoslovakia)	638		470.2	120
Lyons (P.T.T.) (France)	648		463	100
Petrozavodsk (U.S.S.R.)	648		463	10
Cologne (Germany)	658		455.9	100
Jerusalem (Palestine)	668		449.1	20
North Regional (Slaithwaite)	668		449.1	70
Sottens (Switzerland)	677		443.1	100
Belgrade (Yugoslavia)	686		437.3	20
Paris (P.T.T.) (France)	695		431.7	120
Stockholm (Sweden)	704		426.1	55
Rome (No. 1) (Italy)	713		420.8	120
Hilversum (No. 2) (Jaarsveld) (Holland)	722		415.4	17
Kharkov, (No. 1) (U.S.S.R.)	722		415.4	10
Madrid (EAJ2) (Spain)	731		410.4	3
Seville (EAJ5) (Spain)	731		410.4	5
Turi (Estonia)	731		410.4	38
Munich (Germany)	740		405.4	100
Marseilles (P.T.T.) (France)	749		400.5	100
Katowice (Poland)	758		395.8	10
Scottish Regional (Burghead)	767		391.1	60
Scottish Regional (Westerglen)	767		391.1	70
Stalino (U.S.S.R.)	776		386.6	10
Toulouse (P.T.T.) (France)	776		386.6	120
Leipzig (Germany)	785		382.2	120
Barcelona (EAJ1) (Spain)	795		377.4	7.5
Lwów (Poland)	795		377.4	50
Welsh Regional (Penmon) (Anglesey)	804		373.1	5
Welsh Regional (Washford)	804		373.1	70
Milan (No. 1) (Italy)	814		368.6	50
Bucharest (Romania)	823		364.5	12
Kiev (No. 2) (U.S.S.R.)	832		360.6	35
Stavanger (Norway)	832		360.6	20
Berlin (Germany)	841		356.7	100
Sofia (Bulgaria)	850		352.9	100
Valencia (Spain)	850		352.9	3
Simferopol (U.S.S.R.)	859		349.2	10
Strasbourg (France)	859		349.2	100
Poznań (Poland)	868		345.6	50
London Regional (Brookmans Park)	877		342.1	70
Graz (Germany)	886		338.6	15
Linz (Germany)	886		338.6	15
Helsinki (Finland)	895		335.2	10
Hamburg (Germany)	904		331.9	100
Dniepropetrovsk (U.S.S.R.)	913		328.6	10
Toulouse (Radio Toulouse) (France)	913		328.6	60
Brno (Czechoslovakia)	922		325.4	32
Brussels (No. 2) (Belgium)	932		321.9	15
Algiers (Algeria)	941		318.8	12
Göteborg (Sweden)	941		318.8	10
Breslau (Germany)	950		315.8	100
Paris (Poste Parisien) (France)	959		312.8	60
Madrid (EAJ7) (Spain)	968		309.9	5
Odessa (U.S.S.R.)	968		309.9	10
Northern Ireland Regional (Lisnagarvey)	977		307.1	100
Bologna (Radio Marconi) (Italy)	986		304.3	50
Toruń (Poland)	986		304.3	24
Hilversum (Holland)	995		301.5	15-65
Bratislava (Czechoslovakia)	1004		298.8	13.5
Chernigov (U.S.S.R.)	1013		296.2	4
Midland Regional (Droitwich)	1013		296.2	70
Barcelona (EAJ15) (Spain)	1022		293.5	3
Cracow (Poland)	1022		293.5	1.7
Königsberg (No. 1) (Germany)	1031		291	100
Parede (Portugal)	1031		291	5
Leningrad (No. 2) (U.S.S.R.)	1040		288.5	10
Rennes-Bretagne (France)	1040		288.5	120
West of England Regional (Washford)	1050		285.7	50
Bari (No. 1) (Italy)	1059		283.3	20
Tiraspol (U.S.S.R.)	1068		280.9	10
Bordeaux-Lafayette (France)	1077		278.6	60
Radio Normandie (France)	1095		274	20
Vinnitsa (U.S.S.R.)	1095		274	10
Kuldiga (Latvia)	1104		271.7	50
Tripoli (Libya)	1104		271.7	50
Prague No.1 (Melnik) (Czechoslovakia)	1113		269.5	100
Nyiregyhaza (Hungary)	1122		267.4	6.25
North-East Regional (Stagshaw)	1122		267.4	60
Hörby (Sweden)	1131		265.3	100
Genoa (No. 1) (Italy)	1140		263.2	10
Trieste (Italy)	1140		263.2	10
Turin (No. 1) (Italy)	1140		263.2	30
London National (Brookmans Park)	1149		261.1	40
North National (Slaithwaite)	1149		261.1	40
Scottish National (Westerglen)	1149		261.1	50
Kassa (Hungary)	1158		259.1	10
Monte Ceneri (Switzerland)	1167		257.1	15
Copenhagen (Denmark)	1176		255.1	10
Nice-Côte d'Azur (France)	1185		253.2	60
Frankfurt (Germany)	1195		251	25
Freiburg-im-Breisgau (Germany)	1195		251	5
Troppau (Germany)	1204		249.2	5
Lille (Radio P.T.T. Nord) (France)	1213		247.3	60
Rome (No. 2) (Italy)	1222		245.5	60
Gleiwitz (Germany)	1231		243.7	5
Görlitz (Germany)	1231		243.7	5
Cork (Ireland)	1235		242.9	1
Saarbrücken (Germany)	1249		240.2	17
Riga (Latvia)	1258		238.5	15
Burgos (Spain)	1258		238.5	20
Nürnberg (Germany)	1267		236.8	2
Varna (Bulgaria)	1276		235.1	2
Aberdeen	1285		233.5	5
Klagenfurt (Germany)	1294		231.8	5
Vorarlberg (Germany)	1294		231.8	5
Radio Mediterranée (France)	1303		230.2	27
Naples (No. 1) (Italy)	1303		230.2	10
Malmö (Sweden)	1312		228.7	2.5
Bremen (Germany)	1330		225.6	2
Lódz (Poland)	1339		224	2
Dublin (Ireland)	1348		222.6	0.5
Salzburg (Germany)	1348		222.6	2
Genoa (No. 2) (Italy)	1357		221.1	5
Turin (No. 2) (Italy)	1357		221.1	5
Milan (No. 2) (Italy)	1357		221.1	4
Bordeaux-Sud-Ouest (France)	1366		219.6	25
Warsaw (No. 2) (Poland)	1384		216.8	7
Lyons (Radio Lyons) (France)	1393		215.4	25
Vaasa (Finland)	1420		211.3	10
Kaiserlautern (Germany)	1429		209.9	2.5
Turin (No. 3) (Italy)	1429		209.9	5
Paris (Eiffel Tower) (France)	1456		206	7
Bournemouth	1474		203.5	1
Plymouth	1474		203.5	0.3

SHORT-WAVE STATIONS OF THE WORLD

Arranged in Order of Frequency and Wavelength (Stations with an Aerial Power of 20 kW and above in heavy type)

Station.	Call Sign.	mc/s.	Tuning Positions.	Metres.	kW.
Amateurs		1.71 to 2.00		174.43 to 150.00	—
Amateurs		3.50 to 4.00		85.71 to 75.00	—
Calcutta (India)	VUC2	4.84		61.98	10
Bombay (India)	VUB2	4.88		61.48	10
Madras (India)	VUM2	4.92		60.98	10
Delhi (No. 2) (India)	VUD2	4.96		60.49	10
Poděbrady (Prague) (Czechoslovakia)	**OK1MPT**	5.14		58.31	30
Moscow (U.S.S.R.)	RIA	5.85		51.24	15
Moscow (U.S.S.R.)	**RNE**	6.00		50.00	20
Pretoria (South Africa)	ZRH	6.01		49.94	7
Rangoon (Burma)	XYO	6.01		49.94	10
Poděbrady (Prague) (Czechoslovakia)	**OLR2A**	6.01		49.92	30
Zeesen (Germany)	**DJC**	6.02		49.83	5-40
Moscow (U.S.S.R.)	**RW96**	6.03		49.75	100
Poděbrady (Prague) (Czechoslovakia)	**OLR2B**	6.03		49.75	30
Vatican City (Vatican State)	**HVJ**	6.03		49.75	25
Boston (U.S.A.)	**W1XAL**	6.04		49.67	20
Tandjong Priok (Java)	YDA	6.04		49.67	10
Daventry (Gt. Britain)	**GSA**	6.05		49.59	10-50
Cincinnati (U.S.A.)	W8XAL	6.06		49.50	10
Philadelphia (U.S.A.)	W3XAU	6.06		49.50	10
Motala (Sweden)	SBO	6.06		49.46	12
Vienna (Germany)	**DJY**	6.07		49.40	50
Zeesen (Germany)	**DJM**	6.08		49.35	5-40
Lima (Peru)	OAX4Z	6.09		49.24	15
Bound Brook (U.S.A.)	**W3XL**	6.10		49.18	25
Daventry (Gt. Britain)	**GSL**	6.11		49.10	10-50
Wayne (U.S.A.)	W2XE	6.12		49.02	10
Mexico City (Mexico)	**XEUZ**	6.12		49.02	20
Pittsburgh (U.S.A.)	**W8XK**	6.14		48.86	28
Wayne (U.S.A.)	W2XE	6.17		48.62	10
Vatican City (Vatican State)	**HVJ**	6.19		48.47	25
Radio-Nations (Switzerland)	**HBQ**	6.67		44.94	20
Amateurs		7.00 to 7.30		42.85 to 41.09	—
Rome (Italy)	**I2RO11**	7.22		41.55	50
Paris (Radio-Mondial) (France)	TPA4	7.28		41.21	12
Paris (Radio-Mondial) (France)	**TPB7**	7.28		41.21	25
Paris (Radio-Mondial) (France)	**TPP11**	7.28		41.21	25
Tokio (Japan)	**JLG**	7.28		41.21	50
Mexico City (Mexico)	**XECR**	7.38		40.65	20
Tokio (Japan)	**JVP**	7.51		39.95	50
Radio-Nations (Switzerland)	**HBP**	7.80		38.48	20
Radio-Nations (Switzerland)	**HBL**	9.34		32.10	20
Ankara (Turkey)	**TAP**	9.46		31.70	20
Madrid (Spain)	EAR	9.49		31.62	10
Rio de Janeiro (Brazil)	PRF5	9.50		31.58	12
Bangkok (Siam)	HS8PJ	9.50		31.58	10
Mexico City (Mexico)	XEWW	9.50		31.58	10
Melbourne (Australia)	VK3ME	9.51		31.55	5
Daventry (Gt. Britain)	**GSB**	9.51		31.55	10-50
Moscow (U.S.S.R.)	**RW96**	9.52		31.51	100
Skamlebaek (Denmark)	OZF	9.52		31.51	6
Chungking (China)	**XGOY**	9.52		31.51	20
Pretoria (South Africa)	ZRH	9.52		31.50	7
Calcutta (India)	VUC2	9.53		31.48	10
Schenectady (U.S.A.)	**W2XAF**	9.53		31.48	20-25
Tokio (Japan)	**JZI**	9.53		31.46	50
Zeesen (Germany)	**DJN**	9.54		31.45	5-40
Poděbrady (Prague) (Czechoslovakia)	**OLR3A**	9.55		31.41	30
Paris (Radio-Mondial) (France)	**TPB11**	9.55		31.41	25
Vatican City (Vatican State)	**HVJ**	9.55		31.41	25
Bombay (India)	VUB2	9.55		31.40	10
Schenectady (U.S.A)	**W2XAD**	9.55		31.40	20-25
Zeesen (Germany)	**DJA**	9.56		31.38	5-40
Lima (Peru)	OAX4T	9.56		31.37	10
Millis (U.S.A.)	W1XK	9.57		31.35	10
Daventry (Gt. Britain)	**GSC**	9.58		31.32	10-50
Delhi No. 2 (India)	VUD2	9.59		31.28	10
Philadelphia (U.S.A.)	W3XAU	9.59		31.28	10
Sydney (Australia)	**VK2ME**	9.59		31.28	20
Huizen (Holland)	**PCJ**	9.59		31.28	60
Moscow (U.S.S.R.)	**RAN**	9.60		31.25	20
Rome (Italy)	**12RO3**	9.63		31.15	25
Wayne (U.S.A.)	W2XE	9.65		31.09	10
Vatican City (Vatican State)	**HVJ**	9.66		31.06	25
Buenos Aires (Argentine Republic)	LRX	9.66		31.06	7.5
Bound Brook (U.S.A.)	**W3XAL**	9.67		31.02	25
Rome (Italy)	**I2RO9**	9.67		31.02	50
Zeesen (Germany)	**DJX**	9.67		31.02	5-40
Guatemala City (Guatemala)	TGWA	9.68		30.98	10
Lisbon (Portugal)	CSW7	9.74		30.80	10
Dairen (China)	JDY	9.92		30.23	10
Marapicú (Brazil)	PSH	10.22		29.35	12
Ruysselede (Belgium)	ORK	10.33		29.04	9
Buenos Aires (Argentine Republic)	LSX	10.35		28.99	12
Taihoku (Japan)	JIB	10.53		28.48	10
Lisbon (Portugal)	CSW6	11.04		27.17	10
Radio-Nations (Switzerland)	**HBO**	11.40		26.31	20
Motala (Sweden)	SBP	11.70		25.63	12
Moscow (U.S.S.R.)	RIA	11.71		25.62	15
Paris (Radio-Mondial) (France)	TPA4	11.72		25.60	12
Huizen (Holland)	**PHI**	11.73		25.58	25
Boston (U.S.A.)	**W1XAL**	11.73		25.58	20
Vatican City (Vatican State)	**HVJ**	11.74		25.55	25
Daventry (Gt. Britain)	**GSD**	11.75		25.53	10-50
Poděbrady (Prague) (Czechoslovakia)	**OLR4B**	11.76		25.51	30
Zeesen (Germany)	**DJD**	11.77		25.49	5-40
Boston (U.S.A.)	**W1XAL**	11.79		25.45	20
Tokio (Japan)	**JZJ**	11.80		25.42	50
Zeesen (Germany)	**DJO**	11.80		25.42	5-40
Vienna (Germany)	**DJZ**	11.80		25.42	50
Rome (Italy)	**12RO4**	11.81		25.40	25
Daventry (Gt. Britain)	**GSN**	11.82		25.38	10-50
Wayne (U.S.A.)	W2XE	11.83		25.36	10
Lisbon (Portugal)	CWS5	11.84		25.34	10
Poděbrady (Prague) (Czechoslovakia)	**OLR4A**	11.84		25.34	30
Zeesen (Germany)	**DJP**	11.85		25.31	5-40
Daventry (Gt. Britain)	**GSE**	11.86		25.29	10-50
Madras (India)	VUM2	11.87		25.58	10
Pittsburgh (U.S.A.)	**W8XK**	11.87		25.26	24
Paris (Radio-Mondial) (France)	**TPB7**	11.88		25.24	25
Paris (Radio-Mondial) (France)	TPA3	11.88		25.24	12
Moscow (U.S.S.R.)	**RNE**	12.00		25.00	20
Reykjavik (Iceland)	TFJ	12.23		24.52	7.5
Warsaw (Poland)	SPW	13.63		22.00	10
Amateurs		14.00 to 14.40		21.42 to 20.83	—
Radio-Nations (Switzerland)	**HBJ**	14.53		20.64	20
Moscow (U.S.S.R)	RRRF	14.71		20.38	15
Moscow (U.S.S.R.)	**RKI**	15.08		19.89	25
Rome (Italy)	I2RO12	15.10		19.87	10
Lisbon (Portugal)	CSW4	15.10		19.87	10
Zeesen (Germany)	**DJL**	15.11		19.85	5-40
Vatican City (Vatican State)	**HVJ**	15.12		19.84	25
Paris (Radio-Mondial) (France)	**TPB6**	15.13		19.83	25
Boston (U.S.A.)	**W1XAL**	15.13		19.83	20
Daventry (Gt. Britain)	**GSF**	15.14		19.82	10-50
Guatemala City (Guatemala)	TGWA	15.17		19.78	10
Daventry (Gt. Britain)	**GSO**	15.18		19.76	10-50
Moscow (U.S.S.R.)	**RW96**	15.18		19.76	100
Ankara (Turkey)	**TAQ**	15.20		19.74	20
Zeesen (Germany)	**DJB**	15.20		19.74	5-40
Pittsburgh (U.S.A.)	W8XK	15.21		19.72	18
Huizen (Holland)	**PCJ2**	15.22		19.71	60
Poděbrady (Prague) (Czechoslovakia)	**OLR5A**	15.23		19.70	30
Paris (Radio-Mondial) (France)	TPA2	15.24		19.68	12
Boston (U.S.A.)	**W1XAL**	15.25		19.67	20
Daventry (Gt. Britain)	**GSI**	15.26		19.66	10-50
Wayne (U.S.A.)	W2XE	15.27		19.65	10
Zeesen (Germany)	**DJQ**	15.28		19.63	5-40
Buenos Aires (Argentine Republic)	LRU	15.28		19.62	7
Rome (Italy)	**I2RO6**	15.30		19.61	50
Daventry (Gt. Britain)	**GSP**	15.31		19.60	10-50
Skamlebaek (Denmark)	OZH	15.32		19.58	6
Poděbrady (Prague) (Czechoslovakia)	**OLR5B**	15.32		19.58	30
Schenectady (U.S.A.)	**W2XAD**	15.33		19.57	20-25
Zeesen (Germany)	**DJR**	15.34		19.56	5-40
Hicksville (U.S.A.)	W2XGB	17.31		17.33	10
Zeesen (Germany)	**DJE**	17.76		16.89	5-40
Wayne (U.S.A.)	W2XE	17.76		16.89	10
Huizen (Holland)	**PHI**	17.77		16.88	20
Bound Brook (U.S.A.)	**W3XL**	17.78		16.87	25
Daventry (Gt. Britain)	**GSG**	17.79		16.86	10-50
Daventry (Gt. Britain)	**GSV**	17.81		16.84	10-50
Rome (Italy)	**I2RO8**	17.81		16.84	25
Paris (Radio-Mondial) (France)	**TPB3**	17.81		16.84	25
Radio-Nations (Switzerland)	**HBH**	18.48		16.23	20
Zeesen (Germany)	**DJS**	21.45		13.99	5-40
Boston (U.S.A.)	**W1XAL**	21.46		14.00	20
Daventry (Gt. Britain)	**GSH**	21.47		13.97	10-50
Schenectady (U.S.A.)	**W2XAD**	21.50		13.95	20-25
Daventry (Gt. Britain)	**GSJ**	21.53		13.93	10-50
Pittsburgh (U.S.A.)	W8XK	21.54		13.93	6
Daventry (Gt. Britain)	**GST**	21.55		13.92	10-50
Wayne (U.S.A.)	W2XE	21.57		13.91	10
Bound Brook (U.S.A.)	**W3XAL**	21.63		13.87	25
Amateurs		28.00 to 30.00		10.71 to 10.00	—
London Television (Sound)		41.50		7.22	3
London Television (Vision)		45.00		6.66	17
Amateurs		56.00 to 60.00		5.35 to 5.00	—
Amateurs		112.00 to 120.00		2.67 to 2.50	—

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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.

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EDITORIAL COMMENT

B.B.C. Co-operation

Helping the Wireless Industry

SIGNS are not lacking that the B.B.C. intends to co-operate much more closely than hitherto with the wireless industry. Evidence of this has been given during the campaign to popularise television and later in statements made in connection with the R.M.A.'s laudable efforts to plan a better Radiolympia for the coming autumn.

This attitude is, we think, an entirely proper one, and it is to be hoped that the principle of mutual assistance will be developed and extended. Those who supply the programmes and those who supply the sets on which they are received are clearly dependent on each other for the success of broadcasting, and neither could survive, let alone prosper, without the other.

How the B.B.C. Might Help

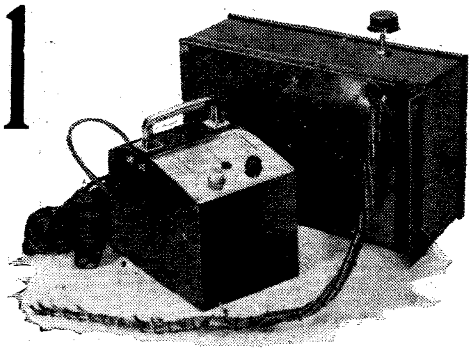
The crying need of the moment is to convince the listening public that it is high time to replace the hopelessly out-of-date sets with which the majority are apparently quite content. The average set, estimated as being at least five years old, is quite incapable of doing justice to the B.B.C.'s transmissions, let alone provide its owner with the other advantages that a good modern set can bring to him. It is in inculcating this idea that the B.B.C. can help most ; there is no longer any need to convince the public that broadcasting is worth while, and in any case attempts to do so *via* the microphone or at wireless exhibitions would be nothing more than preaching to the converted. The wireless industry, for its part, must, of course, see to it that its sets are outstandingly better than those the public is asked to replace.

It is interesting to speculate on the methods that might be adopted to inculcate this idea in the mind of the average listener (who is surprisingly ill-informed on wireless developments). Some extremely interesting broadcasts might be planned with this object in view. For example, a test of quality of reproduction might be arranged by transmitting a few bars of music and/or a few words of speech, first with the full frequency range and then with drastic attenuation of bass and treble ; those who could hear no difference would know that their sets were incapable of doing justice to good transmissions.

Short-wave Possibilities

Again, the public has no idea of the potentialities of short-wave broadcasting, or of the capabilities of the better modern receivers in that direction. With the help of recording, plus an interspersed commentary, a most attractive broadcast, not lacking in the dramatic element which nowadays seems so essential, might easily be planned to illustrate this advantage of modern sets. There are few evenings indeed when a few hours' listening on the short waves would not supply all the material needed, in the form of the shortest of recorded extracts from programmes of interest. Such an item might well be planned to show—and this would be no exaggeration of facts—that an all-wave set is a virtual necessity to anyone who wishes to be well informed on international affairs. And finally, to dispel any idea that receiver design has even now reached finality, the B.B.C. might broadcast simultaneous recordings of an item as received by an ordinary set and by the diversity apparatus at Tatsfield.

Remote Control



ELECTRIC LIGHT WIRING AS THE CONNECTING LINK

By "CATHODE RAY"

USUALLY I resolve not to risk confusing matters with involved details, but this week it looks like being a temporarily fractured resolution. The reasons for this departure are, first, that as you have probably gathered, I am rather keen on remote control, and, secondly, that the one I am going to describe is not only more than averagely interesting, but illustrates fundamental principles—notably Ohm's Law—in very instructive ways. Readers who don't feel quite up to tracing out complicated circuits in detail may be interested in the simplified diagrams showing the principle on which it—the Regentone remote control—works.

Its special features are that no wires are required other than the existing house AC wiring, and that the receiver can not only be switched on and off from any electricity point, but, if it is of the motor-tuned type, any of seven stations can be selected.

One method of using the mains for remote control depends on sending high-frequency signals along them—the so-called "wired wireless."* The Regentone system goes to the other extreme and sends out signals of zero frequency—DC in other words. Fig. 1 shows the general idea. The two mains leads are shown spaced far apart for clearness, instead of close together as they are actually laid around the house. Sundry lamps and things are shown connected; and, of course, the remote control system must not affect any of them. The control unit is shown at the extreme right, plugged in perhaps in an upstairs room, with the extension speaker beside it. When its buttons are pressed the DC signal produced by it affects the relay unit, installed downstairs in the receiver cabinet, and makes it switch the set on or off, etc.

Systems making use of the mains have to contend with a formidable difficulty; any attempt to alter the voltage of the mains seems as hopeless as trying to signal to someone a short distance along the shore by varying the water level of the ocean; and even if either of these feats can be accomplished how can its effect be confined to the place where it is wanted? If the neighbour has a set of the same type on the same mains, what is to stop it from being controlled against his will? The resistance across the mains is very small indeed; the transformer that steps the supply down for distribution to houses has a secondary resistance of a very small fraction of an ohm, and the cables too have as nearly as possible no resistance. Besides that, all the thousands of things

*See *The Wireless World*, Feb. 17, 1938.

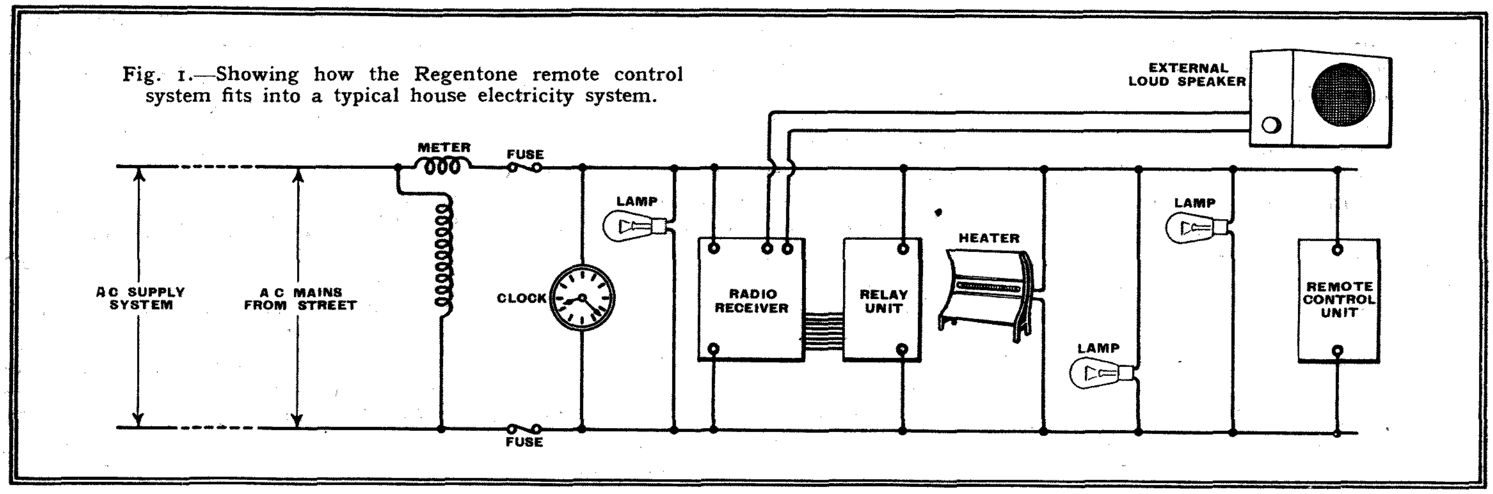


Fig. 1.—Showing how the Regentone remote control system fits into a typical house electricity system.

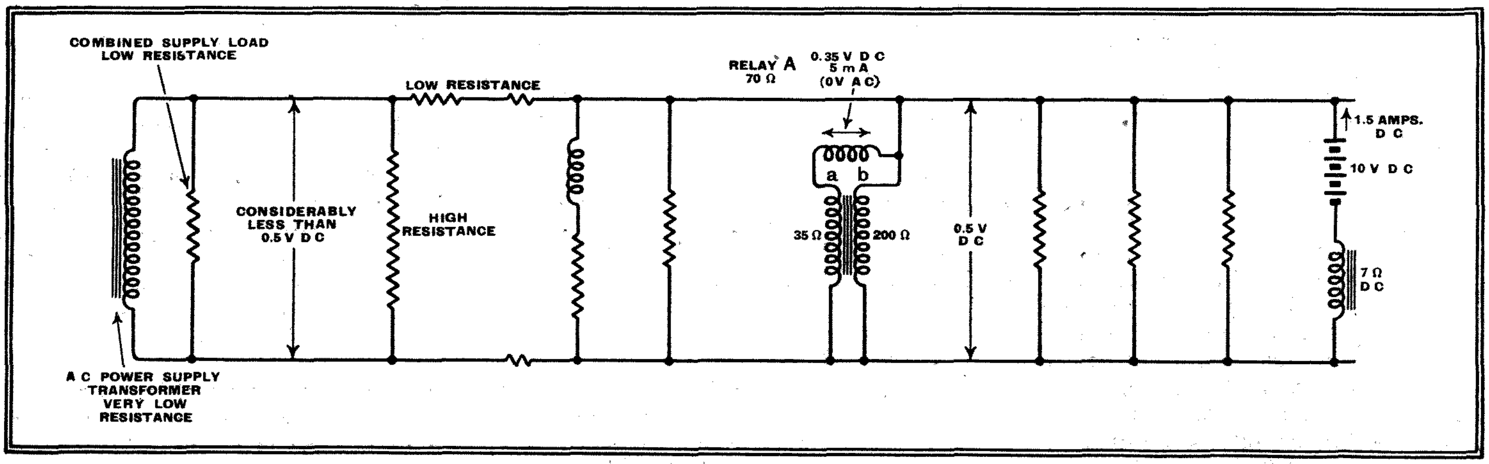


Fig. 2.—The equivalent electrical circuit in simplified form.

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connected in parallel all over the district are equivalent to a very low resistance. It would seem at first that any reasonable current that could be generated in a remote control unit would just pour into this "dead short," and produce no appreciable rise in voltage for working the relay unit, which itself must have a fairly high resistance in order not to take too much mains current. It is like trying to get a reading on a voltmeter that has its terminals shorted by a thick piece of copper. The relay unit must be extremely sensitive if it is to respond to the minute fraction of current that passes through its own relatively high resistance. And yet it must remain unmoved by the full mains AC voltage!

The problem would probably be quite insoluble if it were not for the meter and fuses (see Fig. 1). Although between them they are only a fraction of an ohm, it is a larger fraction than what lies beyond them—the whole electricity supply system. These two low resistances form a sort of potential divider with respect to any voltage that is developed on the house side, ensuring that only a small part of it appears across the mains on the supply side.

Fig. 2 is the electrical equivalent of Fig. 1. The DC source is shown for simplicity as a battery; actually the mains supply is stepped down and rectified to give about 10 volts, and this is connected in series with the mains transformer, which is designed to have a low DC resistance of about 7 ohms. The resistance across the mains being, as I have explained, fractional, this transformer is almost the only resistance in circuit, and the DC passed is 1½ amps. The voltage this can produce across the mains depends on the resistance there; at my place it was a third of an ohm, so something like half a volt DC became available. Actually, as the resistance of the house wiring is not altogether negligible, the voltage varies slightly from point to point.

Rejecting the AC

The next problem is to separate this small DC from 230 or so AC volts. This is done by means of the 1 : 1 transformer shown in Fig. 2. If the secondary voltage is exactly equal to the mains voltage, and the direction of the windings is the same, then the points *a* and *b* are at the same AC voltage and a sensitive relay can be connected there without risk. The resistance of the secondary winding is made low compared with the primary so as to persuade as large a proportion as possible of the DC to flow via the relay. With the resistances as marked, about two-thirds of the available voltage appears across the relay terminals, giving a signal current of 5 milliamps. The relay is of the polarised type; that is to say, the direction in which it moves depends on the polarity of the current, so by reversing the DC it is possible to obtain a different result, say, switching the set off instead of on.

That is the broad principle; to understand how the relay movements are translated into receiver control it is necessary to examine the constructional details. Fig. 3 shows the complete circuit diagram of the control unit, and although it is fairly simple there are one or two little points that have had to be considered in order to get workable results. A full-wave rectifier provides the DC supply, which is smoothed by one of the electrolytic condensers. The arms beneath the actual press-button arms, together with their upper and lower contacts, form a reversing switch for connecting the DC

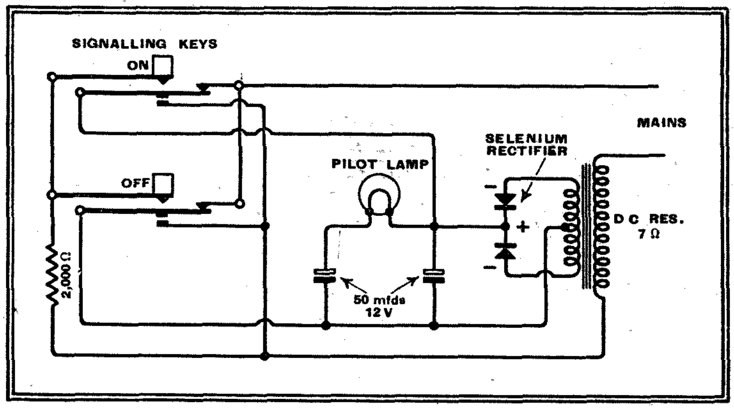

Fig. 3.—Full circuit diagram of the remote control unit.

either way in series with the mains. The "ON" button—which also selects the station according to the number of times it is pressed—makes, say, the lower mains lead positive, and pressing the "OFF" button makes it negative. But to avoid uncertainty due to possible momentary surges the top arms are provided, and connected so as first of all to short-circuit the electrolytic condenser and then to apply power through a 2,000-ohm resistor momentarily; then when the key is pressed right down the heavy current contacts short out the resistor and full power is supplied. To ensure that people do press the key right down, the pilot lamp is arranged so that it can glow only when an appreciable ripple voltage appears across the first electrolytic condenser, which happens only when the unit is functioning properly by sending a heavy current to line. The rectifier transformer has to be substantial, in order to have a low DC resistance and to stand the large signal current tending to saturate the iron core.

Turning now to the relay unit (Fig. 4), there are actually four relays, which I have labelled A, B, C and D. A is the sensitive polarised relay already mentioned. Its armature is an iron strip pivoted at *c* and kept in its normal position by the attraction of two magnetic poles *dd*. The remainder of the magnet can be seen (approximately) in the end view, A′. The armature is also magnetised by this magnet, so that the direction in which it moves when current passes through the coils *ee* depends on the direction of the current, and, therefore, on which button is pressed at the control. So one contact is marked "ON" and the other "OFF" in Fig. 4. When plugging in the control unit a preliminary test has to be made to find out whether the direction of the signals is right; if not, the plug must be reversed.

As there is such a very small current—about 5 mA—available for working this relay, it does not make a very firm contact and cannot be expected to control a large amount of current. On the other hand, a selector switch for controlling the motor tuning system does need quite a lot of current to work it. So an intermediate relay, B, is used. Another thing—and this is very important: as the station that is selected depends on the number of "ON" signals sent it is essential that there shall be no "chatter" at any of the relay contacts, which would send multiple signals and get a "wrong number." There is some risk of this at A, because even a fraction of one per cent. out of balance in the AC-rejecting transformer is enough to apply AC along with the feeble DC and cause vibration. So a very large capacity is connected across the coils of A to smooth out any ripple. Note also that they are connected both ways so as to short-circuit any surge that might otherwise pass through A as a result of switching.

Relay Operation

When an "ON" signal is sent, the "ON" contact is closed, causing DC provided by a local rectifier to pass through the coil of relay B. The rectified supply is about 10 volts and B is 50 ohms, so 200 mA is available for making a good firm contact. At the same time the local DC supply passes through a 1,000-ohm resistor to reinforce the original signal current through A by about 10 mA and hold its contact more firmly against possible vibration due to the resulting mechanical processes. These connections can be seen more clearly in the simplified circuit diagram, Fig. 5. Relay B does two things. It open-circuits the loud speaker, preventing it from reproducing clicks when station-changing; and it makes a contact allowing current to pass from the local DC supply through the 3-ohm coil of relay C. This heavy current is needed because C has to pull the selector switch round by means of a loop passing round a tooth of the ratchet wheel *f*, against the pull of the spring *g*. The selector switch arm starts in the position shown dotted, where it holds open the contacts *h*, in series with the mains supply to the receiver. So when relay C works it allows these contacts to close, switching the set on, and also switches on the tuning

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motor *via* contact 1. This is equivalent to pressing button No. 1 on the receiver. The corresponding station is tuned in.

Meanwhile, what is happening to the relays? The listener will by now be releasing the "ON" button. But you will remember that when relay A made contact it allowed 10 mA from the local supply to pass through its coils—enough current to keep it in contact independently of the distant signal. But when relay C came into action its low resistance dropped the supply from 10 volts to about 2, so the extra current is not enough now to prevent A from letting go immediately the distant button is released.

If the listener doesn't want station 1, he presses the "ON" button the number of times corresponding to the station he does want, and each time C moves the wheel another tooth forward and the selector switch another stud onward. The spring *g* is prevented from pulling the selector arm back again by the pawl projecting from the armature of relay D. The only way of going back to a lower number is to turn the set off and start all over again. When the "OFF" button is pressed, relay A connects with "OFF" and switches on relay D, which releases the selector arm wheel and allows it to fly back into its original position, cutting off the current to the receiver.

Although the general principle is fairly simple, you can see that quite a number of details have had to be ingeniously arranged in order to ensure that the selector does not jump forward several steps for each signal owing to bouncing contacts or vibration. The relays, in fact, are all mounted on rubber cushions. And the circuit values have to be carefully arranged in order to ensure that the system is always sensitive enough to respond to signals in the same house and never sensitive enough to respond to signals outside, or to mains fluctuations, etc. For instance, disconnecting one of the electrolytic condensers across relay A causes relay C to jump about all over the place when the button is pressed. It will be noticed, too, that the "LOCAL/REMOTE" switch, for transferring control from the receiver itself to the remote point, has an intermediate position besides the two labelled. The user is instructed to turn the mains on only when this switch is set to "LOCAL." If it were done with the switch at "REMOTE," the sudden surge that takes place when a transformer is switched on might upset relay A. To make quite sure that this doesn't happen, the transformer is switched on half-way between "LOCAL" and "REMOTE," but the relay is connected only at "REMOTE."

The purposes of the remaining connections between relay unit and receiver will be obvious.

It is impossible to run the receiver off a power point and the remote control off a lighting point because of the resistance of the intervening meters. Even the resistance of branch fuses may be enough to prevent reliable action. And owing to the low DC signal voltage, and the small margin in hand, it is essential for all the wiring to be free from any doubtful contacts or other minor faults that might otherwise be tolerated.

If the person at the remote end wants radio, and the switch is set to "LOCAL," he has to overcome his laziness and walk to the receiver anyway; also, if he is in a room where the control unit is not, he is likewise unlucky. In this respect I have rather a fancy for the very simple "W.B. Long Arm" system, because it requires only a push-button at each control point, and push-buttons are cheap enough to have in every room in the house. They are always ready for use, too, and are not tied to the control of AC sets, as they make use of the extension loud speaker wires. Strictly speaking, you are supposed to have triple wire, and with deplorable want of foresight I had twin wire installed. However, I did specify lead-covered, so this earthed sheath saved the situation by serving as the third wire. This system offers no station selection; but for moderate distances it is not out of the question to use multi-core cable for extending motor-tuned push-button connections, as is done by R.G.D. Special flat cable is made for the purpose.

Of course, if one wants to do the thing really mysteriously, without any wires at all, there is the Philco "Mystery" control. The receiver has to

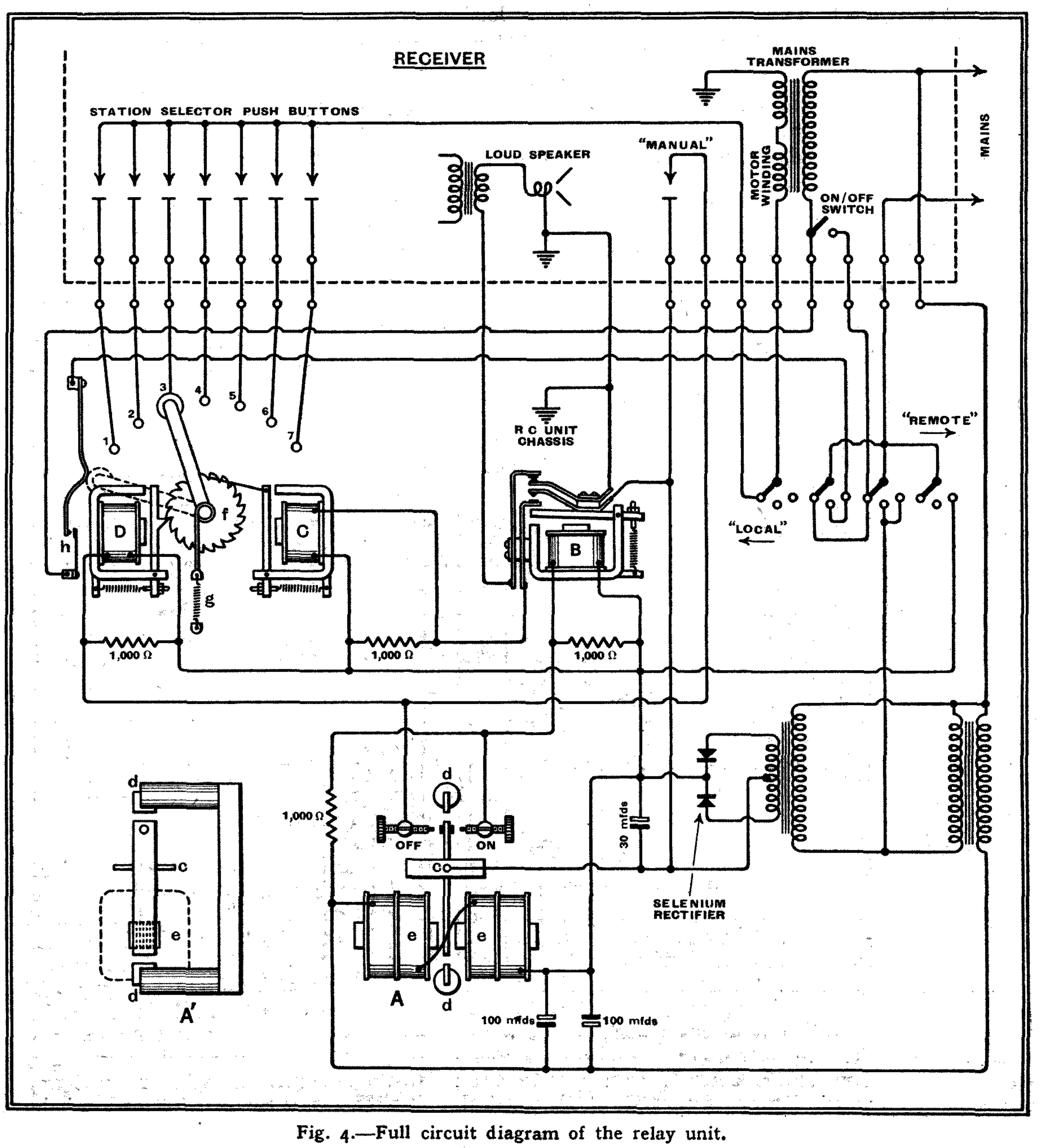


Fig. 4.—Full circuit diagram of the relay unit.

Remote Control—

be rather special, however. But it is certainly somewhere near the ideal to be able to control the set completely from any position. The proper listening post is serve the whole house (and garden) and so having to run it at its excessive volume. Strategically located extension speakers make it very much easier to be considerate to others, and remote control makes it

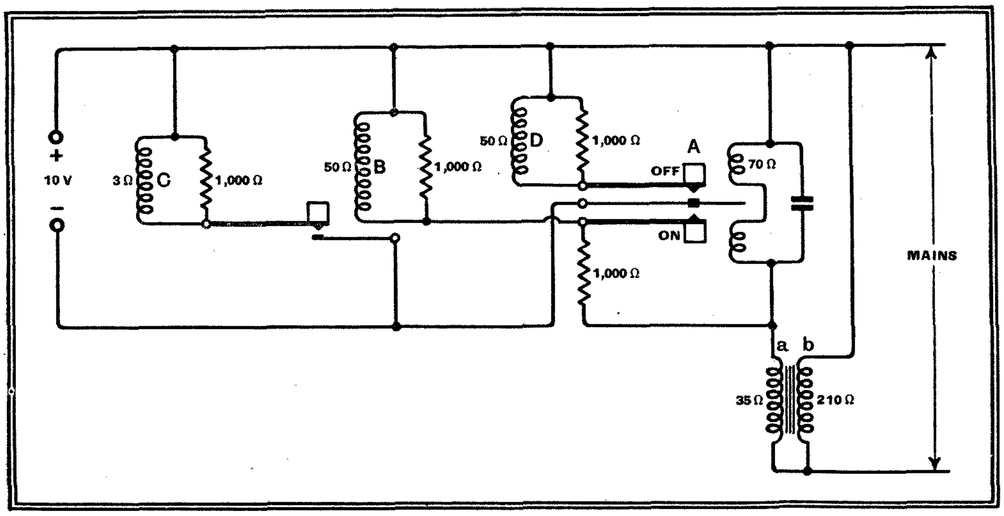


Fig. 5.—Circuit diagram of the relay unit simplified by excluding details such as switching for "local" receiver operation, to make the relay actions clearer.

generally not close to the loud speaker, and often not near any suitable wires.

Now that the lightening evenings remind us of the coming joys of summer and open windows and soft-scented zephyrs, etc., let them also remind us of the loud speaker nuisance that reaches its peak at that season. The general adoption of remote control would lead to a very material abatement of this nuisance, for a lot of it is due to making one loud speaker much easier to use extension loud speakers. Another thing: with remote control there is no excuse for letting the set shout on after the need for it has ceased. I know of people who let it continue through Stock Exchange news, farmers' bulletins, and so forth, not because they have any interest in these things, but because they can't be bothered to go through to the set and switch it off.

It is time to do something about it.

"W.A.C." and "W.B.E."

DISTINCTIONS IN THE AMATEUR TRANSMITTING WORLD

By **"ETHERIS"**

ALMOST every active British amateur transmitter displays on the walls of his wireless room two attractive certificates, one bearing the legend "W.A.C." and the other "W.B.E." These certificates denote that the operator has "Worked all Continents" and "Worked British Empire," and possession of them is a goal to which every newly licensed amateur aspires.

The "W.A.C." certificate is issued by the American Radio Relay League, and to qualify for its possession an amateur must be able to submit written proof of having communicated with a transmitting station in each of the six continents of the world.[1] The "W.B.E." certificate is issued by the Radio Society of Great Britain, and claimants must satisfy that body that they have been in contact with a British possession in five of the six continents in the world (to contact a British possession in all six continents would be almost impossible, since the amount of British territory in South America is very small and the amateur activity there negligible).

Special W.B.E. certificates for 10-metre and telephony working are also issued.

New Worlds to Conquer

In the last year or two, however, many amateurs have found the acquisition of W.A.C. and W.B.E. certificates "too easy." Advances in technique, improvements in apparatus and—be it regrettably whispered—the occasional use of more than licensed input power, have all helped the amateur to "Work all Continents" and "Work the British Empire" with comparative ease. So now they have set themselves up a new series of radio ninepins to be knocked down. Most of these are known by their abbreviations, as are the two awards already mentioned. For instance, there is the "W.A.S." award, which means "Worked All States"—of the U.S.A., that is. It is by no means an easy task, since there are very few amateur stations in Nevada, Utah and Arizona. The remaining forty-five states can be worked comparatively easily.

Another radio ninepin has the designation "W.A.Z." or "Worked All Zones." A "zone" is unknown to the ordinary man in the street, but has been created quite arbitrarily by the amateur transmitter to give him the pleasure of "working" it. Briefly, the world has been divided into forty longitudinal zones. Some of these zones pass through oceans or sparsely populated areas, and are therefore rather difficult to contact.

Yet a third aspiration for the DX-thirsty amateur is the "Century Club." To become a member of this unique

[1] South America is counted as a continent.—Ed.

LOGGING STATIONS. G6CJ of Stoke Poges is seen making an entry in his log book. A transmitter is seen to the left in the background.

"W.A.C." and "W.B.E."—organisation an amateur must be able to prove that he has communicated with one hundred different countries. As might be expected, there are several differences of opinion on what exactly is a country, and the American and British amateur organisations have differing lists. Almost absurd extremes are reached when the Channel Islands and the Isle of Man are regarded as separate countries, in spite of the fact that they both use the same call-sign-prefix as England, namely, "G." Individual countries should possess individual amateur prefixes.

Like Alexander the Great, the amateur transmitter appears ever to be seeking new worlds to conquer, even if he must create those worlds himself. His latest creation is "Worked All Counties of California," which indicates the ludicrous extremes to which some of them will go in order to give themselves something to do.

Most of these queer ninepins are American in origin, and since any American amateur can obtain a transmitting licence after passing the prescribed test, and, moreover, can employ up to 1,000 watts input, it is, perhaps, not surprising that he wants something to do when he has got his licence and his transmitter and his 1,000 watts.

Nevertheless, a certain percentage of British amateurs possess the same outlook. Not content with the quite laudable aim of securing the W.A.C. and W.B.E. awards, they feel they must go on until they have W.A.S. and W.A.Z. and joined the Century Club and done a lot of other harmless but not particularly valuable things.

The Construction of Short-wave Transmitters and Receivers

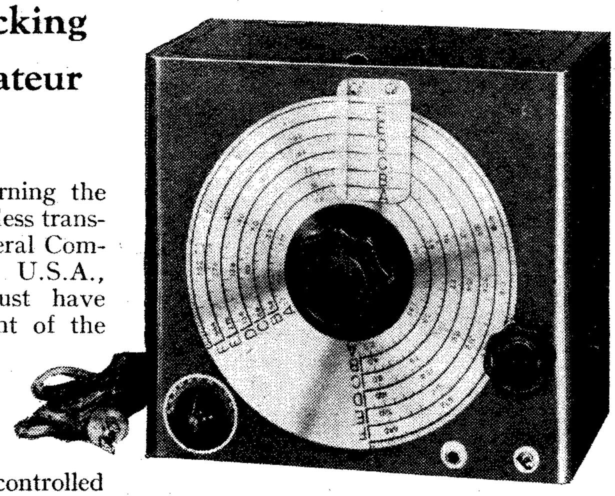
In the fourth number of the Eddystone Short-Wave Manual (second edition) detailed instructions are given for building amateur transmitters and receivers. These include a neat miniature 20-watt transmitter for the 7 and 14 Mc/s bands, a crystal-controlled CW transmitter covering the RNWAR and RAFCWR bands, in addition to the usual amateur frequencies. Receivers range from a simple two-valve set with plug-in coils to a nine-valve communication superhet. with 1,600 kc/s IF and tuning range of 9 to 57 metres. Circuit and wiring diagrams are given, together with a list of suitable parts.

A number of accessories to transmission are also described, and these include a cathode-ray modulation meter using a 3-inch tube, a field strength indicator, absorption wavemeters and a valve keying unit to eliminate key clicks in CW transmission.

The treatment throughout the booklet is essentially practical and gives just the sort of information required to get a station into being with the least possible delay. Copies are obtainable, price 1s. 2d. post free, from Stratton and Co., Ltd., Bromsgrove Street, Birmingham.

Stable Frequency Meter

Designed for Checking Wavelength of Amateur Transmitters



The meter is direct-reading, with separate scales for each of the bands covered.

THE new regulations governing the operation of amateur wireless transmitters, issued by the Federal Communication Commission in the U.S.A., require that every station must have means for accurate measurement of the transmitter frequency independent of the transmitter itself. That is to say it is no longer possible to assume that the frequency is within the allotted band merely because a crystal-controlled oscillator is employed.

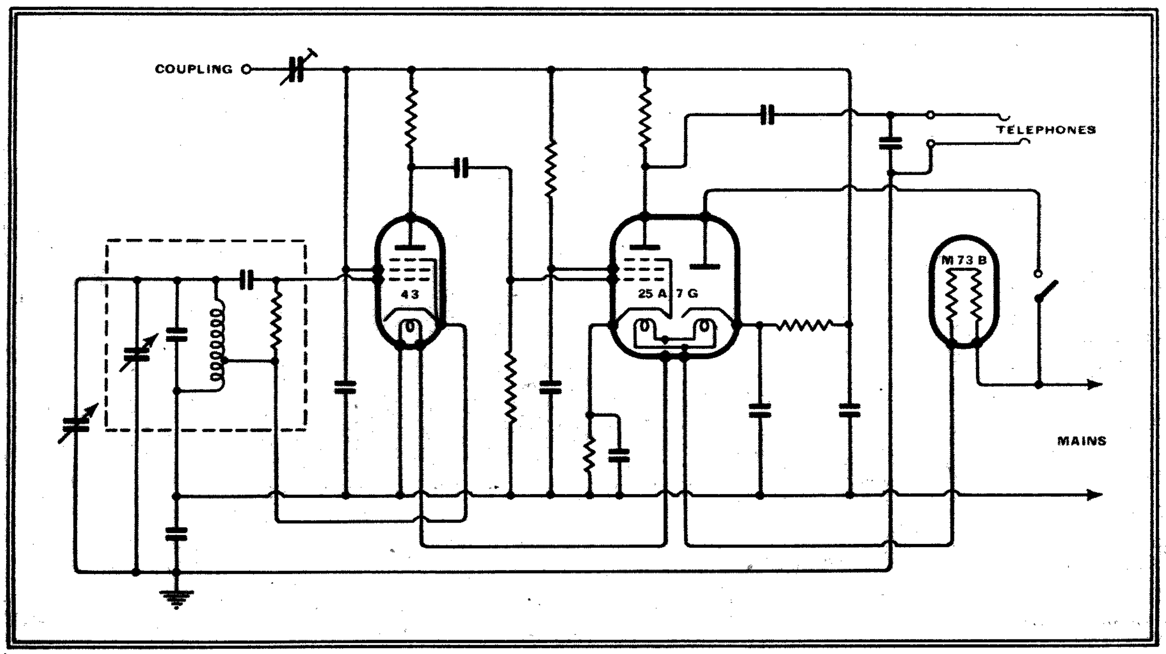
To enable the U.S. amateur to comply with this ruling Edwin I. Guthman and Co., Inc., of Chicago, have introduced a new heterodyne wavemeter described as the Guthman U10 Frequency Meter-Monitor.

Special care is taken in the construction to ensure stability of operation. An electron-coupled oscillator circuit is employed, and this is followed by a Type 25A7G valve functioning as an amplifier and as a half-wave mains rectifier for HT supply. As each range covers a relatively small band of frequencies it is possible to include quite a large fixed condenser across the coil, in addition to the variable condenser, so that small variations in valve capacity have negligible effect on the frequency, and this fixed condenser has a substantially zero temperature coefficient.

There are six scales calibrated in frequency, their respective coverages being: 1.7 to 2.0; 3.4 to 4.0; 6.8 to 8.0; 13.6 to 16.0; 27.2 to 32.0 and 54.4 to 64.0 Mc/s.

It is intended that the calibration should be checked from time to time against standard frequency transmissions and also compared with the frequency of short-wave broadcast stations which have to maintain a high accuracy. There is thus included a calibration setter consisting of a very small variable condenser in shunt with the tuned circuit.

The frequency meter is mains operated, and it is claimed that the drift over a 24-hour test does not exceed 1 cycle in one million.



Circuit diagram of the high-stability meter.

New American "Quality" Receiver

By L. G. PACENT and H. C. LIKEL
(Pacent Engineering Corporation, New York)

HIGH-FIDELITY SET WITH ELABORATE TONE COMPENSATION

HERE is a receiver that differs radically from the majority of American high-performance sets with which it will naturally be compared. The radio-frequency section is essentially designed for local-station work, and is so arranged that it can be used as a remote-control unit.

THE receiver to be described in this article represents a decade of research and development which started with the notable work on tone compensation of J. G. Aceves, for many years assistant to Professor M. I. Pupin, of Columbia University. This was followed by development work in an endeavour to incorporate this basic development in an acceptable commercial instrument.

"Tone compensation" is an expression that should not be used indiscriminately and thoughtlessly, and without regard to its true meaning. The tone compensation as used in this receiver is actual compensation for broadcast attenuation, room acoustics, recording and broadcast deficiencies and other imperfections which tend to destroy the fidelity of the original rendition.

Since Aceves read his classical paper on Tone Compensation before the Radio Club of America in June, 1930, many other papers and articles have been published on this subject. Nevertheless, it has only been within the last year or so that radio and sound engineers have realised that true high-fidelity reproduction is impossible without proper and sufficient tone compensation.

The new Pacent receiver design differs from the ordinary standardised set in the following ways: It is strictly for high-fidelity reception. It includes no short wave, no push buttons and no tuning indicator. The TRF tuner is on a very small chassis separate from the amplifier, so it provides remote control. The audio system contains separately controllable compensation for the high and low frequencies, the adjustments of which are mounted on the tuner chassis. Ten watts of undistorted power output is available at the speaker voice coil. A permanent magnet speaker is used.

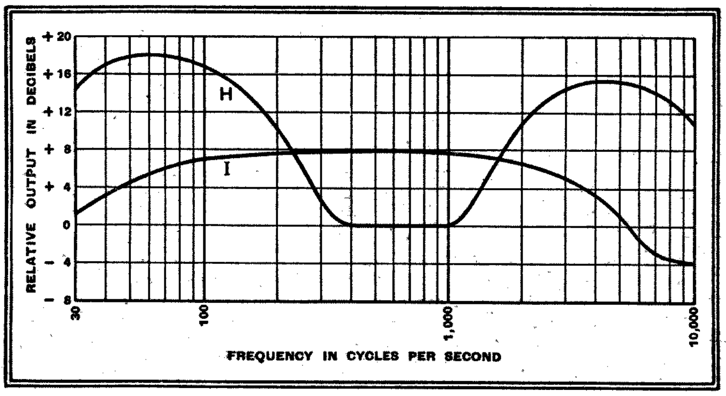


Fig. 2.—Audio-frequency curves of the "gramophone" section of the receiver for different settings of the treble and bass compensation controls: both set at maximum (H) and at minimum (I).

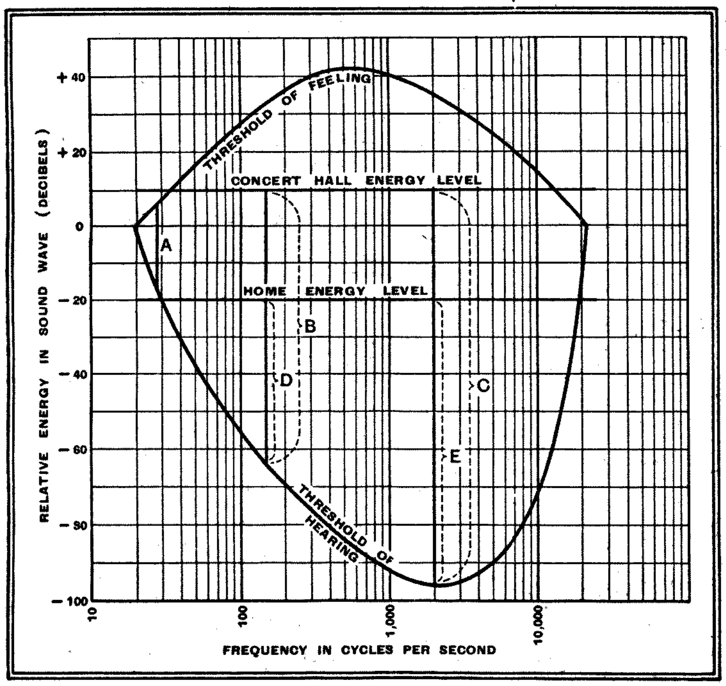


Fig. 1.—Audibility chart showing energy levels with respect to the field of audition.

It is well known that, except under unusual conditions, a highly sensitive and selective receiver is required to reproduce signals from distant stations satisfactorily. The quality of such signals when reproduced, because of high signal-to-noise ratio, tendency to fading, and side-band cutting by the receiver, cannot be called high fidelity. Further, it is also well known that, under any conditions, a specialised receiver capable of wide band acceptance and proper audio and speaker characteristics is necessary to reproduce a high-fidelity signal from any station. Signal-to-noise ratio and fading conditions can only be depended upon to be good in the primary service area of a station. Therefore this receiver need not be sensitive. Thus it is seen that the attributes of a long-range receiver and those of a high-fidelity receiver are almost exact opposites. Any attempt to combine them in the same receiver must make that receiver considerably more costly and probably reduce the effectiveness with which it fulfils both of its functions.

Manual Tuning Only

As a high-fidelity receiver must be tuned accurately at all times, the idea of employing push-button tuning was dropped. Moreover, with an insensitive receiver, where the dial is not crowded with stations and where only a few of those available are to be tuned and their location may be marked on the dial, manual tuning is not a hardship.

A tuning indicator might be desirable, but it cannot be operated from the regular circuits of a high-fidelity receiver. This is due to the fact that in this type of receiver the acceptance curve must be relatively flat around the carried frequency of the station being tuned. Inasmuch as the tuning indicator indicates, in effect, the amplitude of the acceptance curve at the carrier frequency of the received signal, the receiver may be considerably detuned without the indicator showing any change

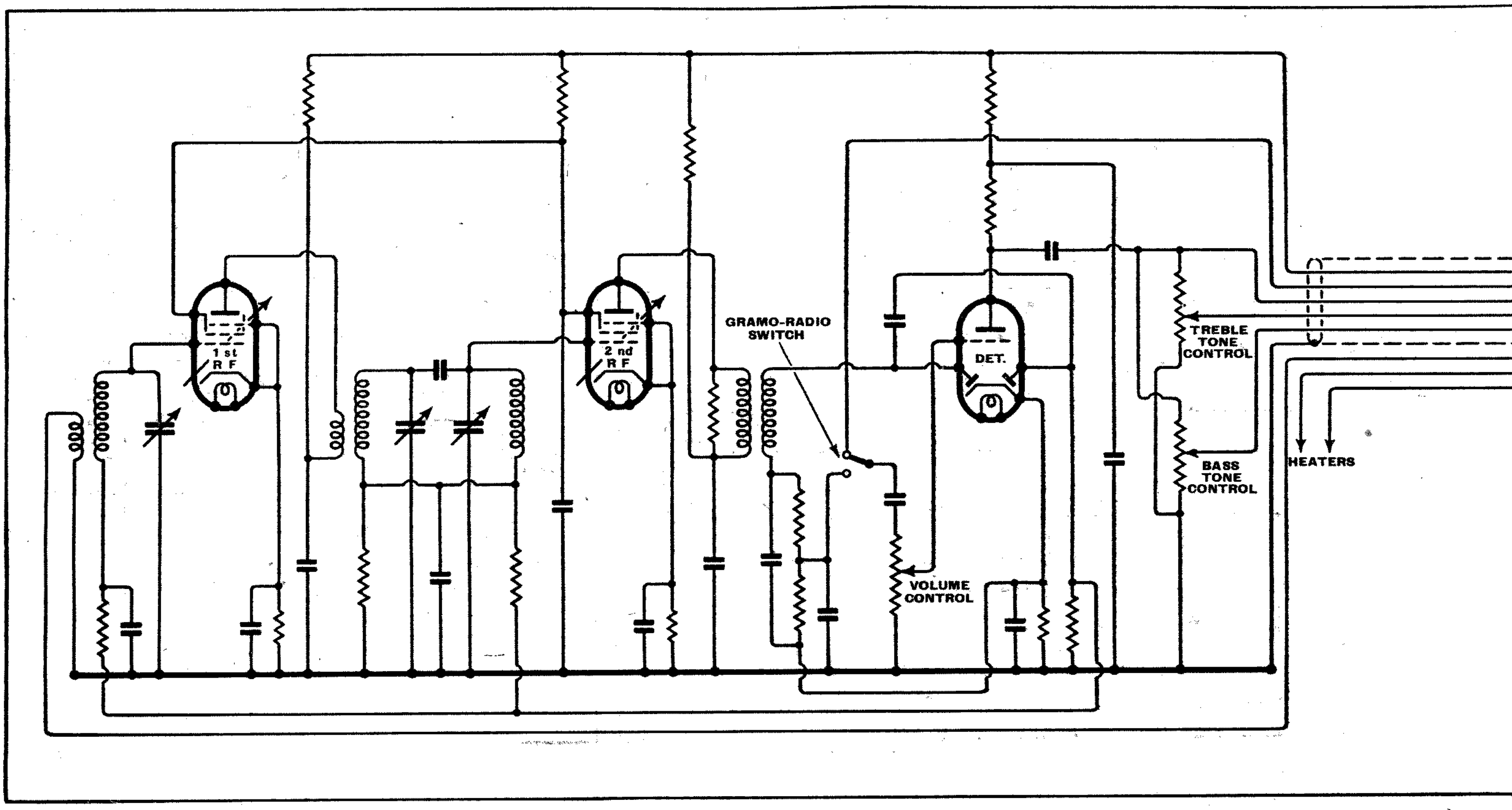


Fig. 3.—Circuit diagram of the complete receiver. The tuner-detector unit, on the left, is joined to the audio-frequency section by a multiple cable through a plug-and-socket connector.

in value. This difficulty may be overcome by including extra sharply tuned circuits tracked to the centre of the high fidelity band-pass circuits. These circuits would serve no purpose but the operation of the tuning indicator. As they complicate the design, increase the tuner size and cost—and in the final analysis the ear is the ultimate judge as to whether the receiver is properly tuned—it does not seem good judgment to include them in the design.

Of course, as soon as it is stated that the receiver need not be sensitive the question arises, shall it be of tuned radio frequency or of superheterodyne design? This question can be debated at great length from a purely technical point of view without reaching any conclusion. This very fact indicates that either type of circuit can be made to perform its functions satisfactorily. It must be remembered, however, that any noise detracts tremendously from the entertainment value of a high-quality signal. Generally it is conceded that a superheterodyne circuit generates more noise and brings in many more beat notes of all kinds than an equivalent tuned radio-frequency circuit. Thus the selection must fall on TRF.

The tuned radio frequency circuit of this receiver consists of a conventional high-gain aerial input coupling giving as good a signal-to-noise ratio as possible. This is followed by a band-pass coupling to a second RF amplifier, which is linked to the detector and AVC diodes by an untuned transformer. AVC is applied to both RF stages. The result is a circuit with very broad band acceptance but sufficient selectivity to avoid interference in such a relatively congested area as that in and around New York City. To keep down distortion the AVC has been made just great enough to prevent blasting when changing from the weakest to the strongest station within the proper range of the receiver. The band covered is from 500 kc/s to 1,600 kc/s—that is, 190 to 600 metres.

This circuit has been built on a chassis only 8⅛in. × 4⅛in. × 3⅝in. over the chassis only, or 8⅛in. × 4⅛in. × 6in. over the dial and knobs. This small size lends itself to remote control and as a matter of fact the design was worked up with it in mind. This was done because it is believed that a high-fidelity receiver should be tuned and the tone adjusted from the point at which it is to be listened to or as near there as possible; at any rate, never from a position immediately adjacent to the loud speaker, the usual "all in one cabinet" practice. By having the tuner connected to the amplifier chassis by a cable it becomes possible not only to tune and control volume as is done in the usual remote control devices, but also to control the high and low frequency compensation, a very important feature.

"Scale Distortion"

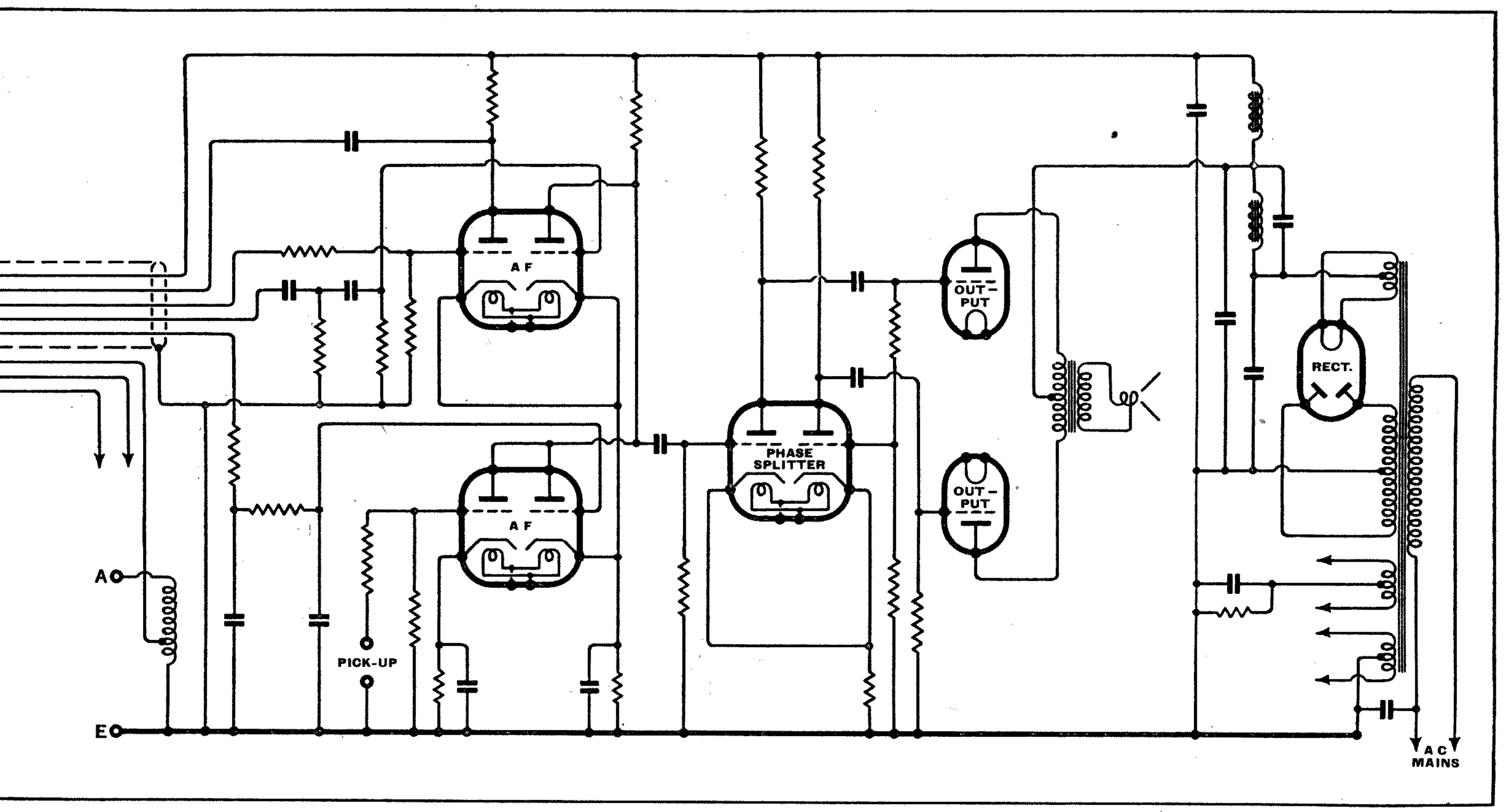
Of course, there are those who will maintain that since many of the broadcasting stations now claim to be linear from the microphone to the aerial up to at least 8 kc/s, the receiver needs no compensation. They are quite correct if this reproduction is to be at the same level as that of the original. This is usually not the case, however, particularly for those musical items for which high-fidelity reproduction is most important. The maximum allowable loudness in the home is much less than the best loudness for such musical items. Under these conditions compensation is absolutely necessary if the reproduced sound is have the same tonal balance at domestic volume as it would have if listened to at concert volume.[1] A little study of the graph showing the field of audition will disclose the reason. See Fig. 1.

Suppose that we ran through the frequency spectrum, generating a sound wave which at every frequency contained the amount of energy representing the greatest loudness in a sound wave from a symphony orchestra listened to in a concert hall. The loudness as indicated by the ear at any frequency would be in proportion to the ordinate included between the threshold of hearing and that energy level, or the threshold of feeling, whichever is lower, as for instance ordinates A, B and C.

Now suppose we run through the frequency spectrum again in the same way, but at the energy level representing maximum home loudness. Here we see that the sound at the frequency of A, which at the higher energy level was about ⅓ as loud as the maximum loudness, as represented by C, is not heard at all.

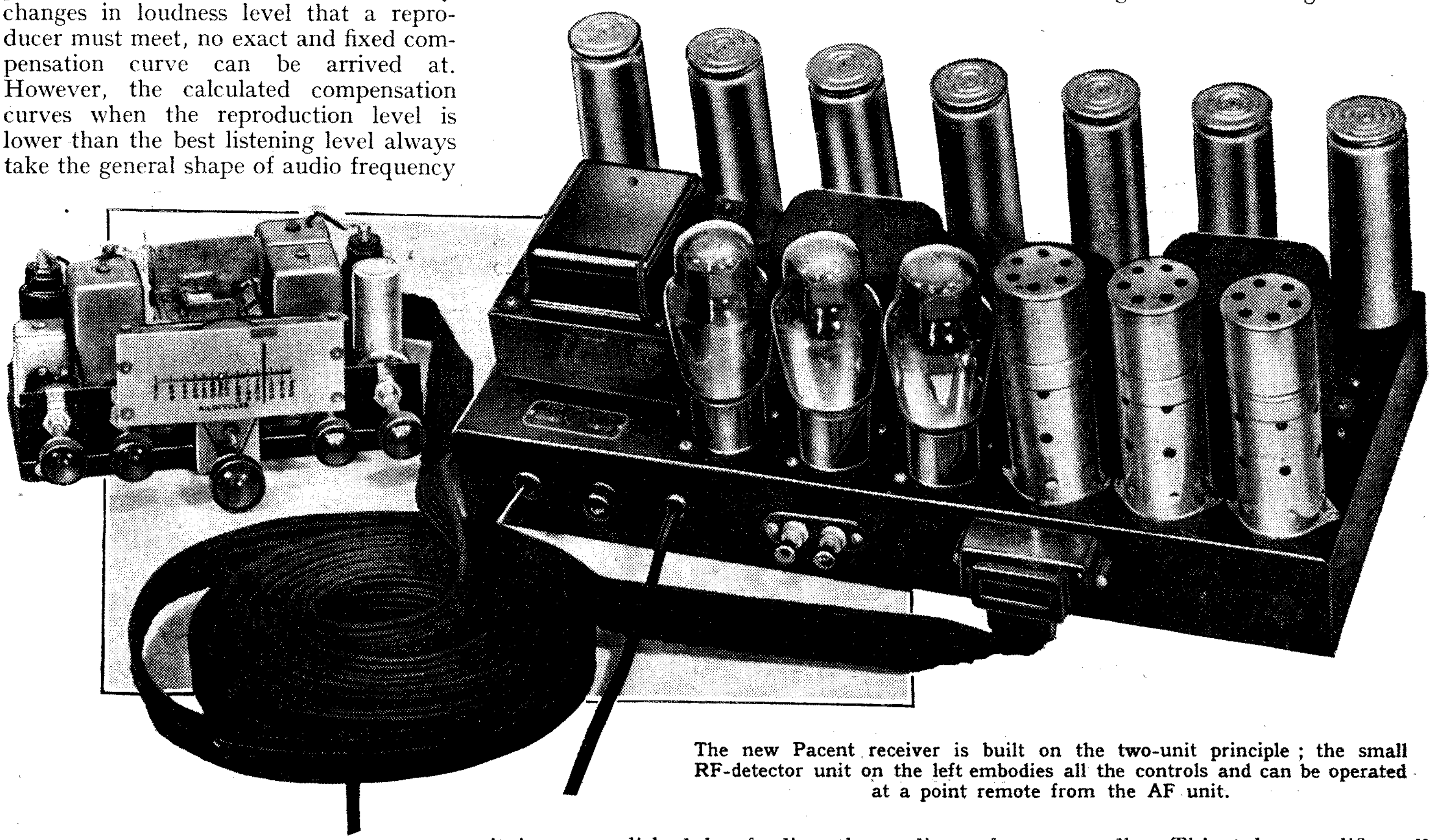
Originally the ordinate B was about 90 per cent. that of the maximum, C. Now the corresponding ordinate D is only about 70 per cent. of the maximum at its energy level, E. This changing in the

[1] For a simplified explanation of this effect see "Scale Distortions" *The Wireless World*, Sept. 24th, 1937.—ED.



loudness ratio between the middle frequencies and the "high" and "lows" must occur every time the reproduction level is changed. Because of the different heights of the various frequency components in each sound wave and the many changes in loudness level that a reproducer must meet, no exact and fixed compensation curve can be arrived at. However, the calculated compensation curves when the reproduction level is lower than the best listening level always take the general shape of audio frequency response curves with the bass and treble adjustments at full on. When the reproduction level is greater than the best listening level the compensation curve takes the opposite shape. This is the shape of the audio characteristic when the bass and treble controls are set at minimum. Fig. 2 shows these two curves.

This compensation and the control over it is accomplished by feeding the audio frequency output of the radio chassis to the amplifier over three separately shielded lines. One of these lines connects directly to the source of the audio voltage; the other two are connected to this point through potentiometers. On the amplifier chassis are found three 6C8G twin triode amplifier tubes. The direct line connects to one of the grids through a linear voltage divider which gives a loss of over 20 db. This tube amplifies all frequencies delivered to its grid equally. The two lines from the potentiometers go to two other triode element grids, one reaching its grid through a non-resonant



The new Pacent receiver is built on the two-unit principle ; the small RF-detector unit on the left embodies all the controls and can be operated at a point remote from the AF unit.

New American "Quality" Receiver—

low pass filter, the other through a non-resonant high pass filter. The output of the three tubes is joined in the plate circuit. Obviously, at this point, when the potentiometers are at "full," the pass frequencies of the filters will be greater in magnitude than other frequencies by approximately the loss in the linear voltage divider, minus any loss in the filters.

By proper adjustment of the volume control and the bass and treble controls any degree of compensation between the two extremes shown by the curves may be had. Of course, full positive compensation should only be used when operating at extremely low volume. The greater the loudness of the reproduction the less compensation needed until at the maximum loudness of which the set is capable the compensation controls should be set at minimum position, which, because of the distributed constants in the cable and elsewhere results in the proper shape of response curve for this condition.

To employ ample compensation, as is done here, a relatively large power output must be available. For instance, when 16 db. of bass compensation is used a 50-cycle note will demand the full 10 watts output of which the amplifier is capable when the middle frequency is only 0.25 watt. As this is a good setting for the average living room it makes it obvious that any instrument with lower output must either overload on the bass or be insufficiently compensated.

Controlling Gramophone Reproduction

So that gramophone reproduction may be controlled from the remote RF chassis, the crystal pick-up output is fed through one of the 6C8G triode elements which is used as a line matching device. The output of this tube is delivered to a shielded wire in the cable which connects to the gramo.-radio switch on the RF chassis. The remaining two triodes are used in a phase splitting circuit which feeds the push-pull output stage, in which a pair of 6A3 triode valves are used.

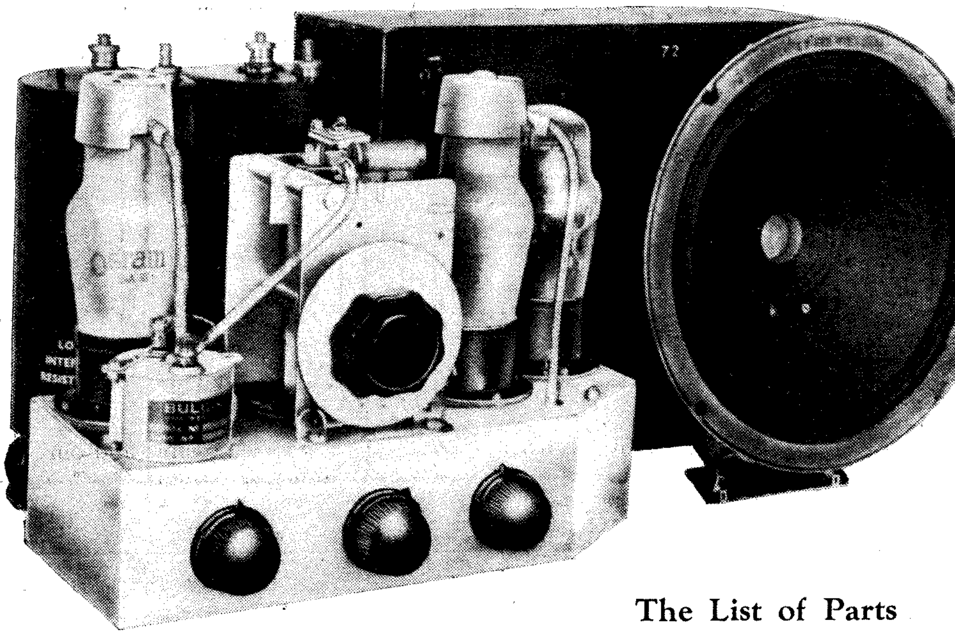
To keep the entire design on the same high plane only class "A" amplification has been used throughout and only triode tubes in the audio amplifier. A 10-kc/s filter is provided for use when needed.

The actual reproduction of the sound has been entrusted to a special 12in. high-fidelity permanent magnet speaker. This gives an advantage over any electric field speaker which requires a hum bucking coil to eliminate hum. The very presence of the hum bucking coil is an admission of an AC component to the flux density in the air gap. Although the hum bucking coil sets up in the voice coil circuit an equal and opposite EMF to that generated in the voice coil itself by the AC flux and thus makes the speaker quiet when no signal is applied, it does not prevent this AC flux from modulating any signal when it is applied. This effect does take place, and it can be very easily proven either mathematically or experimentally.

In Next Week's Issue

The Stand-by Three

SELF-CONTAINED BATTERY RECEIVER



ALTHOUGH a mains-operated set may be used for ordinary listening, there are many occasions on which a separate battery receiver is of value. It forms a good emergency receiver for use in the event of a failure of the mains supply and it is available for service if the regular set breaks down; in addition, it is a convenient portable set for use out of doors or away from home where no mains supply is available.

The construction of a battery set also forms one of the best introductions to wireless and has consequently an especial appeal to the beginner. "The Stand-by Three" is of especial interest from this point of view, for it is not only simple but capable of an outstandingly good performance.

The Circuit

Three valves are used and are arranged as an RF amplifier, grid detector and pentode output stage. There are two tuned circuits and the set covers the medium and long broadcast bands. Quite high sensitivity is obtained, for it is intended that the set be used with a small aerial. Some fifteen feet of wire indoors, or hung out of a window, is adequate for the reception of the local stations in most circumstances.

In view of its category as a stand-by receiver dry batteries are used for LT as well as for HT. The consumption is 0.2 amp. at 6 volts for LT and 9 mA. at 120 volts for HT; with the sensitive moving-coil loud speaker good volume and quality are secured.

The List of Parts

1 Condenser, 2-gang, 0.0005 mfd. — **Polar "Bar"**
1 Dial — **Eddystone 1099**
1 RF Choke — **Bulgin HF8**
1 Trimmer — **Bulgin SW99**
2 Screened Grid Cap Connectors — **Bulgin P64**
2 Valve Holders, 7-pin (without terminals) — **Clix Chassis mounting standard-type V2**
1 Valve Holder, 5-pin (without terminals) — **Clix Chassis mounting standard-type V1**

Fixed Condensers:
3 0.0005 mfd., tubular — **T.C.C.451**
1 0.0001 mfd., tubular — **T.C.C.451**
1 0.002 mfd., tubular — **T.C.C.451**
1 0.005 mfd., tubular — **T.C.C.451**
2 0.1 mfd., tubular — **T.C.C.341**
1 50 mfds., 12 volts, electrolytic — **T.C.C. "FT"**

1 Reaction Condenser, 0.0002 mfd., differential — **Bulgin N23**

Resistances:
1 100 ohms, ½ watt — **Erie**
1 500 ohms, ½ watt — **Erie**
1 10,000 ohms, ½ watt — **Erie**
1 65,000 ohms, ½ watt — **Erie**
1 200,000 ohms, ½ watt — **Erie**
1 500,000 ohms, ½ watt — **Erie**
3 2 megohms, ½ watt — **Erie**
1 10 ohms — **Bulgin AR10**

1 Potentiometer, wire-wound, 500 ohms — **Reliance "TW"**
1 Switch, 3-way, 6-pole — **Bulgin S208**
1 Set of Coils, PA1, PA2, PHF1 and PHF2 — **Wearite**
1 Battery Cable, 4-way — **Bulgin BC2**
1 Length screened sleeving — **Goltone**
3 Knobs — **Bulgin K10**
4 Connectors — **Clix No. 22**
Cabinet — **Peto-Scott**
Chassis — **B.T.S.**
Miscellaneous: — **Peto-Scott**
4 lengths systoflex, 1 oz. No. 22 tinned copper wire, 2 wander plugs. Screws: 36 ¼in. 6 BA R/hd., 3 ½in. 4 BA R/hd., all with nuts and washers.
Loud speaker, PM, with transformer to give 12,000 ohms load — **Goodmans B/605/12000**
2 Dry Cells, 3 volts — **Ever Ready 2062**
1 HT Battery, 120 volts — **G.E.C.BB50**

Valves:
2 W21 (7-pin metallised), 1 KT2 — **Osram**

Cathode-Ray Tubes

THE STORY OF THEIR DEVELOPMENT FOR TELEVISION RECEPTION

(Concluded from page 244 of last week's issue)

By O. S. PUCKLE, A.M.I.E.E.

Continuing the history of the cathode-ray tube the steps which led to the present high-vacuum television tubes are discussed. The chief differences between electrostatic and electromagnetic tubes are treated and some modern tubes of special design are explained.

THE next important development was made by Bedford, in England, and by von Ardenne, in Germany, at the same time. They added to the cathode-ray tube an already known device, viz., the Wehnelt cylinder, which takes the form of a metal cylinder surrounding the cathode.

The function of the Wehnelt cylinder is to control the rate of flow of electrons from the cathode: when the cylinder is made more negative the beam current or, in other words, the number of electrons forming the beam, is reduced.

In gas-focused tubes, instead of controlling the heating current, the potential of the cylinder may be varied to control the ionisation of the gas and hence to focus the beam. Obviously the application of a television picture signal to the cylinder of a gas-focused tube will control the brilliancy of the fluorescent spot but, since it also alters the focus of the beam, a gas tube is useless for intensity modulation systems. Bedford's tube containing a grid and another invention of his, a shield surrounding the deflectors for the purpose of collecting return electrons from the screen, is shown in cut-away form in Fig. 11. The presence of the shield surrounding the deflector plates is of great value, since it has the effect of increasing the input impedance of the deflector plates and thus increases the accuracy of measurements made with the tube, especially when examining the potentials across high impedance circuits.

Although it is not generally appreciated, the addition of the Wehnelt cylinder, or grid, as it is now generally known, is by far the most important contribution to the development of the cathode-ray tube so far as television is concerned. Even some of the original tubes could, at least in theory, have been used for television reception provided they were fitted with a grid and none of the more modern tubes would have availed for this purpose without it, so that had no one carried out this important work, intensity modulation television, as used to-day, would have been impossible and only the velocity modulation system [20, 26] could have been employed.

Although it is believed that Wehnelt designed his cylinder about the year 1905, the author has been unable to find any record of its use in a cathode-ray tube prior to the work of Bedford and von Ardenne.

It is of interest to speculate on the probable development of television had there been no means of modulating the intensity of a cathode-ray beam. Either television would have developed along purely mechanical lines, at least so far as reception is concerned, or a velocity modulation system would have been adopted and, in this case, mechanical receivers would have been out of the question.

In case some readers are unfamiliar with the salient features of velocity modulation as applied to television they will be briefly described. In an intensity modulation system, such as is employed at the Alexandra Palace, the instantaneous illumination of the receiving fluorescent screen is controlled by the application of a varying potential to the grid. This potential varies in amplitude with the light and shade in the transmitted scene. On the contrary, however, in a velocity modulation system the apparent instantaneous illumination is varied by altering the rate at which the beam is made to scan the fluorescent screen. Thus, when the beam traverses the screen slowly the illumination, as seen by the eye, is brighter than when it is made to traverse rapidly. By constantly varying the rate of traverse in accordance with the degree of light and shade in the transmitted scene, an image of the scene can be reconstituted at the receiving end. Such a system has several advantages—the illumination of the received scene is greater, since no light is abstracted (as is the case with the intensity modulation system), but is merely removed from the darker parts and added to the lighter parts of the scene. Since the beam current is constant, defocusing and spot enlargement do not take place as happens when the spot brilliancy is increased in the present system. As the picture and scanning information are inseparable, no line synchronising signals are required. On the other hand, as pointed out above, mechanical reception becomes impossible.

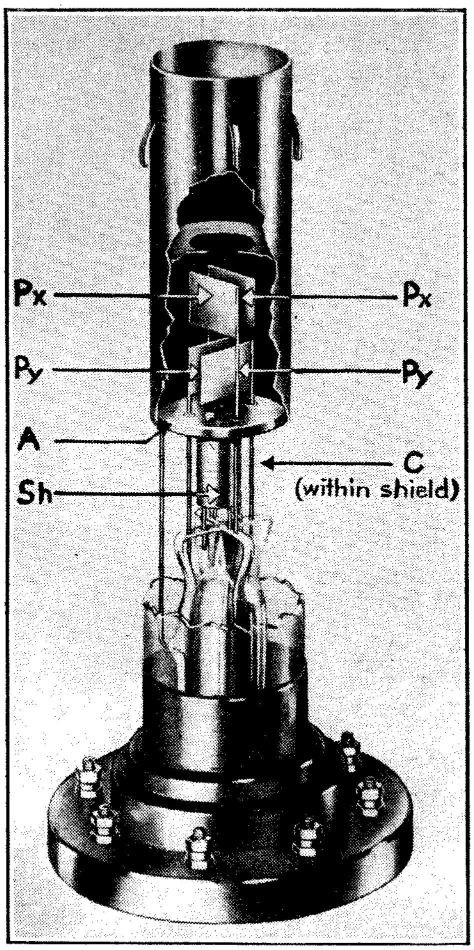


Fig. 11. Bedford tube made by A. C. Cossor, Ltd.

Fig. 12. The effect of origin distortion.

Origin Distortion

It was obvious as long ago as 1934 that gas-filled cathode-ray tubes were quite unsatisfactory for intensity modulation television systems, and many engineers commenced work on the development of a suitable high-vacuum, or hard, cathode-ray tube. Amongst these may be mentioned the names of Zworykin [22], von Ardenne, Bedford, Brucke [25], Scherzer [25], Knoll and Ruska [10], all of whom have done valuable work in this field.

Several workers in the field of cathode-ray technique have attempted to overcome

Cathode-Ray Tubes—

a peculiar effect known as origin distortion. This is an effect due to the presence of the gas and results in a reduced sensitivity for a few volts on either side of the zero value of deflecting plate potential. It is, however, absent with magnetic deflection. The effect of origin distortion is shown in Fig. 12, and the only satisfactory method of overcoming the effect is an extremely ingenious one due to von Ardenne, who suggested that one plate of each pair of deflectors should be split in half at right angles to the direction of the beam. When this is done, the application of an appropriate fixed DC potential between the two halves of the plate enables the point at which origin distortion occurs to be shifted away from the used portion of the screen and, indeed, it may be removed entirely from any part of the screen area by the application of a sufficiently large potential. A tube in which origin distortion arrangements are applied to each pair of plates is shown in Fig. 13.

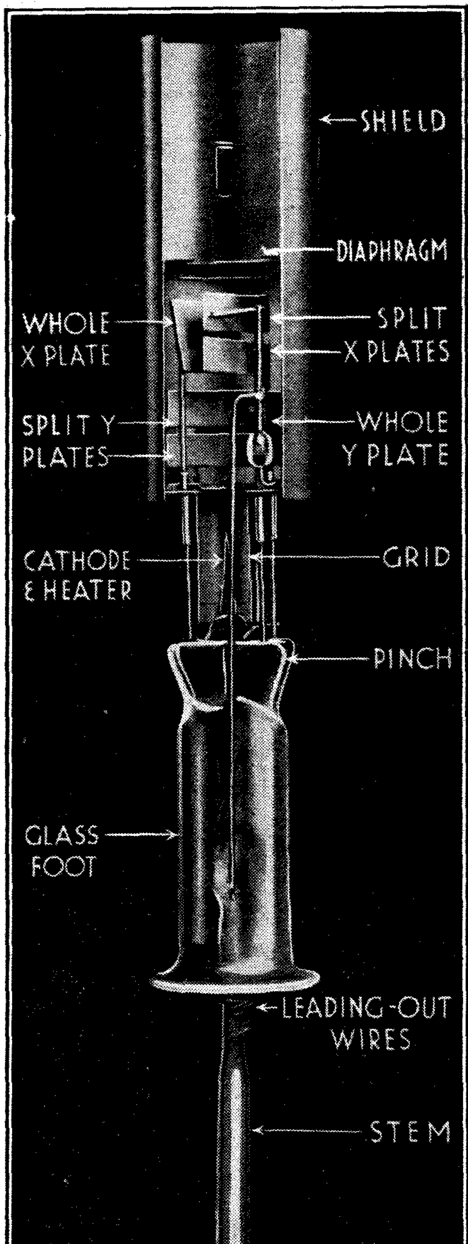


Fig. 13. Bedford tube incorporating von Ardenne's split-plate arrangement for avoiding origin distortion.

In the high-vacuum cathode-ray tube the electron beam is brought to a focus by means of potentials applied to diaphragms and/or cylinders, the whole assembly being known as an electron lens. In the case of a striction coil, the electrons are constrained to follow convergent helical paths by the action of a magnetic field but, in the case of electrostatic fields they travel straight along the length of the tube instead of in helical paths. An electron lens has almost the same effect upon a beam of electrons as an ordinary glass lens has upon a beam of light. There is, however, one great difference in that light is bent by passing from one medium to another in which the refractive indices are different, e.g., from air to glass, bending taking place only at the junction of the two surfaces. While passing through the glass of the lens no bending takes place, but the beam is bent a second time at the point of emergence from the lens, i.e., at the second junction of the glass and air surfaces. In the case of an electron lens consisting, for instance, of two parallel plates each having a hole in its centre, the application of two different potentials to the two plates gives rise to an electrostatic field of force and, consequently, to a potential gradient between them. A beam of electrons passing through the holes experiences an accelerating or, for a reversal of polarity, a decelerating force and a radial force during the whole of its passage between the plates. The change of refractive index of the electron lens is thus continuous along the path of the beam between the plates, with the result that the beam follows a curved path through the lens instead of being bent only upon entering and leaving the lens as is the case with a beam of light and a glass lens.

The Electron Lens Structure

Electron lenses can be of single-stage form, as a light lens in a reading glass, or they may be complex as in the case of a microscope. Furthermore, it is also possible to make an electron mirror.

Electron beams and electron lens systems evince many of the effects of light beams and lenses. Electron beams may be convergent, divergent or parallel and they may exhibit the effects of coma, aberration and astigmatism. Moreover, electron lenses may be spherical or cylindrical, and electron prisms are also used. The deflecting plates in a cathode-ray tube, for instance, are electron prisms whose refractive index and, consequently, deflecting power are varied by altering the potentials applied thereto.

The simplest practical form of electron lens system consists of a cathode surrounded by its grid and having two pierced parallel plates mounted with their central holes in line with the cathode. The grid is made negative with respect to the cathode while the first anode has a positive potential of some hundreds of volts and the second anode a positive potential of some thousands of volts. However, this form of tube is not much in evidence nowadays, and the more common forms consist either of two or three cylinders becoming progressively larger as they are farther from the cathode or two plates, as in the simple form of tube, with a single cylinder between them. The potentials of the anodes were commonly made increasingly positive the farther they lay from the cathode, but it is now more usual to join the first and second plate anodes and to make them both highly positive, the intermediate cylinder residing at a potential about one quarter of that of the other two. The internal structure of such a tube made by A. C. Cossor, Ltd., is shown in Fig. 14, and an external view is given in Fig. 15, while Fig. 16 shows a similar, but smaller, tube made by Ediswan.

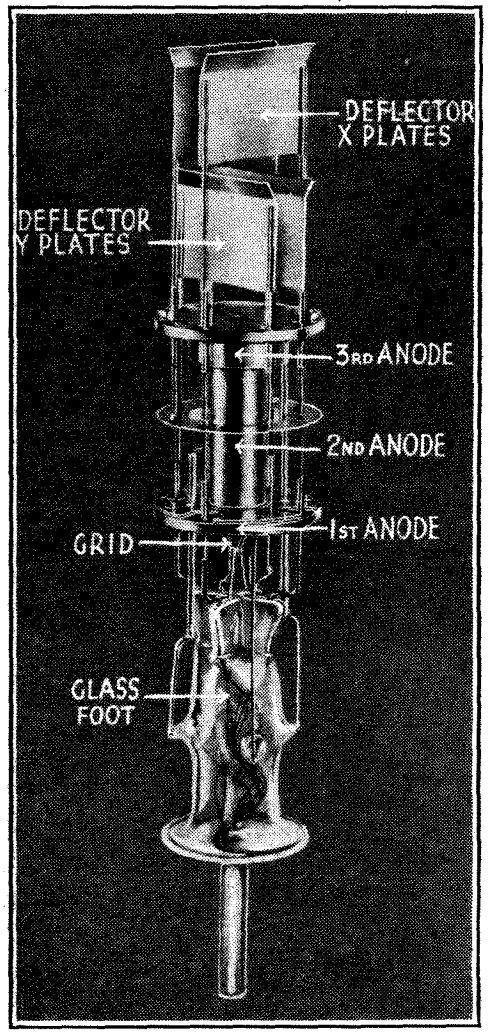


Fig. 14. Internal view of the Cossor three-anode tube.

The focus adjustment in a hard tube is brought about by adjustment of the potentials applied to the anodes: In the case of the tube having two plates and one cylinder, the potential of the cylinder (A2) is made adjustable for focusing purposes.

In a modern hard tube the grid affects only the brilliancy of the image, although there is a second order effect in which an enlargement of the spot is brought about when the spot brilliancy is made too great. The tube is thus suitable for television reception since the brilliancy may be

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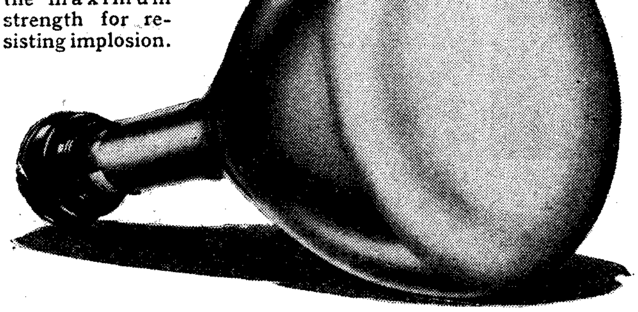
modulated without any appreciable effect on the focus.

There has of late, been a partial reversion to the original form of tube in that magnetic deflection and magnetic focusing of the beam are once more coming into prominence. Tubes in which the focusing and deflection is carried out magnetically have certain advantages, viz., they are somewhat cheaper to produce and they do not exhibit defocusing near the edges of the screen to so great an extent as occurs with electrostatic tubes. This is chiefly due to the fact that in magnetically focused tubes the maximum beam diameter can be made much greater with a resultant larger convergence angle, and magnetic deflection systems can be constructed in which the deflecting field is considerably more homogeneous than is normally the case with electrostatic systems. Of course, if deflecting plates were arranged outside the tube the necessary homogeneity of the deflecting field could be obtained, but only at the expense of greatly reduced deflection sensitivity, and this arrangement is, therefore, usually out of the question. Furthermore, the use of external electrostatic deflectors cannot be tolerated since the application of a potential difference to them would induce charges on the inner wall of the glass which would tend to cancel the charge on the plates and thus leave the beam almost undeflected.

Fig. 15. External view of the Cossor 10 inch television tube. This tube was the first to employ an "onion" shape bulb designed to provide the maximum strength for resisting implosion.



Another advantage of magnetic tubes lies in the fact that the focus remains good with a larger value of beam current and hence with a brighter spot than is the case with electrostatic tubes. This occurs because a wider convergence angle, as obtained with these tubes, means that the electrons forming the beam are, except in the immediate vicinity of the screen farther apart for the same beam current and hence their mutual repulsion is less. This repulsion, in a narrow beam, results in serious spreading of the spot since it occurs over a large length of the beam. Where the beam comes rapidly from a large diameter to a focused condition the defocusing effect due to mutual repulsion of the electrons is, obviously, much reduced.

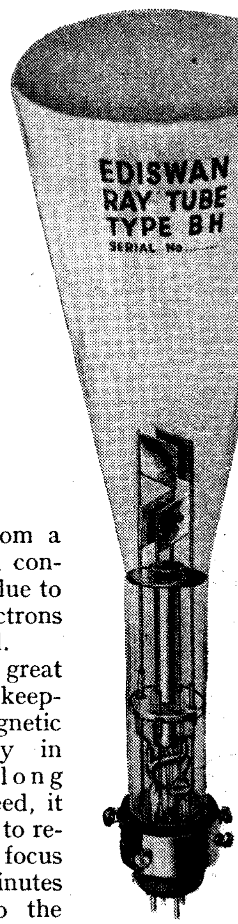


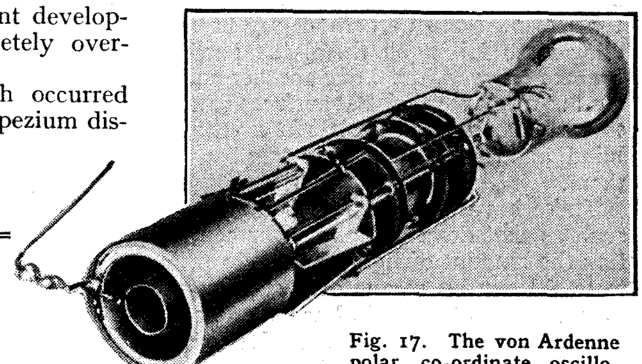
Fig. 16. An Ediswan general purpose cathode-ray tube.

Until a short while ago, great difficulty was experienced in keeping the beam of a magnetic cathode-ray tube properly in focus for long periods. Indeed, it was necessary to re-adjust the focus every ten minutes or so due to the change in resistance of the focusing coil as its temperature increased with time. Unfortunately, the increase in temperature necessitated an increase in focusing current which still further increased the temperature so that a stable condition could never be reached. Recent developments have, however, completely overcome this difficulty.

Another disadvantage which occurred was that, in order to avoid trapezium distortion, is was necessary to apply push-pull deflection potentials to electrostatically deflected cathode-ray beams. This difficulty has been completely overcome by Fleming-Williams,[38] who has designed a deflection system, by specially shaping and arranging the plates, in which trapezium distortion is reduced to less than one per cent. This arrangement is an inestimable advantage both for television and for ordinary measurement purposes.

Another form of cathode-ray tube which, although of no direct use for television purposes, is of extreme interest, is the polar co-ordinate oscillograph developed by von Ardenne. The tube and the circuit used with it are shown in Fig. 17, and the resultant image in Fig. 18. A circular trace is obtained on the screen by the application of deflecting forces of equal amplitude, but 90 degrees out of phase, applied to the tube along two axes at right angles to one another. The potential to be examined, which is applied to the cylindrical deflector system, modulates the accelerating potential on the anode of the tube and so alters the deflectional sensitivity of the system producing the circle. This results in a change in the diameter of the circle and hence depicts the wave form under examination. The arrangement has certain advantages of which the most important is that it forms a very simple method of examining phenomena of extremely short duration occurring at infrequent intervals. It is thus of value for examining the waveform of television synchronising signals.

A great deal of development has taken place in connection with fluorescent materials, notably by Levy and West.[32] Green and sepia screens have been superseded by white screens and the brilliancy has been increased about tenfold. Television receiving tubes for producing a large projected picture will not be very effective and will have a short operating



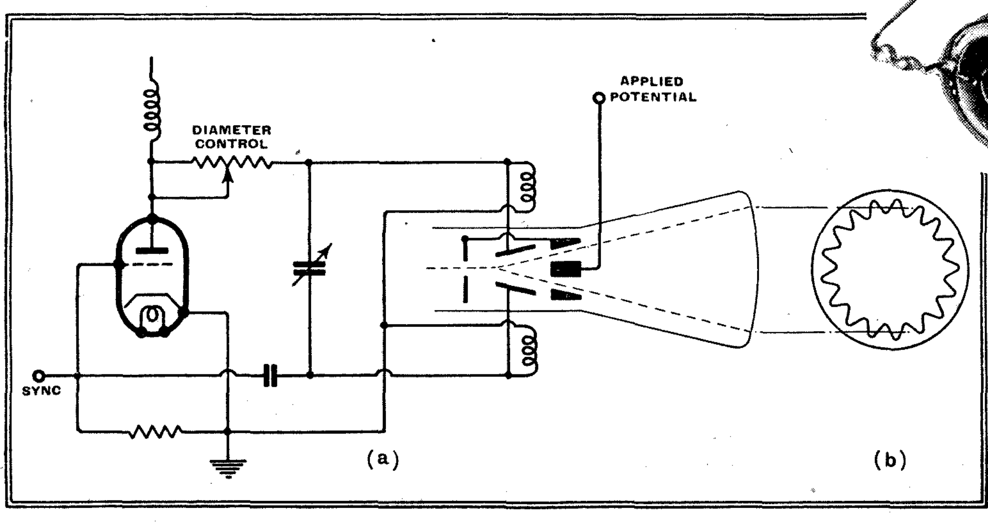


Fig. 17. The von Ardenne polar co-ordinate oscillograph. Circuit for use with the polar co-ordinate oscillograph (a). Variation of circle diameter due to application of potential to be examined is seen to the right of the circuit (b).

Cathode-Ray Tubes—

life until some material is produced which is better able to withstand the necessary intense bombardment and to give brighter illumination than is at present the case. There is also a need for further investigation into methods of fixing the fluorescent materials to the glass wall of the cathode - ray tube. Screens have been prepared by sintering and by the use of various binders having potasium, sodium, borax and sulphur bases, but no method so far tried produces ideal results.

It is, of course, possible that some suggestion, such as that made by Stevens[37], in which a screen of "Oildag" or some similar preparation is used, may prove to be the line along which television projection may develop. Stevens suggested that a thin layer of Oildag between two glass sheets might be

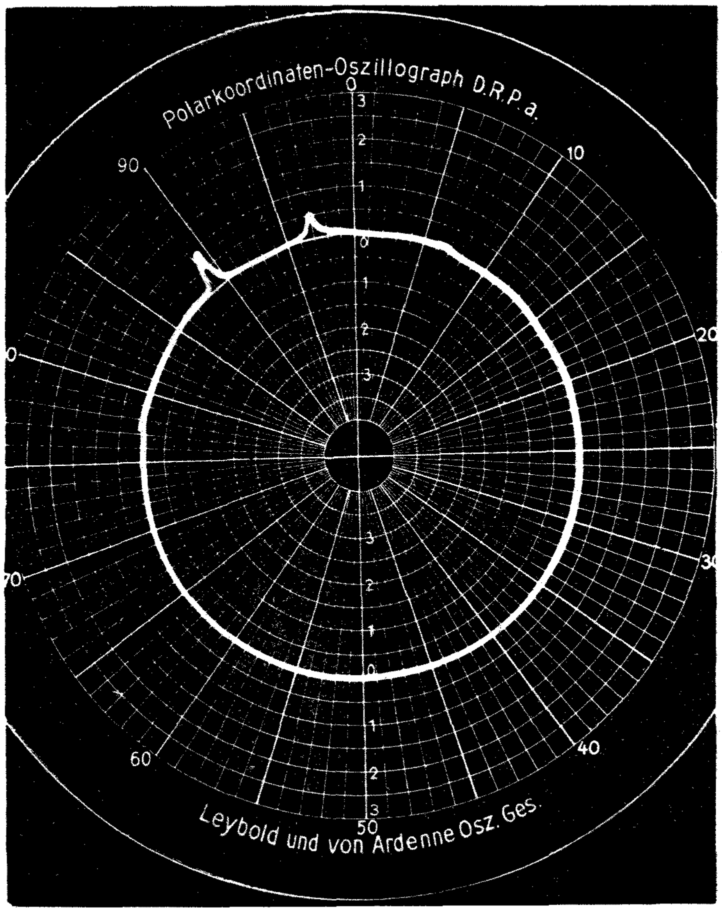


Fig. 18. Image obtained with the Von Ardenne polar co-ordinate oscillograph.

used as a light shutter controlled by a cathode-ray beam. Oildag consist of flat particles of carbon immersed in oil and they normally lie flat and thus form a screen which is opaque to a light behind the screen. When a cathode-ray beam is allowed to fall upon them, the particles become charged, repel one another and so tend to turn with their flat surfaces parallel to each other, like the slats in a venetian blind, and thus allow light to pass between them.

There have been numerous suggestions such as that described above for controlling the amount of light allowed to penetrate a layer by means of a cathode-ray beam, but so far as is known no really successful method has yet been devised.

The author is indebted to numerous books and papers for much of the information contained herein and he gladly records his acknowledgement of this debt.

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PROBLEM CORNER—12

Test Your Powers of Deduction

ANOTHER letter from Henry Farrad's postbag, published to give readers an opportunity of testing their own ability to solve wireless problems.

7, Former Row,
Coresline.

Dear Mr. Farrad,

I have a press-button receiver of the type in which one row of trimmers are condensers and the other row are permeability tuned coils of very constant inductance. I see that according to the latest international wavelength agreements the medium broadcast band has been extended from 1,500 to 1,560 kilocycles, to be allocated at the Montreux Conference. I am all right on the capacity trimmers, but the inductance trimmer that covers that part of the band does not go below 200 metres; and, although I can get a replacement coil that does, the makers only guarantee a wavelength or frequency adjustment ratio of 1.3 to 1. Now, that would be good enough if it were not that I want to cover the National wave (261 metres) on the same adjustment. Even if the National wavelength is altered at Montreux it is necessary to avoid a gap below the next coil in the set. 1,560 kc/s is about 192 metres, and from there to 261 is a ratio of 1.36, even allowing nothing to come and go on. So it looks as if the coil will not cover it.

What can you suggest?

Sincerely yours,
Henry Myecrowe.

What did Henry Farrad advise, and why? *Turn to page* 285.

NEWS OF THE WEEK

B.B.C. RECEPTION IN SCANDINAVIA

Alleged Limited Range Refuted

A RECENT article and subsequent letters in *The Times* drew attention to the difficulty experienced in receiving B.B.C. transmissions in Sweden. *The Wireless World* Scandinavian correspondent, although unable to state how British stations are received in Stockholm and North Sweden, emphatically states that the medium-wave stations can easily be picked up after dusk anywhere in South Norway, Denmark and Central and South Sweden. He also assures us that Droitwich can be heard anywhere in Denmark or South Sweden after noon.

It was stated in *The Times* that the cheaper sets were the chief offenders, but we learn that the standard type of cheap set in Denmark and Sweden is the three-valve superhet. As the majority of these receivers cover at least one short-waveband, Daventry's transmissions are also available. Our correspondent states that these can easily be received during daylight.

These opinions were confirmed by the Assistant Postmaster-General when replying to a question on this subject in the House of Commons last week.

POLICE WIRELESS

Experiments in Essex

WIRELESS communication is regarded by the Home Office as being of the utmost importance in an experiment designed to bring about a higher standard of motor driving by the provision of specially trained motor police patrols.

Essex is one of the areas chosen by the Home Office for the experiment, and the Chief Constable, Captain F. R. J. Peel, is establishing a self-contained police wireless system for the county.

The Essex Standing Joint Committee has voted £700 for the station, which will be erected at Danbury, near Chelmsford, and tests will begin as soon as the Post Office allocate an ultra-short wavelength.

If the experiment is successful, stations to cover the whole county will probably be erected, at Cutler's Green and Brentwood (both about 400ft. high), and probably at Colchester.

Such stations as these would have interesting possibilities in time of war, when they might well be used to keep communications going where telephone lines had been destroyed.

CHEAPER RECEIVERS FOR CANADA?

Proposed Royalty and Import Duty Reductions

REDUCTIONS in customs tariffs on imported radio components and lower royalty and patent payments to the Canadian radio patent pool are forecast as a result of an enquiry into the radio manufacturing industry by the Canadian Tariff Board at Ottawa.

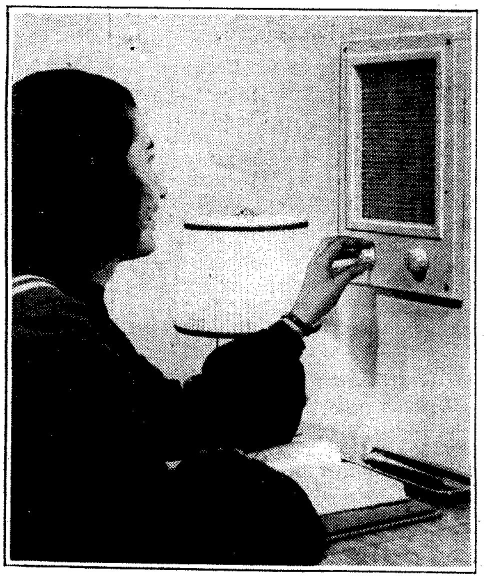
The enquiry, which was held in two sessions, one during last summer and the other on February 27th and 28th, is the outcome of charges of monopoly or combine in radio patents on circuits and valves by Canadian General Electric, Northern Electric, Westinghouse and Marconi. Because of the high annual licence fee charged by the patent group, there are very few makes of receivers made in Canada. The cheapest Canadian set costs about $25.

Canadians have been paying a far higher price for receivers types in Canada which are identical with sets made in the United States by the parent company. According to one manufacturer appearing before the Board the price difference on identical sets ranges from 50 to 90 per cent.

Some Canadian manufacturers have contended that because of the low sales in Canada (there are at present about 1,400,000 receivers in use in the Dominion) parts are more costly to produce than in the United States and that electrical code regulations in various Canadian provinces increase the manufacturing costs. Other manufacturers have opposed these arguments by proving that in Canada royality payments for the use of patents are more than double similar royalties paid in the United States; this applies to both valves and complete sets.

The enquiry has shown that there should be a reduction of import duty on many components not manufactured in Canada and from the remarks of the chairman on royalty payments it appears that the Government intends to take some action on the charges made against the patent holders. A certain percentage of Canadian tourists to the United States now bring back American-made sets bought at prices far below the Canadian set of similar make. The Canadian Radio Manufacturers' Association tried unsuccessfully to stop this some time ago.

RADIO IN EVERY ROOM is one of the amenities provided in the famous Elephant, Hotel, Weimar the only hotel in Germany having a suite permanently reserved for Herr Hitler. Volume, tone control and programme selection can be effected from each speaker unit, all the units being energised from a central multi-channel receiver. A similar system is supplied in this country by Correx Amplifiers; it was described in *The Wireless World* on October 22nd, 1937.



MORSE CODE ALTERATIONS

IT does not seem to be generally known that at the Cairo Telecommunications Conference the "full stop" and "comma" morse symbols were altered. These have become:—

Full stop (.) · — · — · —
Comma (,) — — · · — —

The new comma symbol — — · · — — formerly represented the exclamation mark (!), which no longer appears in the official list. Thus the professional operator loses the conventional time-honoured symbol for expressing surprise or amusement, though the amateur transmitter still has his unofficial "Hi."

BIG-SCREEN TELEVISION

The B.B.C.'s Policy

THE televising of the Harvey-Gains fight marked the second occasion upon which the B.B.C. had granted permission for the reproduction of their transmissions in places of public entertainment.

A statement intended to make clear the B.B.C.'s position with regard to such re-diffusion states that, although primarily concerned with the provision of a home service, the B.B.C. does not oppose experiments in large-screen re-diffusion of its programmes before paying audiences, when the programmes concerned are either of events of national importance and interest, independent of commercial promotion, or when the subject is a sports event, the rights of which are held by a promoter.

For the present, therefore, the B.B.C. will raise no objection to the re-diffusion of events in the latter category if agreemen as to terms is reached between the re-diffuser and the promoter, subject to certain conditions. The conditions include an undertaking that no exclusive rights shall be given to any one group or system, and that all applicants shall be granted rights on equal terms, based approximately on the relative seating capacity of the theatres concerned.

RADIO-THERAPY

Wider Facilities for Training Radio-Therapists

THE Cancer Bill, which has already passed through the House of Commons and has come up for the second reading in the House of Lords, is primarily one to provide funds for the diagnosis and treatment of cancer.

In moving an amendment regretting that the Bill contains no provision for further research into the cause of the disease, Lord Balfour of Burleigh, Chairman of the Medical Research Council, deplored going ahead with an expenditure of £600,000 or £700,000 on treatment which was tentative when new methods were coming into use.

He said that in America there was an apparatus called a cyclotron which was capable of emitting a ray which might put not only radium but X-rays entirely out of date in the treatment of cancer. There are two cyclotrons being built in this country, but in physics laboratories, and there was nothing available for medical and biological research.

Lord Dawson of Penn agreed with the amendment to the Bill and stressed the lack of skilled radio-therapists. Radio-therapy, he said, did not at present offer

News of the Week—

sufficient scope to encourage men to take it up as a study, but the Bill would be able to meet that difficulty.

To establish an adequate research unit would cost about £30,000 a year for ten or fifteen years, and Lord Balfour appealed to the leader of the House for a statement that he would support the appeal to the Chancellor of the Exchequer for the necessary funds.

IRELAND'S SHORT-WAVE TRANSMITTER

THE number of Irish people in Ireland is less than three millions, while the number of the Irish race throughout the world is estimated at some thirty-five millions. Ireland has now joined the countries operating a short-wave station for the benefit of its people beyond its shores.

The new station, which has commenced test transmissions on 17.84 and 9.595 Mc/s (16.82 and 31.27 metres) is situated at Moydrum, Athlone, the geographical centre of Ireland. The transmitter, which can use any wavelength between 16 and 80 metres, has been built by Standard Telephones and Cables, of London. The nominal power is 1.5 kW, but this can be greatly increased should circumstances call for it. According to the *Irish Radio Times*, there is less than 4 per cent. distortion at 90 per cent. modulation, and the transmitter gives an overall frequency response characteristic level to within -1 db. between 30 and 10,000 c/s. It is fitted with a high-stability variable frequency oscillator system, but crystal control can be used later for spot wavelengths.

A MILLION SETS IN SIX MONTHS

DR. HORST SCHAEFER, the representative of the German radio industry in the Ministry of Propaganda and Enlightenment, foreshadows, in a recent article in *Rundfunkarchiv*, further plans for the extensive rationalisation of the industry.

The sales of the People's Receiver and the Small German Receiver have not yet reached saturation point, and the new territories opened up during last year have increased the figures for the sale of these two sets up to a million from August to January 31st. It has now been decided to mass-produce the more standard and lower-priced superhets also.

Dr. Schaefer's account of the giant strides of the German radio industry ends thus: "Rationalisation here means: producing the maximum *political* effect with the minimum expenditure of technical material and labour."

SUBSIDISED BATTERIES

Popularising Listening in Norway

THERE are very many districts in Norway which are still without electricity; in fact, the population of these districts is roughly a quarter of Norway's total population. To encourage inhabitants in these districts to purchase wireless receivers the Norwegian State broadcasting organisation, Norsk Rikskringkasting, has not only provided a battery model of the "All-People's Set," but is subsidising batteries.

When taking out a new licence in such districts the purchaser is given three coupons which entitle him to two HT batteries and one LT battery a year at reduced prices. A 120-volt HT battery which normally costs the equivalent of 18s. is purchased for 7s. 9d. under this scheme. The difference in price is being borne jointly by the N.R. and the radio industry.

B.B.C. MAN FOR C.B.S.

Tribute to British Television

MR. D. H. MUNRO, B.B.C. Television Productions Manager, sails on May 4th for America, where for a period of at least six weeks he is to assist Mr. Gilbert Seldes, Television Director of the Columbia Broadcasting System, in setting up a studio organisation in New York on Alexandra Palace lines.

It was as an announcer in Aberdeen that Mr. Munro joined the B.B.C. in 1926. He came to London in 1929, where, as productions assistant at Savoy Hill, he was intimately concerned with the development of multi-studio production involving the use of the then unproven dramatic-control panel.

He co-ordinated the first "Round the Empire" broadcast in 1932, and when Mr. Gerald Cock became Director of Television in 1935, he chose D. H. Munro as Productions Manager.

FROM ALL QUARTERS

A Royal Customer

HIS MAJESTY KING FAROUK OF EGYPT, who was presented with an 11-valve superhet by the Swedish radio manufacturers, Aktiebolaget Gylling & Co., of Stockholm, has placed an order for a further three similar sets for the Abdin Palace, Cairo. A feature of the receiver is that the tuning dial includes a map of Europe on which the positions of the stations are marked, the name of the station to which the set is tuned being illuminated.

Broadcasting in the Bahamas

THE old transmitter in the Bahamas, which was superseded by the new 1-kW medium-wave station, ZNS, at Nassau, which was opened by his Excellency the Governor on January 26th, is to be modified and used for short-wave transmissions. It is intended that eventually the two transmitters shall radiate simultaneously, thus providing a service not only for Nassau itself but for the Outer Islands.

Anti-Piracy Drive Result

DURING the first fortnight of the anti-piracy drive which started in Calcutta on February 1st the number of licences issued by the Calcutta General Post Office and Sub-Post Offices shows an increase of 100 per cent. over the corresponding period last year.

Call-Sign Number Plates

THE latest manifestation of the enthusiasm of wireless amateurs in America is to arrange for their motor car registration numbers to be identical with their call-signs. A Michigan amateur who succeeded in pursuading the authorities to allot him a motor car number of this type has set the example to over five hundred fellow amateurs who have all obtained official consent to do likewise.

Television Stations for U.S.A.

NINETEEN licences to operate television stations have been granted in the U.S.A. The highest power licence is held at present by the R.C.A. at Camden, New Jersey, which is permitted to operate with a power of 30 kW on both sound and vision transmitters. None of the licensees has yet applied for permission to sell time to advertisers.

Northern Navigation

RECENT additions to the aids and safeguards to navigation in northern waters are six radio-beacons in Norway and two radio-telephony transmitters on the Norwegian lighthouses Bremstein and Fulehuk. Fifteen of the proposed twenty-six radio beacons to be erected in Sweden have also been completed, and two lighthouses at Klaipeda (Memel) and Nidden, Lithuania, have been equipped with radio beacons having a range of fifty nautical miles.

Duddell Medallist

MR. ROBERT W. PAUL, M.I.E.E., the well-known pioneer in the manufacture of electrical measuring instruments, has been awarded the sixteenth Duddell medal by the Physical Society. This medal is awarded to persons who have contributed to the advancement of knowledge by the invention or design of scientific instruments, or by the discovery of materials used in their construction. Mr. Paul, who is nearly seventy, is perhaps best known for his invention in 1903 of the Unipivot galvanometer. He has for nearly twenty years been associated with the Cambridge Instrument Company.

Polarised Light Dials

REFERRING to our recent paragraph on "Multi-band Tuning Dials: Uses of Polarised Light," we are informed by M. Pierre Hémardinquer, of Neuilly-sur-Seine, France, that he holds patents on this subject, the first of which, numbered 20,955, was applied for in 1934.

News from China

THE short-wave broadcasting station XGOY at Chungking, China, changed its wavelength on March 21st from 31.58 metres to 25.21 metres (11.9 Mc/s). News in English is broadcast each evening at 11 p.m. G.M.T.

International Exhibition in 1940

AN important International Communication Exhibition, in which radio and television will play a leading part, is being prepared in Cologne for 1940.

Scandinavian SW Tests

THE amateur organisations of the four Scandinavian countries are staging a "Team Test" on April 8th and 9th on 3.5, 7, 14, 28 and 56 Mc/s. Teams of five operators representing each country will compete for a challenge cup and for a special trophy to be awarded for the best 'phone results on 56 Mc/s.

Radio Paris

DURING May the new 450-kW Radio Paris transmitter at Allouis will begin testing during the night.

Aeronautical Telecommunications

A NEW edition (in French) of the Regulations for the International Aeronautical Telecommunications Service will shortly be obtainable on application to the Air Ministry, Adastral House, Kingsway, London, W.C.2. This new edition will be the January 1st, 1937, edition revised to December 31st, 1938. The price of the volume together with the subscription for the set of amendments as published during the year will be £1.

Suppressing Interference

THE annual cost to the Post Office of assisting listeners to obtain reception free from interference was stated by the Assistant Postmaster-General in the House of Commons last week to be approximately £95,000.

San Francisco Short-wave Station

W6XBE, the G.E.C.'s new 20-kW short-wave transmitter at the San Francisco Fair, described in these pages on January 5th, is transmitting on 9.53 and 15.33 Mc/s in English, Spanish, Portuguese, Chinese and Japanese.

Electron Optics

VISITORS are especially welcome to the Fourth "Kerr Memorial" lecture to the Television Society, which will be given at the Institution of Electrical Engineers, Savoy Place, London, W.C.2, at 7 p.m. on Wednesday, April 19th. The subject will be "Electron Optics," and the lecturer, Mr. L. M. Myers, of Marconi's. Tickets are obtainable from Mr. G. Parr, 68, Compton Road, Winchmore Hill, London, N.21, or from Mr. J. J. Denton, 17, Anerley Station Road, S.E.20.

Miscellaneous Advertisements and Easter

SLIGHT alterations are necessitated in our printing arrangements with the approach of the Easter holidays, and miscellaneous advertisements intended for the issue of April 13th must therefore be received not later than first post on Thursday, April 6th.

The Modern Receiver Stage by Stage

Part IV.—THE FREQUENCY-CHANGER

THE frequency-changer is an extremely important part of a superheterodyne, and in this article some of its characteristics are dealt with in detail. The oscillator, in particular, receives considerable attention.

IN the foregoing parts we have seen how the signal-frequency circuits and RF amplifier function in main outline and we now have to consider the frequency-changer. The purpose of this is to take the wanted incoming signal, whatever its frequency, and provide an output at a certain desired fixed frequency.

There are two main methods of frequency-changing. The older one is to mix with the signal a voltage derived from a local oscillator and to apply the mixture to a rectifier. The output of the rectifier then consists of a current made up of a large number of different frequencies, the chief ones being the input signal, the local oscillator and the sum and differences of these frequencies. Thus, if the signal is 1,000 kc/s and the oscillator 1,500 kc/s, then the output contains in addition to these, frequencies of 500 kc/s and 2,500 kc/s.

The modern method of frequency-changing is multiplicative, and rectification, as such, is not necessary. The signal and oscillator frequencies are applied to different electrodes of the same valve in such a way that the electron stream is modulated by one before it reaches the other. The heptode, octode, triode-hexode and triode-heptode are examples of modern frequency-changing valves and are now almost universally employed to the exclusion of the older type.

In practice, the input to the frequency-changer is not a single frequency but consists of the wanted signal and its sidebands and neighbouring signals. It consists, in fact, of everything that passes through the RF circuits.

Consequently, all these signals appear transposed in frequency in the output. Thus, suppose we have a signal on 1,000 kc/s with sidebands up to ± 5 kc/s and there are other signals on 970 kc/s and 1,040 kc/s. If the oscillator is on 1,450 kc/s, these signals appear in the output at 450 ± 5 kc/s, 480 kc/s and 410 kc/s respectively. There are also the sum frequencies and other unwanted ones.

The process of frequency-changing leaves the frequency difference between signals the same but changes the ratio of their frequencies. Now, selectivity in practice depends very largely on the ratio of the frequency difference to the carrier frequency. Obviously, if the frequency difference is constant the lower the carrier frequency the greater is the percentage frequency difference. Taking round figures, consider the case of wanted signals on 10 Mc/s, 1 Mc/s and 100 kc/s, in each case with another signal on a frequency 10 kc/s different. That is, on 10.01 Mc/s or 9.99 Mc/s, 1.01 Mc/s or 0.99 Mc/s, 110 kc/s or 90 kc/s. The frequency difference is 0.1 per cent. in the case of the 10 Mc/s signal, 1 per cent. at 1 Mc/s and 10 per cent. at 100 kc/s.

So put it another way; if we have sufficient selectivity at 1 Mc/s (300 metres) to separate the wanted signal from a neighbour 10 kc/s away, then to obtain the same freedom from interference at 10 Mc/s (30 metres) the interfering signal would have to be 100 kc/s away. At 100 Mc/s, however, it need only be 1,000 c/s away.

In practice, of course, this is modified by the fact that it is usually possible to obtain higher values of Q at high frequencies than at low, so that selectivity does not fall off as rapidly as one might expect as the frequency is raised. Nevertheless, the broad fact remains that the lower the operating frequency the higher the selectivity.

In very early superheterodynes the intermediate frequency was usually 30-50 kc/s in order to take full advantage of this. A low frequency, however, is disadvantageous from the point of view of image interference, which we shall discuss later, and when the superheterodyne first became really popular a frequency of 110 kc/s was generally used. In America, where there is no long-wave band, the usual frequency was 175 kc/s.

More recently, and largely because of the inclusion of short-wave bands, a higher frequency has become normal practice. Nearly always the frequency lies between 450 kc/s and 470 kc/s, the two most popular frequencies being 456 kc/s and 465 kc/s.

As most of the selectivity is obtained in the IF amplifier, the selectivity is substantially independent of the signal-

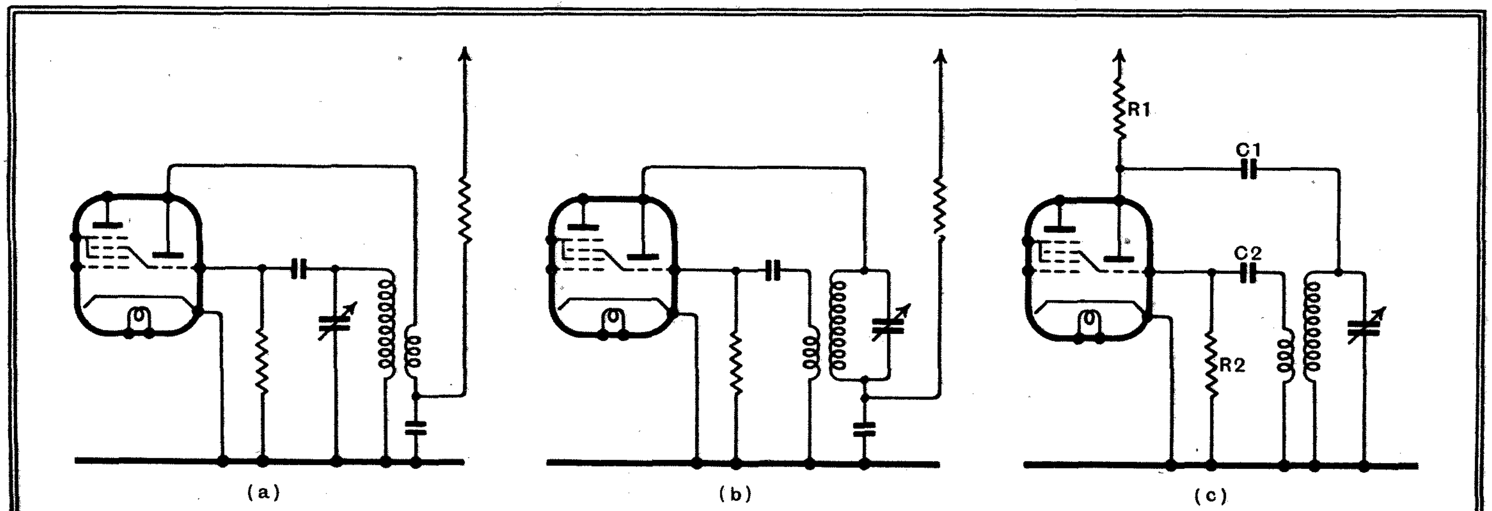


Fig. 8.—Three arrangements of the reaction-coil oscillator are shown here. At (a) there is the tuned-grid circuit, at (b) the tuned-anode, while (c) shows the shunt-fed tuned-anode oscillator.

The Modern Receiver Stage by Stage—
frequency and, ignoring the effect of the two signal-frequencies circuits, the rejection of an interfering signal is just as good at 10 Mc/s as it is at 1 Mc/s or lower. This is an impossible result with any other receiver and is the main advantage of the superheterodyne. The second great advantage is that as the IF circuits have fixed tuning we can use as many as we like without complicating the operation of the receiver or making it unduly expensive.

It is found in practice that more than four tuned circuits which have to be adjusted for every signal is too costly, and the general practice is to use only three. Even the smallest superheterodynes have five tuned circuits in the signal chain and large ones have eight or more.

Comparing a superheterodyne with a straight set, each having the same number of tuned circuits, the selectivity of the former is greater on all wavebands except the long. Here it is lower, for the usual intermediate frequency of 465 kc/s is higher than signal frequency. This is not important, however, because the normal superheterodyne has more tuned circuits than the straight set and the signal-frequency is low enough for even the latter to give adequate selectivity.

Enough has been said to show that the superheterodyne has real advantages over the straight set, and we shall now consider the frequency-changer itself. This always comprises two parts—a mixer and an oscillator—and for these functions two valves are needed. Usually the two valves are combined, and in the triode-hexode, for instance, there are two electrode assemblies in a common glass envelope.

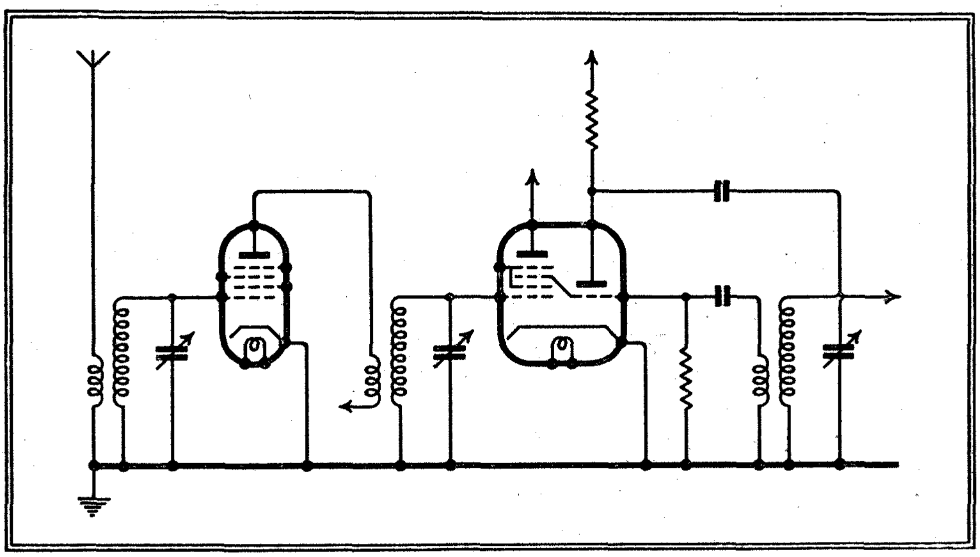


Fig. 9.—The skeleton circuit of the receiver as so far discussed is shown in this diagram.

The Oscillator Circuit

The oscillator is almost invariably a triode, and as its cathode is common with that of the mixer, and as it is usually necessary for one side of the gang condenser to be earthed, there is no real alternative to the reaction-coil oscillator. This is perfectly satisfactory on medium and long waves, but in comparison with other circuits has certain disadvantages on short waves which become more important as the frequency gets higher. These disadvantages, however, only become serious above about 30 Mc/s (below 10 metres).

The general arrangement of the tuned grid reaction-coil oscillator is shown in Fig. 8 (a) and the tuned-anode circuit at (b). It will be observed that in the triode-hexode the grid of the triode section is internally connected to one of the grids of the hexode section, usually called the injector grid. For proper frequency-changing a certain amplitude of oscillator voltage is needed on the injector grid and hence on the triode grid. The voltage required varies with different valves but usually lies between 6 volts and 20 volts.

Now, a bigger voltage can be developed across a tuned circuit than across an untuned coil, and it is, consequently, easier to obtain a large voltage on the grid with the tuned-grid than with the tuned-anode oscillator. There are, however, certain small coupling effects between the triode grid and the signal grid of the hexode, due partly to small capacities and partly to space charge in the valve. This unwanted coupling makes the initial adjustments more difficult because they are no longer independent of one another and, more important, it increases the liability of the oscillator to drift in frequency.

The tuned-anode oscillator is better because the tuned circuit is only coupled to the grid of the triode by the reaction coil and it is thus more loosely coupled to the grid. There is, consequently, less interaction, and frequency drift is smaller.

Whether or not it is possible to obtain sufficient oscillator amplitude with tuned anode depends on the coils and the valve. The difficulties are greater on short waves. In general, it is quite possible to use tuned anode with coils of average efficiency provided that the set is not required to tune to too low a wavelength, that the valve does not require too great an oscillator amplitude and that the triode section has a high mutual conductance. With a suitable valve it is quite satisfactory down to 15 metres, or even lower.

The precise circuit of Fig. 8 (b) is not used because it is generally necessary for one side of the tuning condenser to be earthed, as it is one section of a ganged assembly. The tuned circuit is more often shunt fed, as in (c).

It is desirable that the amplitude of oscillation should be substantially constant at all frequencies. The amplitude is governed primarily by the valve and the dynamic resistance of the tuned circuit, assuming constant coupling. The dynamic resistance varies appreciably with frequency, and as a consequence special steps are often taken to keep the amplitude constant.

One of the most effective is to shunt the tuned circuit with a resistance, for this greatly reduces the variations in the dynamic resistance although it reduces its absolute magnitude. In the shunt feed circuit of Fig. 8 (c) the anode feed resistance R performs this function in some degree as well as forming a DC path for the anode current. Additional damping may be necessary on some or all bands, and this can be provided by a resistance directly in shunt with the tuned circuit.

Another commonly used method is to insert a resistance in series with the reaction coil, between this coil and C2. In conjunction with the input capacity of the valve this resistance forms a kind of potentiometer by means of which the reaction coil is coupled more loosely to the valve. The input impedance of the valve falls with increasing frequency and the reaction coil becomes more loosely coupled.

This is a valuable property because the dynamic resistance usually rises towards the high-frequency end of a band and the amplitude of oscillation increases. By inserting a resistance in series with the reaction coil an opposite effect is introduced and the two tend to compensate one another.

On the medium- and long-wavebands resistances of 200-3,000 ohms are commonly used, the optimum value being found by trial to suit valve and coil. On short waves this system is less valuable because it is difficult to obtain a suitable value of resistance. The valve input impedance is much lower and the series resistance must also be lower; values of the order of 10-50 ohms are often necessary, and these are difficult to obtain in compact and inexpensive form with low inductance and capacity.

On short waves, therefore, it is often better to dispense with a series resistance and to shunt the tuned circuit with a resistance in order to even up the amplitude of oscillation. The adjustment for even amplitude must be done experimentally, and it is fortunate that the grid current of the oscillator gives a ready check on the amplitude.

The current can be checked by inserting a low-range milliammeter in series

The Modern Receiver Stage by Stage—
with the grid leak R2, naturally at the "earthy" end—and the amplitude of oscillation is nearly equal to 1.2 times the product of the current (amperes) and the resistance of R2 (ohms). Constant current indicates constant amplitude.

The circuit of the receiver as we have so far discussed it is shown in Fig. 9. The main characteristics of the two signal frequency and the oscillator circuits should now be clear. The three tuning condensers are ganged for operation by a single control, and the coils are arranged so that they can be replaced by others for covering different wavebands. The ganging and switching will be our next considerations.

Test Report

G.E.C. MODEL BC 4050

Table Model Superhet (4 Valves + Rectifier) with Mechanical Press-button Tuning. Price 10 guineas

THIS receiver is the AC model in a new series which has been produced to provide the benefits of push-button tuning in a chassis of good all-round performance at a reasonable price. Mechanical press-button control rotates the main tuning condenser to the required setting on each button. Slightly more effort is required to operate the buttons than in a switch-controlled system, but in this particular receiver the difference is hardly noticeable. On the other hand, one has the satisfaction of seeing the pointer rotate to its new position when a button is pressed and of being able to check the identity of the station from the dial.

Circuit.—A single tuned circuit precedes the triode-hexode frequency changer. The usual band-pass filters precede and follow the IF stage, which operates at 456 kc/s. A double-diode-triode serves as signal rectifier, first audio amplifier, and AVC rectifier. AVC is applied to both frequency changer and IF amplifier on medium and long waves, and on the IF amplifier only on short waves. The AVC delay is reduced on the short-wave range. Resistance-capacity coupling is employed between the first audio amplifier and the tetrode output valve. Additional RC filters are included to lift the bass and treble response. A continuously variable tone control is connected across the anode circuit of the output valve. The mains transformer is fitted with an electrostatic screen between primary and secondary.

Performance.—On medium waves the range and selectivity easily reach the standard expected of a four-valve superheterodyne. The signal-to-noise ratio on short waves is as high as one has a right to expect from a set without a stage of RF amplification. There are no self-generated whistles due to second-channel interference or oscillator harmonics on medium and long waves. Overloading of the frequency changer may occur if near to the local station, but an alternative aerial tapping has been provided to overcome this difficulty.

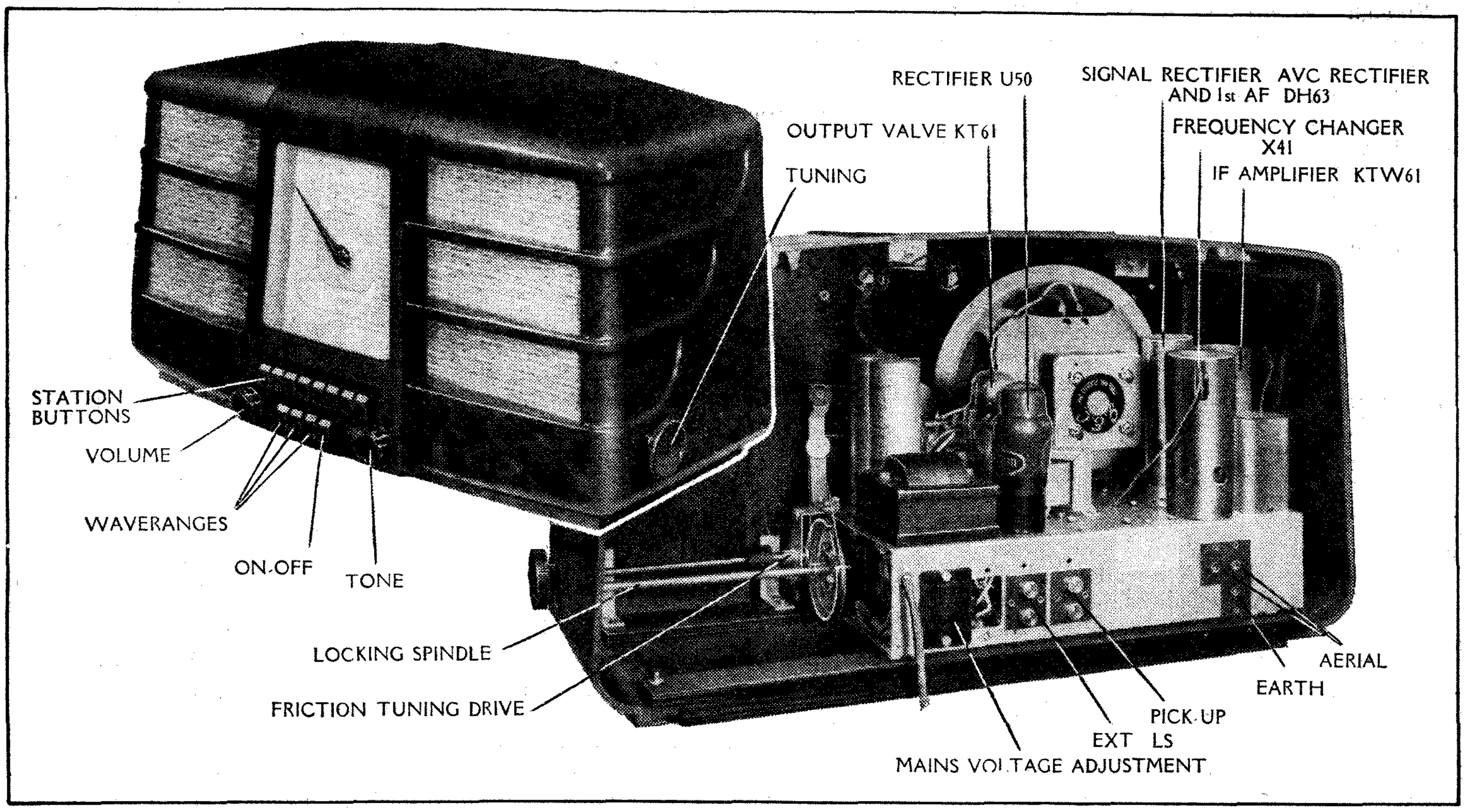
The long-wave performance both as regards range and selectivity is unquestionably above the average. Reception is quite free from the "mush" often associated with this range, and the German long-wave transmitter, which is usually inextricably sandwiched between Droitwich and Radio-Paris, stands clear of its neighbours with but a trace of sideband interference, which is easily dealt with by the tone control. The volume is comparable with that from Radio-Paris.

Selectivity on medium waves in terms of practical results is equivalent to the loss of one channel on either side of the local station (London Regional at 15 miles).

The short-wave range will always provide good entertainment from the European transmitters, and from America whenever the conditions make reception

WAVERANGES

Short - -	*16.5 — 50 metres*
Medium -	*192 — 550 metres*
Long -	*1,000 — 2,000 metres*



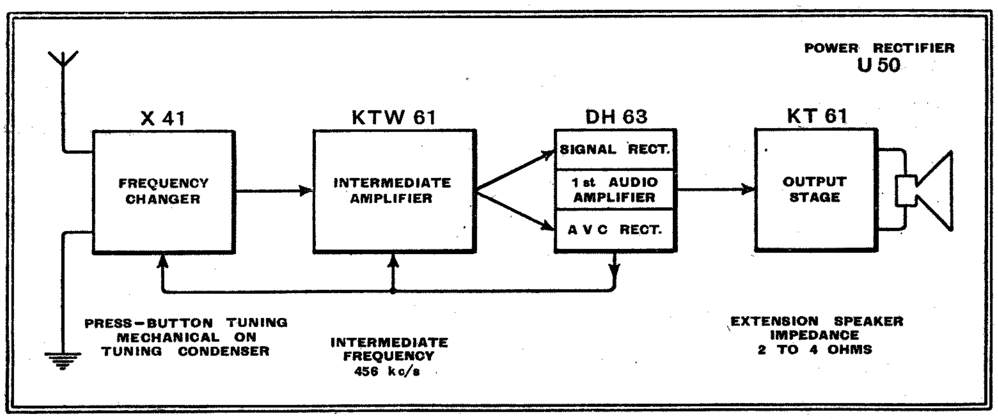
Arrangement of controls and layout of valves and terminal panels in the G.E.C. Model 4050.

G.E.C. Model B.C. 4050—

worth while. When the American stations are too weak for this set they would have a very poor signal-to-noise ratio on a more powerful receiver. The slow-motion ratio of the manual tuning control is just adequate for short-wave requirements, but it is a little tiring to have to keep the knob depressed during tuning operations if one wishes to indulge in a general search of the scale.

The electrical filters which have been included in the circuit to lift the bass and treble are effective in providing a tonal balance which can be readily adapted to suit the requirements of each waverange and all types of programme. On medium waves a reduction of high note response seems called for, but on long waves the full treble response just compensates for the effects of the good selectivity on this range. The loud speaker is a good one with a full-bodied response. Overloading in the output stage is marked by a sudden deterioration of quality when the permissible limits of power handling have been overstepped, which is preferable to the incipient distortion which often sets in as the upper limit is approached. The receiver is at its best on organ and orchestral transmissions in which a broad tone predominates. Speech should be kept at a natural level to avoid over-emphasis of the low frequencies.

Constructional Features.—The moulded bakelite cabinet has a durable polished finish and is of pleasing proportions. Indirect illumination is provided for the rectangular tuning scale and a pointer of shapely profile combines the rigidity called for by the mechanical press-button action with high reading accuracy.



Schematic circuit diagram of the G.E.C. Model 4050.

The press-buttons are arranged in two ranks, the top row for stations and the bottom row for waverange and on-off switching. Stations can be allocated in any ratio between medium and long waves, but it is necessary to operate the waverange controls for press-button as well as manual tuning. The mechanism is of the double rack and pinion type. Slight lateral play has been allowed to each button; this gives the necessary latitude for fingers above the average in thickness and generally adds to the ease and comfort of operation.

Access to the tuning mechanism and the underside of the chassis may be effected by removing a plywood panel from the base of the cabinet.

Sensible large-diameter screw terminals are provided instead of the usual pressed sockets for pick-up and extension loud speaker leads.

Summary.—Standard 4-valve superheterodyne performance on short and medium waves with complete freedom from whistles. Long-wave performance well above average. Quality of reproduction has a full-bodied tone not usually met with in table model receivers. Mechanical tuning device gives advantage of push-button station selection without the complication of separate tuned circuits. No restrictions as to wavelength or even waverange of station allocated to any given button.

RANDOM RADIATIONS

By "DIALLIST"

The Glad Spring

"THOUSANDS of new vacuum cleaners will soon be put into use by housewives for their spring cleaning," says a newspaper columnist. Fine for the housewives who use them, but not quite so fine for listening enthusiasts who happen to be neighbours of any of them—assuming, that is, that the said vacuum cleaners are not innocent of radiating interference. What an amazing people we are! It's years now since man-made interference began to be really serious. We didn't nip the thing in the bud, as well we might have, but just sat down to see what would happen. Matters grew rapidly worse and worse until from all sides came listeners' complaints of spoilt reception. Then *The Wireless World* urged that a committee should be appointed by the I.E.E. to enquire into the matter.

Hastening Slowly

The Committee met and set about tackling the job seriously. For months and months it thrashed out the question from every possible angle. It produced an admirable report recommending legislation. That was a long time ago, and absolutely nothing has materialised. The Post Office, which receives tens of thousands of complaints about interference in the course of each year, does its best by investigating each of them and suggesting remedies. But it can merely advise or persuade; it cannot *compel* anyone to do anything. We were told that legislation on the subject would come soon; the chaotic mass of existing wireless telegraph acts was to be swept away and an entirely new Wireless Telegraphy Bill presented to Parliament without delay. We haven't had that Bill, but we have had, and still are having, delay. Meantime, in the reports of electric supply undertakings all over the country we read that thousands and thousands of new homes have been given mains supplies during the preceding twelve months. In these homes, as well as in those which already had mains supplies of electricity, domestic appliances that radiate fiercely are being installed in immense quantities, and there is no official word warning householders against doing so.

Making Things Worse

The longer we put things off the more difficult it's going to be to solve this already thorny problem of man-made interference. You can't suddenly make it illegal to sell, buy or operate interfering apparatus. If you tried to do so there would be a terrific outcry on the plea of hardship from all concerned. Hence, when legislation on the subject is eventually framed, it will undoubtedly have to allow a period of grace, and I shall be very much surprised if that period isn't at least three years for domestic appliances, and probably longer than that for heavier machinery. France, Germany and other countries took the bull by the horns long ago by making laws against interference, which seem to work pretty satisfactorily. There can't be any question that the prevalence of interference in this country is largely responsible for the fact that the reception of short-wave broadcasting hasn't become more popular as a hobby; nor is there the least doubt that it is applying the brakes to television. I know that if you care to spend several pounds in installing anti-interference devices you can in most instances get rid of a large percentage of man-made interference; but that's no proper way of tackling the problem.

Not in the Lists

HAVE you, I wonder, come across a transmission from an American General Electric Company's station which doesn't appear in any list of short-wave stations that I've seen? This is W6XBE of San Francisco, which is being operated in connection with that city's Treasure Island—Golden Gate International Exhibition. The station is rated at 20 kilowatts, though the effective carrier power of its beamed transmissions is claimed to be 200 kilowatts. It operates on W2XAD's 15.33 megacycle

Random Radiations—

(19.57 metre) channel between 4 a.m. and 7 a.m. and between 3.30 p.m. and 7 p.m. Pacific Standard Time. So vast is the North American continent that Pacific Standard Time is eight hours behind that of Greenwich (in the extreme west of Alaska it's eleven hours behind), so that 4 am. to 7 a.m. P.S.T. corresponds to noon to 3 p.m. G.M.T., and 3.30 to 7 p.m. P.S.T. to 11.30 p.m. to 3 a.m. G.M.T. If, therefore, you find an American station at work on the channel mentioned during these hours, it's not W2XAD, but W6XBE.

Problematical

Whether or not these transmissions have been heard in this country I don't know; I've tried for them without success. You see, the earlier one is directed towards Asia, the bearing of the middle of the beam being 54 deg. west of true north from San Francisco, and the second is directed towards South America on a bearing 54 deg. east of true south. Neither of the corresponding great-circle courses passes over this country. If either of the transmissions is received at all, it must come the long way round the world. I tried on the day that this note was written for the earlier transmission with a big communication receiver containing two RF and three IF stages. With the beat-frequency oscillator in use a weak carrier could be found on 15.33 megacycles, but no modulation whatever could be detected. The signal, anyhow, was so feeble that it produced no discernible movement of the needle of the delicate tuning meter.

Up the Garden

It happened that I had a friend with me whilst making this trial on the 15-megacycle band, and when W6XBE couldn't be found I turned the band-spread knob to see whether anything else was to be heard from the United States. Close to W1XAL's usual setting I came across something of outstanding merit; so good, that we both agreed that we'd never at any time heard anything better from America—strong, clear, no trace of fading or atmospherics. It was a kind of feature programme, describing an aeroplane flight from New York to the Pacific Coast. I diagnosed it as a propaganda programme for American air lines, probably sent out by one of the Radio City transmitters. It went on so long that my friend had to go before the call-sign came through, but I waited eagerly for it. When it *did* come I got a bit of a shock. "That," said a B.B.C. voice, "was a recorded programme 'Coast to Coast.' The next item in transmission No. 2 is Johann Strauss." I had been listening to GSI. I wonder in how many logs that "Coast to Coast" item will figure as having been received direct from W1XAL? Probably in a good many, for it was in two at least of the Empire transmissions.

The Oscillograph in Servicing

AN interesting folder, "The GM3155 at Work," has been prepared by The Mullard Wireless Service Co., Ltd., to illustrate some of the applications of their latest oscillograph in tracing obscure faults in receivers.

By means of a series of photographs the cause of an unusual form of overload distortion is tracked down and shown to be parasitic oscillation on one half-cycle due to an open circuit on the tone connector circuit. The sequence of three checks which narrowed down the search are described and make interesting reading.

This is a fault which would have been impossible or at least have taken considerable time to locate by ordinary meter methods and is a good example of the value of an oscillograph to the serviceman.

Actual photographs of oscillograms also illustrate the use of the oscillograph in circuit alignment and in the examination of the waveform of television time bases. An interesting wave is one showing a ripple due to sound channel interference on the double peaked resonance curve of a tuned circuit.

Television Programmes

Sound 41.5 Mc/s Vision 45 Mc/s

An hour's special film transmission intended for demonstration purposes will be given from 11 a.m. till 12 noon each weekday. The National or Regional programme will be relayed on 41.5 Mc/s from approximately 7.45 to 9 p.m. daily.

THURSDAY, MARCH 23rd.

3, Eric Wild and his Band. **3.30,** British Movietonews. **3.40,** 227th edition of Picture Page.

9, "Dance Without Music," a play based upon episodes in the life of Jack Sheppard, by Mervyn Mills. **9.50,** Gaumont-British News. **10,** 228th edition of Picture Page. **10.30,** News.

FRIDAY, MARCH 24th.

3, Gaumont-British News. **3.10,** Grand National Commentary. Viewers will see a plan of the course. **3.30,** Vanity Fair—fashion parade. **3.45,** Marcel Boulestin describes "Rouget Marseillaise"—a national dish. **4,** Charles Heslop—"In the Barber's Chair."

9, Marcel Boulestin. **9.15,** Vanity Fair. **9.30,** "The Switchback," a comedy by James Bridie. **11,** News.

SATURDAY, MARCH 25th.

3-4.15, The Vic-Wells Ballet presents "The Sleeping Princess," based on the fairy tale by Perrault. The music by Tchaikovsky. Narration by Elizabeth Cowell.

9, Trudi Binar in Cabaret. **9.30,** Gaumont-British News. **9.40,** "Anglais-Francais"; a battle of wits refereed by E. M. Stéphan. **10.10,** "Joie de Vivre"—Cartoon Film. **10.15,** Eric Wild and his Band. **10.45,** News.

SUNDAY, MARCH 26th.

3, Roland Smith—coloured bass baritone. **3.10,** Cartoon Film. **3.15,** "Graveyard of Ships"—Film. **3.25,** Animal Cartoons by Arnrid Johnson. **3.35-4.5,** Television Surveys, No. 7, Dinghy Sailing, O.B. from the Ranelagh Sailing Club at Putney.

8.50, News. **9.5,** Oliver Goldsmith's play "She Stoops to Conquer." **10.35-10.45,** Jean Colin and the B.B.C. Television Orchestra.

MONDAY, MARCH 27th.

3, Charles Heslop in "Pick-Me-Up," with Phyllis Monkman and Queenie Leonard. **3.35,** British Movietonews. **3.45,** Talk by Reginald Arkell. **3.55,** Cartoon Film.

8.15, "Magyar Melody," O.B. from His Majesty's Theatre. **11.30,** News.

TUESDAY, MARCH 28th.

3-4.30, "The Switchback" (as on Friday at 9.30 p.m.).

9, La Chauve Souris. **9.30,** British Movietonews. **9.40,** "Leviathan"—a survey of sea monsters. **10.20,** Cartoon Film. **10.25,** "Graveyard of Ships"—Film. **10.35,** Talk by Reginald Arkell. **10.45,** News.

WEDNESDAY, MARCH 29th.

3, O.B. of Boat Race training. **3.10-4,** "Dance Without Music" (as on Thursday at 9 p.m.).

9, Gaumont-British News. **9.10,** "The Sleeping Princess" (as on Saturday at 3 p.m.). **10.25,** News.

The Wireless Industry

A NEW company, Electronic Engineering Services, Ltd., Swakeleys Road, Uxbridge, Middlesex, has been formed under the chairmanship of Mr. W. J. Brown, B.Sc., A.M.I.E.E., M.Inst.R.E., to give engineering service in connection with the use of certain American products. The company is the sole agent in this country for "Ohmite" resistances, and other products handled include "Gammatron" valves, "Guardian" relays and the Tobe-Deutschman "Mu-Switch."

The Edison Swan Electric Co., Ltd., have installed their "Loudspeakerphone" intercommunication system in fourteen branches of the Hull Co-operative Society.

The range of T.C.C. multiple wet electrolytic condensers now includes triple types and the dual type has been released for the retail market.

We have received from Standard Telephones and Cables, Ltd., illustrated pamphlets giving summarised characteristics of "Standard Radio" aircraft equipment, the new 10kW medium-wave broadcast transmitter, the omnidirectional radio beacon and the types RMX-1 and RMY-1 general purpose short-wave and long-wave receivers.

A new list of replacement chassis and a descriptive leaflet of the Trophy 8 communication receiver have been issued by the Peto Scott Co., Ltd., 77, City Road, London, E.C.1.

"Designing an Individual Receiver"

Switching Relay : Output Grid Circuit

IN the circuit diagram illustrating this article (published in our issue of March 9th) a relay marked "R" was shown. This relay was developed by the author for his own use, and switches the set on and off from the extension points. It had to be wired between one speaker terminal and the lead sheathing of the twin extension wire, the sheath being earthed. As it was desirable that in the event of trouble the relay could be cut out of action, this was, if possible, to be performed by the speaker control switch. The main contacts of the relay were permanently connected across the set main switch.

It should be added that an unfortunate but fairly obvious error occurred in the part of the diagram showing the push-pull output stage. The 450-ohm bias resistance should be connected between the slider of the 30-ohm potentiometer and the earth line, while the junction point of the 0.25-megohm grid resistances should be joined directly to the earth line.

HENRY FARRAD'S SOLUTION

(See page 278)

HENRY FARRAD suggests that he goes right ahead and gets a 1.3 ratio coil. For Mr. Myecrowe has apparently overlooked the fact that the waveband to be covered by the coil is not 192 to 261 metres, but 148 to 187, which requires a ratio of only 1.26. The permeability trimmers are, of course, used for the oscillator circuits; their constancy of inductance would be wasted on the relatively non-critical preselector circuits. The frequency band to be covered is 1,560 to 1,149 kc/s, and, assuming an IF of 460 kc/s, this requires the oscillator to tune from 2,020 to 1,609 kc/s, or 148 to 187 metres, as stated above. The full 1.3 ratio might be disposed over the range 2,050 to 1,590 kc/s to allow some margin at each end.

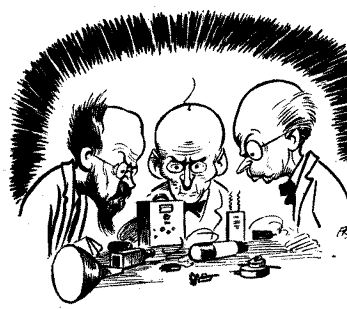
Whether Mr. Myecrowe will find any station in the 1,500 to 1,560 kc/s band worthy of being set up on a push-button remains to be seen, of course.

UNBIASED

By FREE GRID

Wireless Manufacturers Vindicated

WHATEVER may be said of me in my obituary notice, I think that both my friends and my enemies will agree that I have always endeavoured to be just to all men, even to wireless manufacturers, whom I have been compelled in the interests of my readers to take to task from time to time. It is, therefore, with pleasure that I respond to the invitation extended to me by one of our largest set-makers to place on record the strenu-



Manufacturers' research department.

ous efforts which the research departments of all big wireless manufacturers make to improve their wares by keeping a strict eye on all the latest gadgets and vying with each other to be the first to incorporate them in their sets.

According to this manufacturer's statement, an elaborate report has recently been presented to him by his research department, from which it appears that American midgets occasionally get very hot, with the result that the wax with which the coils are impregnated melts and drips into the vanes of the tuning condensers where it congeals, and, in the words of the report, "this is apt to cause a serious loss of efficiency." Doubtless all of you can see as clearly as I can that only men with first-class brains capable of such superlative efforts of observation and deduction are required in these research departments, and so there is no chance of you or I getting a job there.

But this is not all. The world-famous American engineers who designed these sets so marvellously to serve the dual purpose of wireless receivers and portable cooking stoves are not content to let this sort of thing continue. Unlike you or I who, with our common third-rate brains, would have suggested better ventilation, thus restricting the usefulness of the set as a cooking stove, these great designers have devised a cup, fitting just below the coils, to collect the melting wax and to prevent it dripping into the vanes.

Unfortunately, however, like so many American inventions, the job is really only half done, and it has been left to British manufacturers to get on with the job of inventing some method by which the cup can be caused automatically to pour the wax over the coils again. To my mind the solution is simple, and I cannot think what our British designers are boggling at. I should solve the problem by arranging that when the weight of the wax gathered in the cup exceeded a certain value, it closed an electric contact which would have the effect of starting up a small electric motor to raise the cup and tip it upside down over the coils.

This would not, at any rate, be any more complicated than the practice of the makers of some AC/DC sets who, instead of using a mains-voltage dial light, use a low-voltage one in series with the valve heaters, and then put an elaborate thermal-delay switch in shunt with it to prevent it being burnt out by the rush of current when first switching on.

Stand-by Crystal Sets

I SEE that somebody has raised the question of the necessity of every household having a crystal set as a stand-by in case the power stations were put out of action in a national emergency. This is an excellent idea for those who are within crystal-shot of a broadcasting station. Those outside it would be better served by having an ordinary battery set and a hand or pedal-operated generator to charge the LT battery in case the power supply to the local charging station was cut off. HT would, of course, be supplied from the LT battery by means of a vibrator.

High Jinks in Holland

ON my way back from Scandinavia the other day after my recent unfortunate motoring mishap, I decided to journey via Germany and Holland as I wished to call on a Dutch friend of mine in Amsterdam. On arrival at the Dutch frontier I stopped to change from German into Dutch costume, as I have always believed in the old maxim, "When in Rome, do as Rome does," although I must admit that, on occasion, this practice of mine has caused me some embarrassment, as things get a little difficult in places like Samoa, where a string of beads is considered the hallmark of good taste, anything more being thought ostentatious and vulgar.

As some of you may know, a very common sight in Holland is the unobtrusive little mirror set in the roof of the porch at such an angle that a person in the front room can, without being seen himself, see a reflection of the caller's face As I stood waiting on my friend's doorstep, I glanced up towards the mirror, but to my astonishment its place had been taken by a cathode-ray tube, and it suddenly struck me that my friend, who is a kind-hearted man, must have installed a television set to enable his callers to while away the time while they cooled their heels on his doorstep. Unfortunately, no picture was visible, and thinking that a fault must have developed in the gear, I walked to the front gate and rolled along a big Dutch cheese which was propping it open, my object being to stand on it, so that I could diagnose and remedy the trouble in the set, as the Dutch are a slow-moving people and I realised that I should have some time to wait.

Unfortunately, however, Dutch cheeses, being spherical in shape, are most difficult objects to stand on, and as my friend's wife opened the door I was involuntarily precipitated violently into her arms, a state of affairs which might well have led to scandal in a country like Holland, where the matrimonial tie is regarded very seriously. However, all's well that ends well, and after apologies had been made and accepted, my friend and I turned to the more serious matters of life and started to discuss wireless and television.

To my surprise the installation over the porch was not, as I had thought, a television receiver but a transmitter. My friend had, he said, been suddenly struck with the incongruity of using a mirror for viewing his visitors in these days of tele-

Precipitated into her arms.

vision and had replaced it by a televisor. This not only made him the envy of his neighbours, but enabled him to view his intending visitors from the comfort of his bed or his armchair or anywhere else in the house, without the necessity of going to the window of the front room in order to see the mirror and give his visitors the once-over before opening the door.

Readers' Problems

A Selection of Queries dealt with by the Information Bureau, and chosen for their more general interest, is published on this page.

Choosing a Microphone Transformer

IT is desired to match a moving coil microphone to the input valve of an amplifier and our enquirer wishes to know how to obtain the ratio of the microphone transformer. The impedance of the speech coil is stated to be 7.5 ohms.

There are several ways in which this can be done, and one which gives quite satisfactory results is to load artificially the secondary of the transformer by a resistance of known value. It can then be regarded as a loaded transformer and the ratio calculated from the input and output load impedances.

If, for example, a resistance, which can conveniently be a volume control, of 50,000 ohms be used the problem resolves itself into matching 7.5 ohms to 50,000 ohms, and making the impedance of the secondary winding high compared with the load resistance. About two to three times at a frequency of 50 c/s would serve for most purposes. This would mean a secondary inductance of about 400 henrys.

The ratio is then calculated by dividing the secondary load by the primary load, the microphone impedance in this case, and taking the square root. The ratio will be found to be 1 to 81.7; a 1 to 80 ratio would answer quite well.

Metres to Kilocycles

SOME who have been accustomed to think of the relation of one station to another on the dials of their receivers by the respective wavelengths employed will doubtlessly find it a little difficult at first to fall in line with the suggestion made in the Editorial Comment in our issue of March 2nd last to think in terms of frequency. A few have actually enquired for a simple conversion formula and an explanation of the relationship between wavelength and frequency.

It is often taken for granted by the more enlightened that such matters are too obvious to justify a description, but for the benefit of those who have asked for a little assistance, we give the following explanation.

Wireless waves have a velocity of 300 million metres per second, so that if the wave is one metre long 300 million complete waves, or cycles, will appear at any given point in space each second. The frequency would thus be stated as 300 million cycles per second, or for convenience 300 megacycles per second, which is contracted to 300 Mc/s.

Dividing the velocity of propagation by the wavelength in metres gives the frequency in cycles per second, a kilocycle is one thousand cycles and a megacycle one million cycles per second. A 1,000-metre wavelength is thus 300,000 c/s or 300 kc/s.

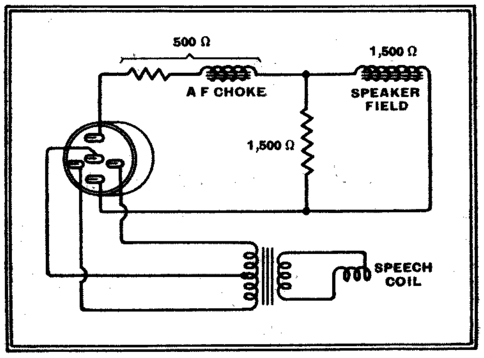
The point that may at first cause a little confusion is that whereas one was accustomed to associate the longer wavelengths of any broadcast band with the higher scale readings on the dial it will have to be remembered that the high frequencies now fall at the lower scale readings. The correct thing to do would be to change the dial for one on which the engraved scale, if one is used, reads from right to left. Low frequencies would then be related to low numbers and the higher to the larger numbers on the scale.

Energising 1,500 Ohms LS Field from P-P QA

A READER wishes to know if a loud speaker with a field resistance of 1,500 ohms, and which requires only 60 mA, can be used with our Push Pull Quality Amplifier and how it should be connected.

In the original amplifier the loud speaker field winding formed part of the HT smoothing circuit, and it dropped 150 volts with 120 mA flowing through the field. This voltage must be dropped across any field winding used to replace it and provision has to be made to pass 120 mA.

If a resistance of 1,500 ohms is joined in parallel with our reader's field the two will pass 120 mA, but the combination will drop 90 volts only. A resistance of 500 ohms will now have to be connected in series with this combination to bring the total resistance up to 1,250 ohms. By shunting the field with a 1,500 ohms resistance it will not now contribute very much to the smoothing, but this will not matter if an additional smoothing choke is included for the earlier valves



Method of energising a 1,500 ohms 60 mA LS field winding from the Push Pull Quality Amplifier.

in the amplifier, as was the case in the original model. When this choke is omitted, however, as it has been in some similar amplifiers, a smoothing choke of 500 ohms, or alternatively one of lower DC resistance with a fixed resistance in series as shown in the figure here, should be employed.

Club News

Exeter and District Wireless Society

Headquarters: Y.W.C.A., 3, Dix's Field, Southernhay, Exeter.
Meetings: Monday at 8 p.m.
Hon. Sec.: Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

At the meeting held on March 13th Mr. W. S. Pyrah lectured on "The Manufacture of Starter Batteries." This was followed by a film of a tour round the works of Joseph Lucas, Ltd.

On March 27th the Society's amplifier, which has been reconstructed by Mr. C. J. Poulter, will be tested.

Brentwood Amateur Radio Society

Headquarters: "Old Basing," Alwyne Avenue, Shenfield, Essex.
Meetings: First and third Thursdays of each month.
Hon. Sec.: Mr. B. A. Pettit, "The Laurels," Worrin Road, Shenfield, Essex.

Recent activities have included a talk on DF and lectures by representatives of R. A. Rothermel and Co., Ltd., and the Edison Swan Electric Co., Ltd., on their firms' products. Future activities include a visit to the Ongar station and a practice DF field day with the Romford and District Radio Society. It is intended to hold DF tests throughout the summer, some of them in conjunction with other Essex societies.

Ilford and District Radio Society

Headquarters: St. Albans Church Room, Albert Road, Ilford, Essex.
Meetings: Thursdays at 8 p.m.
Hon. Sec.: Mr. C. E. Largen, 44, Trelawney Road, Barkingside, Ilford, Essex.

We have received a copy of the "Bulletin," a magazine published periodically by the Society.

Recent activities have included lectures by representatives of several well-known firms, including Ediswan, T.C.C. and Haynes Radio. The programme for the immediate future is as follows:—

March 30th.—Lecture by a representative of the Tungsram Electric Lamp Works.
April 6th.—Informal meeting.
April 13th.—Transmitter demonstration by Mr. E. G. Coe.
April 20th.—Demonstration by Mr. H. T. Stott.

Surrey Radio Contact Club

Headquarters: 74, George Street, Croydon, Surrey.
Meetings: First Tuesday in the month at 8 p.m.
Hon. Sec.: Mr. A. B. Willsher, 14, Lytton Gardens, Wallington, Surrey.

The club held its annual general meeting on March 14th. It is regretted that owing to an increase in expenditure the club's subscription has had to be raised. It has been decided, however, that this may be paid in two half-yearly instalments. At the conclusion of the meeting Mr. Billingshurst gave a talk on portable midget receivers.

We are compiling a register of wireless clubs and societies and should be glad if secretaries who have not communicated with us recently will let us know if any alteration has been made in the particulars concerning their club.

Cardiff and District Short-wave Club

Headquarters: Toc H Rooms, Crown Court, Duke Street, Cardiff.
Meetings: Thursdays at 8 p.m.
Hon. Sec.: Mr. H. H. Phillips, 132, Clare Road, Cardiff.

We have received a copy of the "News Reel," a magazine published periodically by the Society. The Society, which has now entered upon its fourth year, has been exceptionally active during the past few months. The annual supper and social evening is being held to-night, March 23rd, at the Philharmonic Hotel, Cardiff. Tickets cost 2s. each. Evening dress will not be worn.

March 30th.—Annual general meeting.
April 13th.—R.S.G.B. night.
April 27th.—Programme to be arranged.
May 11th.—R.S.G.B. night.
May 25th.—Discussions on the National Field Day schedules.

Croydon Radio Society

Headquarters: St. Peter's Hall, Ledbury Road, South Croydon, Surrey.
Meetings: Tuesdays at 8 p.m.
Hon. Pub. Sec.: Mr. E. L. Cumbers, 13, Campden Road, South Croydon, Surrey.

At the last meeting a demonstration of high quality was given by the chairman, Mr. P. G. Clark.

The annual general meeting will be held on March 28th, after which a series of 10-minute talks will be given by members.

Slough and District Short-wave Club

Headquarters: 35, High Street, Slough, Bucks.
Meetings: Alternate Thursdays at 7.30 p.m.
Hon. Sec.: Mr. R. J. Sly, 16, Buckland Avenue, Slough, Bucks.

At the last meeting VP6AH, who is in this country on a short visit, gave a talk on the conditions in his home country, Barbados. At the next meeting a talk will be given by G3XH on "Microphones and Amplifiers."

Hoddesdon and District Radio Society

Headquarters: Blairgowrie, Station Road, Broxbourne, Herts.
Meetings: Second and fourth Wednesdays in the month at 8 p.m.
Hon. Sec.: Mr. T. Knight, Caxton House, High Street, Hoddesdon, Herts.

The Society ask us to announce that their transmitting station, G5HO, operates at 11 a.m. on Sundays, on the 1.7 megacycle band. It is also licensed for 7, 14, 28 and 56 megacycles. This summer it is hoped to increase portable activities and to build DF gear. The Society would welcome the co-operation of other transmitting stations. On April 12th a lecture will be given on DF, and on April 26th there will be a lecture and demonstration on "Ultra-Short-Wave Receivers."

Medway Amateur Transmitters' Society

Headquarters: The Navy Wives' Club, Dock Road, Chatham, Kent.
Meetings: Tuesdays at 8.15 p.m.
Hon. Sec.: Mr. S. A. C. Howell, "Veronique," Broadway, Gillingham, Kent.

A very interesting talk on television was given by Mr. J. E. Bryde in February. The President has commenced a series of elementary technical discussions. Arrangements are well in hand for the Society's forthcoming Radio and Television Exhibition.

Recent Inventions

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

SCANNING ELECTRODES

WHEN electrostatic scanning is used in a cathode-ray tube, there is a tendency for the lines of force of the deflecting plates to spread over the edges and to curve outwards towards the metallised lining of the tube. This distortion of the field affects the focusing of the scanning stream as it passes through the deflecting plates, and causes the stream as it sweeps outwards to lose its correct focus on the fluorescent screen. The marginal parts of the picture therefore appear "blurred," relatively to the centre parts.

According to the invention, the control field is prevented from spreading by bending the edges of each deflecting plate slightly inwards. Alternatively, a small additional electrode, suitably biased, is provided just inside the edge of each plate so that it exercises a correcting effect on the course of the scanning stream at each end of its traverse.

V. Zeitline; A. Zeitline; and V. Kliatchko. Convention date (France) November 17th, 1937. No. 497631.

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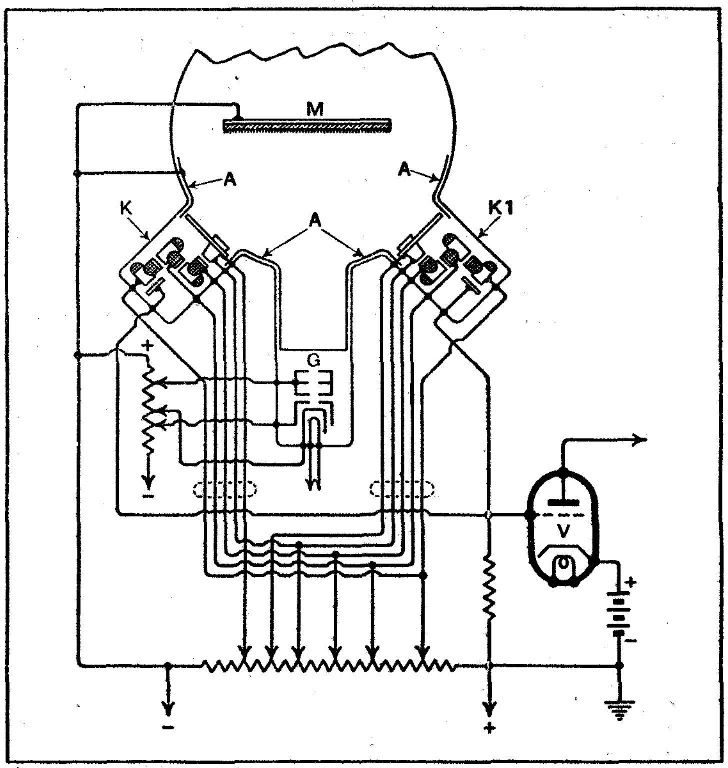
ICONOSCOPE TUBES

THE sensitivity of a television transmitter of the Iconoscope type is determined very largely by the "shot" effect of the stream, which sets a limit to the signal-to-noise ratio of the output current. The "shot" disturbance can be lessened by reducing the beam current, but the extent to which this can be done is again limited by the capacity value of each of the "unit cells" of the mosaic screen, since these must be discharged to produce the signal currents.

According to the invention, a mosaic screen of small capacity is made by depositing the layer of photo-electric material on to a thick backing-plate of insulation. This enables the electron beam to be cut down to ensure a favourable signal-to-noise ratio, any loss of strength in the picture currents then being made good by passing them through a pair of electron multipliers mounted inside the cathode-ray tube.

As shown, the picture to be televised is projected on to the mosaic screen M (which is, in practice, set at an angle to the tube axis). The screen is scanned by a beam from the gun G, and the electrons so liberated are drawn by the positive voltage on the metal anode lining A into the two electron multipliers, K, K1. These are connected in parallel, and feed the amplified signal currents to an amplifier V.

Marconi's Wireless Telegraph Co., Ltd. (assignees of G. A. Morton). Convention date (U.S.A.), May 15th, 1937. No. 497551.



Television scanning tube designed to improve signal-noise ratio.

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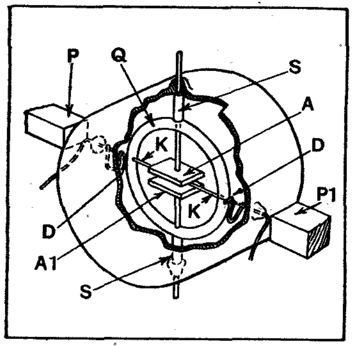
ULTRA-SHORT-WAVE VALVES

THE figure shows the electrode assembly of a valve designed for ultra-short-wave working. The two anodes A, A1 are carried by supports S, which are fused through the top and bottom of the glass bulb and are provided with sleeves to abut against the periphery of a ring Q of quartz or other insulating material. The cathode K passes through holes made in the same ring, and is held by stops D, which bear against the outer surface of the ring. The ring is compressed initially so as to put the cathode under a certain amount of tension.

As the valve heats up the cathode expands slightly, but the ring Q alters, too, and so automatically maintains the tension and spacing of the cathode. The valve can be operated as a magnetron if a magnetic field is provided across the pole-pieces P, P1.



Ultra-short-wave valve with compensation against the effects of heat.

Standard Telephones and Cables, Ltd. (assignees of A. L. Samuel). Convention date (U.S.A.), July 16th, 1937. No. 497563.

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PUSH-BUTTON TUNING

RELATES to tuning systems of the motor-driven type, where a station is selected by operating a push-button, whereupon the tuning condenser is automatically rotated until it "homes" on to the desired wavelength. Usually the available stations are grouped in different wavebands, and the wave-change switch must be set to its proper position before pressing the button.

According to the invention, no matter on what waveband the circuits are set, the pressing of any selector button automatically operates the wave-change switch to bring it to the proper setting before the driving motor is allowed to proceed to tune the circuits. If, however, the button selected belongs to the waveband to which the circuits are already set, tuning takes place in the normal fashion.

E. K. Cole, Ltd., and A. W. Martin. Application date, January 13th, 1938. No. 497774.

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SUPERHET RECEIVERS

THE use of a fixed intermediate frequency in a multi-band superhet set is open to the objection that it is usually too high for optimum selectivity and tracking in the broadcast band and too low in frequency and too selective when receiving short waves.

According to the invention, the waveband switch changes the intermediate frequency as well as the tuning of the preselector circuits. The change is made in a predetermined fashion, and preferably so that the fixed intermediate frequency used on each separate waveband is approximately one-third the lowest frequency in that particular band of signal frequencies.

The tuning coils of the preselector and IF stages are interchangeable, so that the IF coils used for one waveband are made to serve as the preselector coils for the next lower waveband, and so on progressively.

Marconi's Wireless Telegraph Co., Ltd. Convention date (U.S.A.), May 29th, 1936. No. 496145.

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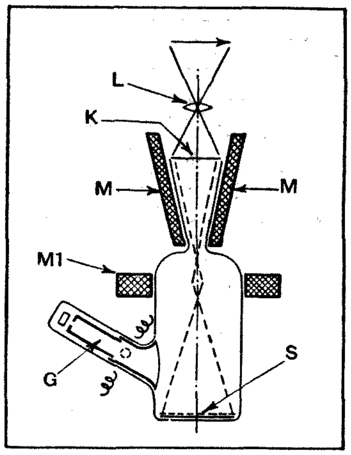
FOCUSING SYSTEMS

THE picture to be televised is projected through a lens L on to a photo-sensitive cathode K, and the composite stream of electrons set free from the cathode is subsequently focused on to a mosaic-cell electrode S, where the image-charges set up are scanned by an electron stream from the gun G of the tube in the ordinary way.

From the point of view of good definition, it is desirable that the area of the cathode K and screen S should be made as large as possible in order to facilitate the subsequent scanning operation. On the other hand, the composite stream must be focused by electron-optical methods, and this means that distortion increases with the cross-section of the stream.



Television tube with extra focusing coil.

The figure shows how an effective compromise is made by subjecting the picture stream, as it leaves the cathode K, to the action of the converging magnetic field from an inclined coil M before the stream enters the field of the usual focusing coil M1.

H. G. Lubszynski. Application date, May 20th, 1937. No. 497645.

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The Wireless World

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EDITORIAL COMMENT

The Service Engineer

His Responsibility to Broadcasting

IN days gone by members of the public whose receivers developed faults took an awful risk when they called in an "expert" from the local wireless shop to see what was wrong. Broadcasting came upon us so suddenly that, whilst the manufacturers were turning out receivers as fast as it was possible for them to do so, no organisation had been set up which was capable of maintaining those sets in proper order after they were in the hands of the public.

The local service-man in those days was generally untrained and tried to locate faults by "hit-and-miss" methods, often without instruments of any kind, so that it was small wonder that servicing came into disrepute, not only with the public, but also with the local radio dealer, who found that it was impossible to undertake servicing except as a liability to himself.

Equipment

To-day every wireless trader who hopes to stay in the business recognises the importance of service to his customers, and whilst the process may be slower than it should be, he is, nevertheless, acquiring trained service-men and by degrees equipping them with those instruments which are the essential tools of their trade.

The confidence of the public in service is returning, and the public is coming to recognise that expert service in maintaining receivers in a proper state of efficiency must be paid for in the same way that the cost of any other skilled service has to be met.

In turn, the dealer is finding that, efficiently run, his service department is profitable in itself. That is not all; the industry is now recognising that since wireless sets are in almost general use throughout the homes of the country, it is no longer easy to sell "just another wireless set." There has got to be a reason for replacing the old one. It is the service-man who has the entry into the customer's home. He is called in when an old set gives trouble, and if he is a good service engineer he will be able to effect the necessary repairs, but at the same time he will not encourage the customer to keep on spending money on a receiver which is not worth it and he will then be asked about a new set.

Technical Men should urge "Better Reception"

More and more to-day the prosperity of the industry in the direction of sales of receivers comes through social visits of technical friends or the professional visits of a service engineer to individual homes. The aim of every reader of *The Wireless World* should be towards raising the general standard of wireless reception. When he hears reproduction which he knows to be deplorable in quality he should not let it pass but should encourage the owner of the set to do something about it. In all probability the owner has got used to the bad quality and is quite unconscious of the shortcomings of the set.

If broadcasting is to be maintained on a high level in this country and is not only to provide enjoyment for the older members of the family, but also train the young ear to an appreciation of musical quality, then support must be given by those who are technically trained to a long overdue campaign for "better reception."

The Wireless World Stand-by Three

A COMPACT THREE-VALVE BATTERY RECEIVER

HERE is a receiver design that fulfils several purposes. The set described is particularly simple and straightforward and so provides an excellent introduction to wireless construction; when completed, it serves as an admirable stand-by in all cases where a mains supply is not available, and for intermittent and occasional use it has at least one major advantage over the conventional battery portable. Lastly, a set of this kind would be a virtual necessity in times of emergency.

PROBABLY the majority of listeners employ a mains-operated receiver, and rightly so, because it gives a better performance and costs less in upkeep than a battery set. The latter, however, is not merely of interest only to those who do not possess a mains supply; it is a highly desirable adjunct to the mains set.

A self-contained battery set can readily be moved about, and is consequently as suitable for outdoor use as for indoor. At picnics or in the sick-room it is equally suitable, and it forms an admirable stand-by in case of failure of the mains supply—a point not to be overlooked during the present unsettled state of the world.

A receiver which is intended primarily for emergency use needs rather different characteristics from one which will be employed for regular listening. In the first place, it must work from a small aerial; secondly, only the reception of a few stations need be considered important; thirdly, high quality of reproduction and large volume are less important than intelligibility of speech; and, fourthly, the batteries must be of a type that do not require regular attention.

Let us start by considering the question of the batteries, since our decision here will affect the other matters in some degree. The choice is between dry batteries and accumulators. The use of accumulators for the HT supply in a small, self-contained set need not be considered, but it is possible to derive the HT from the LT supply with the aid of a vibrator transformer and smoothing equipment.

The disadvantage of this scheme is that it costs more than a dry battery initially, and it increases the current drain on the LT accumulator, thus making more frequent recharging necessary. Its advantage is that HT battery renewals are avoided.

The relative weight to be attached to these points depends on the receiver. If a performance comparable in all ways with that of a mains set is required, then the HT supply must be 60 mA. at 250 volts, or even more. The cost of such a supply from dry batteries is normally prohibitive, and it is cheaper in the long run to use a vibratory supply unit with a 6- or 12-volt accumulator. Even then frequent recharging of the battery is needed.

A small battery set, however, may need only 10 mA. or so at 100-120 volts, and there is little doubt that the dry battery is the more economical source. This is especially the case when the receiver is intended for intermittent rather than continuous use, for dry batteries are then at their best.

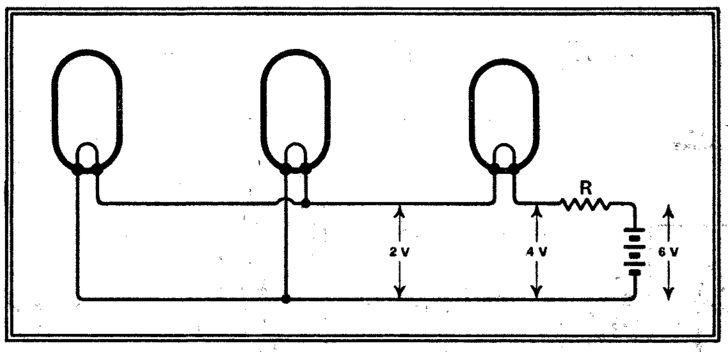
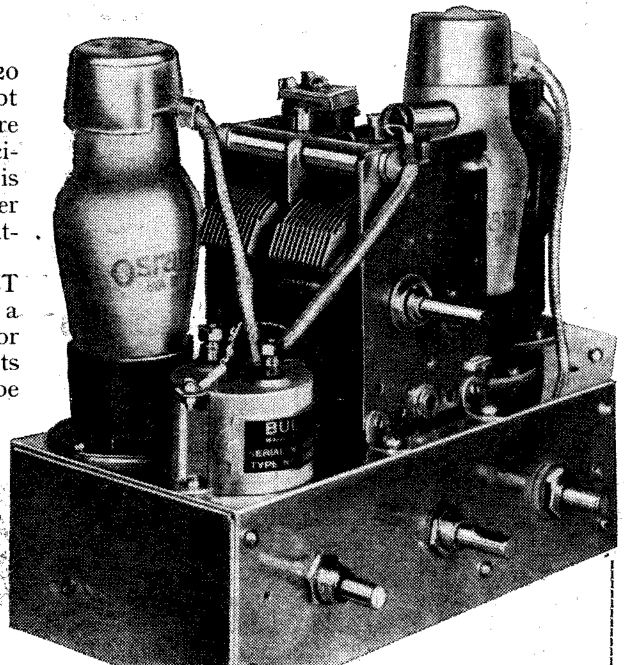


Fig. 1.—The arrangement of the filament circuits of the valves is shown in this diagram.

Now let us turn to the LT supply. The alternatives are a 2-volt accumulator or a 3-volt or 6-volt dry battery. At 2 volts the current required is likely to be about 0.3-0.5 ampere according to the valves selected. A small accumulator will supply this easily, and for continuous use is undoubtedly the better.

An accumulator requires regular attention, however, if it is to keep in good condition. In the case of a stand-by set the chances are that it will be forgotten, and just when the set is wanted it will be found that it has lost its charge or even started to sulphate. There is also the question of recharging. In the unhappy event of war it is possible that charging facilities would be temporarily interrupted, just as the mains supply might fail for a time. The receiver would then be useless at a time when it would be urgently wanted.

The dry battery is free from these limitations, and is quite suitable for intermittent use, although it is less convenient and more costly for a regular supply. The disadvantages of the dry battery are that



A front view of the receiver chassis with the RF valve in the foreground.

The Stand-by Three—

its voltage falls during its life and that its life in hours is much less if it is used for considerable periods at a time than if it is only used for short spells with intervals of rest. The maximum life is secured with intermittent use, a low-current drain and the provision of a higher voltage than that needed by the valves with a dropping resistance.

A receiver could be designed, for instance, to work off a 4-volt supply, and the obvious thing to do is to use a three-cell battery giving 4.5 volts. The voltage, however, would drop fairly quickly and settle down at something like 3.5 volts for a long time before it begins to fall off rapidly at the end of its life. It would have to be replaced as soon as the voltage fell much below 4 volts if the receiver were to function properly.

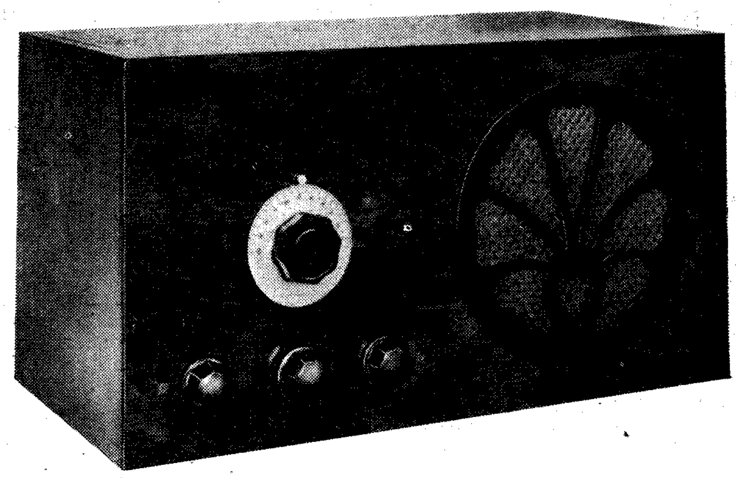
The Filament Circuit

By using a 6-volt battery, however, a longer useful life can be obtained. A series resistance is necessary, of course, to drop the voltage, but this can be reduced in value as the voltage falls, and at length cut out entirely when the battery reaches 4 volts only. It is then in any case worn out.

The disadvantage of this course is that a good voltmeter or ammeter is really needed to adjust the voltage accurately. Where such a meter is available it is advisable to use it, but it is not essential, for modern valves are rather tolerant of small variations in filament voltage. With a little care it is quite possible to obtain satisfactory results without using a meter.

As we decide to use dry batteries for both HT and LT, it is obvious that the current consumption of the set must be kept at a minimum. The requirement of working from a small aerial demands high sensitivity, however, so that we must pick our valves and circuit carefully.

For the output stage a pentode is an obvious choice, since it gives a greater output than a triode for a given drain on the HT supply. The modern type also requires a much smaller signal input, so that increased sensitivity results. The current consumption of the different pentodes available is 0.15 amp., 0.2 amp., and 0.3 amp. at 2 volts.



The complete receiver and loud speaker can be housed in a cabinet of moderate proportions.

Now, the current consumption of British RF pentodes varies from about 0.1 amp. to 0.18 amp. As we desire to arrange the set for 4 volts it is clear that for economy the valve filaments must be series connected. For a two-valve set we should naturally choose both valves to take 0.15 ampere.

A two-valve set will not give the required sensitivity, however, and three valves are needed. As RF pentodes take less current than output pentodes it is clear that it would be wise to pick the valves so that the current taken by the early stages equals the current of the output valve. The first two valves can then have their filaments wired in parallel, and the two connected in series with the pentode filament, as shown in Fig. 1.

It is clear that these conditions are best met by choosing valves taking 0.1 ampere for the early stages and 0.2 ampere for the output. For the latter the Marconi or Osram KT2 is suitable. At 120 volts it takes 6.2 mA. anode current and 1.3 mA. screen current—a total of 7.5 mA.—and gives an output of some 250 milliwatts into a load of 12,000 ohms. It needs 3 volts grid bias.

To precede the output stage we need a detector. As high sensitivity is needed, there is no real alternative to the grid detector; it is simple and reliable, it gives

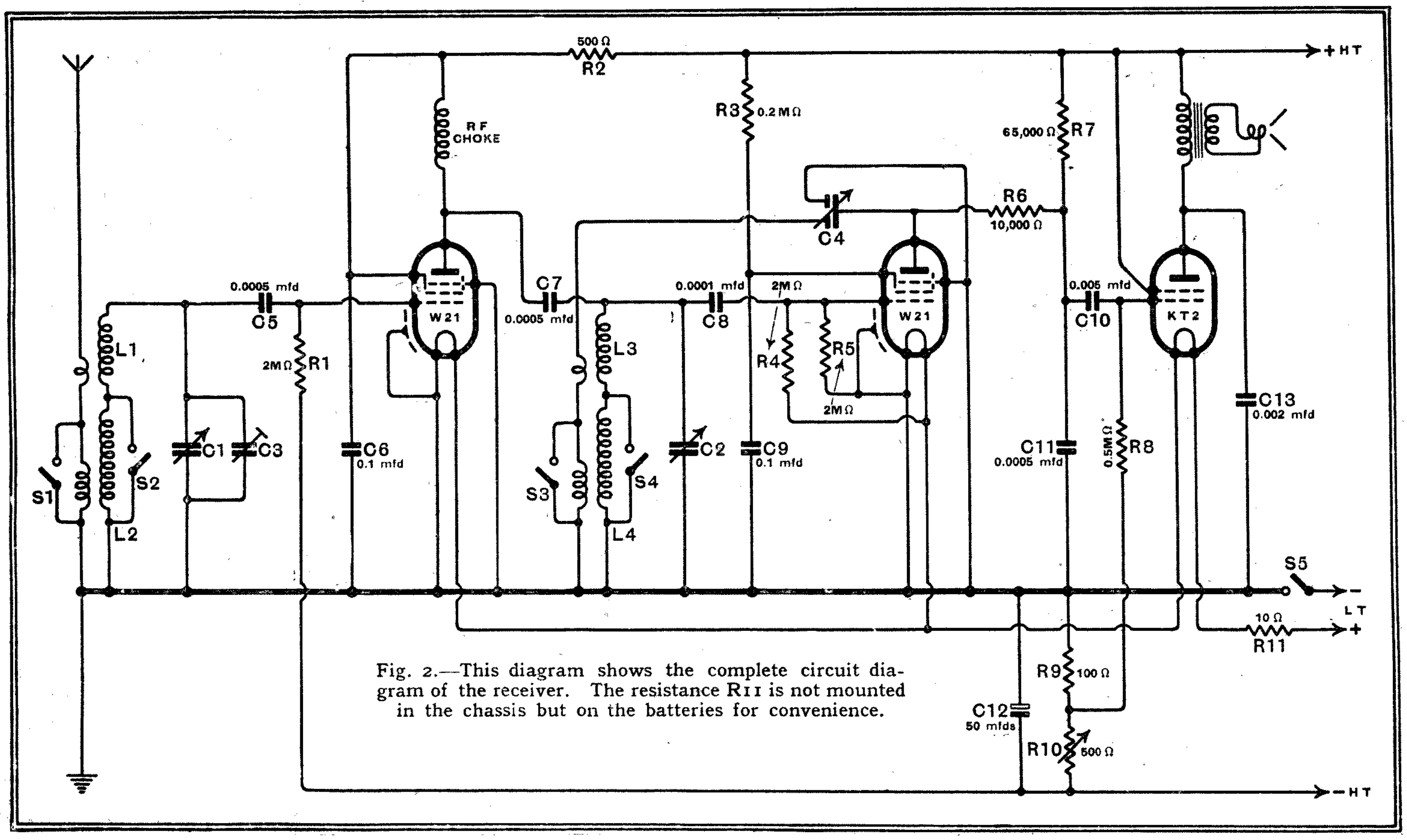


Fig. 2.—This diagram shows the complete circuit diagram of the receiver. The resistance R11 is not mounted in the chassis but on the batteries for convenience.

The List of Parts Required to Build The Stand-by Three

1 **Condenser**, 2-gang, 0.0005 mfd., **C1, C2** — **Polar "Bar"**
1 **Dial** — **Eddystone 1099**
1 **Trimmer, C3** — **Bulgin SW99**
1 **Reaction Condenser**, 0.0002 mfd., differential, **C4** — **Bulgin N23**

Fixed Condensers:
- 3 0.0005 mfd., tubular, **C5, C7, C11** — **T.C.C. 451**
- 1 0.0001 mfd., tubular, **C8** — **T.C.C. 451**
- 1 0.002 mfd., tubular, **C13** — **T.C.C. 451**
- 1 0.005 mfd., tubular, **C10** — **T.C.C. 451**
- 2 0.1 mfd., tubular, **C6, C9** — **T.C.C. 341**
- 1 50 mfds., 12 volts, electrolytic, **C12** — **T.C.C. "FT"**

Resistances:
- 1 100 ohms, $\frac{1}{2}$ watt, **R9** — **Erie**
- 1 500 ohms, $\frac{1}{2}$ watt, **R2** — **Erie**
- 1 10,000 ohms, $\frac{1}{2}$ watt, **R6** — **Erie**
- 1 65,000 ohms, $\frac{1}{2}$ watt, **R7** — **Erie**
- 1 200,000 ohms, $\frac{1}{2}$ watt, **R3** — **Erie**
- 1 500,000 ohms, $\frac{1}{2}$ watt, **R8** — **Erie**
- 3 2 megohms, $\frac{1}{2}$ watt, **R1, R4, R5** — **Erie**
- 1 10 ohms, **R11** — **Bulgin AR10**

1 **Potentiometer**, wire-wound, 500 ohms, **R10** — **Reliance "TW"**
1 **Set of Coils**, PA1, PA2, PHF1 and PHF2 — **Wearite**
1 **Switch**, 3-way, 6-pole — **Bulgin S208**
1 **RF Choke** — **Bulgin HF8**
2 **Screened Grid Cap Connectors** — **Bulgin P64**
2 **Valve Holders**, 7-pin (without terminals) — **Clix Chassis mounting standard-type V2**
1 **Valve Holder**, 5-pin (without terminals) — **Clix Chassis mounting standard-type V1**
1 **Battery Cable**, 4-way — **Bulgin BC2**
1 **Length screened sleeving** — **Goltone**
3 **Knobs** — **Bulgin K10**
4 **Connectors** — **Clix No. 22**
Cabinet — **Peto-Scott**
Chassis — **B.T.S.**
Loud speaker, PM, with transformer to give 12,000 ohms load — **Goodmans B/605/12000**
2 **Dry Cells**, 3 volts — **Ever Ready 2062**
1 **HT Battery**, 120 volts — **G.E.C.BB50**

Valves:
- 2 W21 (7-pin metallised), 1 KT2 — **Osram**

Miscellaneous: — **Peto-Scott**
- 4 lengths systoflex, 1 oz. No. 22 tinned copper wire, 2 wander plugs. Screws: 36 $\frac{1}{4}$in. 6 BA R/hd., 3 $\frac{1}{2}$in. 4 BA R/hd., all with nuts and washers.

The Stand-by Three—

high gain, and it enables reaction to be secured easily. A triode is usually adopted, and has the disadvantages of a high input capacity and a low input resistance.

The use of an RF pentode as a detector is distinctly advantageous and also enables rather higher amplification to be secured. Resistance coupling is satisfactory, reliable and cheap.

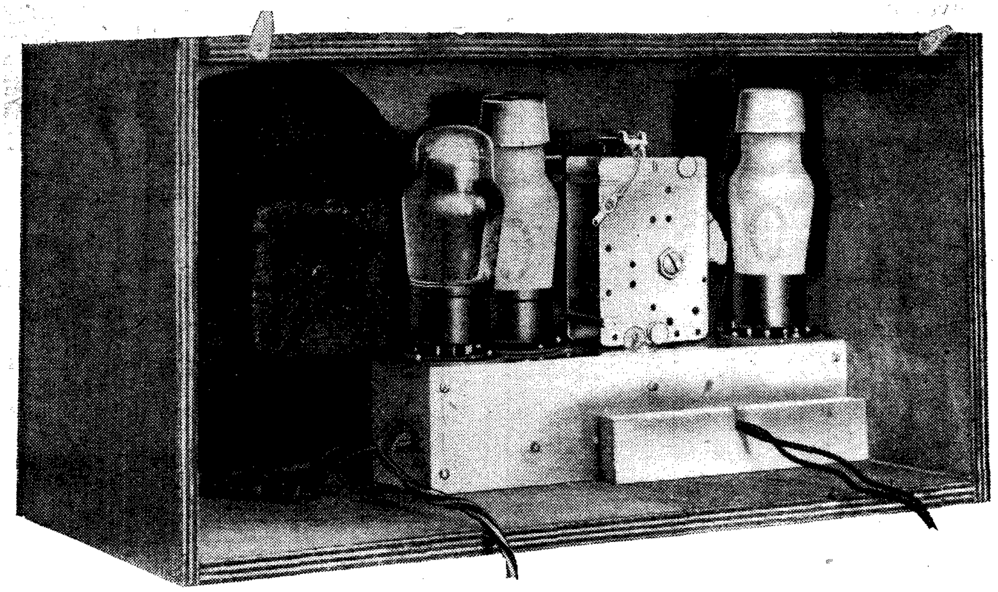
Before the detector we have one valve only and there are two ways in which it can be used. It can be an RF stage or a frequency-changer. If the receiver is a straight set two tuned circuits, with reaction, will be used, partly for economy and partly to avoid the loss of sensitivity which a third circuit would introduce. If the set is a superheterodyne there will still be two variably tuned circuits, one at signal and the other at oscillator frequency. A fixed-tuned coupled-pair, with reaction, would couple the frequency-changer to the detector and form the IF circuits.

The selectivity of the superheterodyne would be much greater than that of the straight set, but the sensitivity would be considerably lower. This is because a valve operating as a frequency-change gives only about one-third the effective gain of that of an amplifier. The superheterodyne is the more complicated and the more difficult to adjust of the two and it is likely to be much more affected by low battery voltage.

We thus decide on the straight set and the complete circuit diagram is shown in Fig. 2. For the medium-wave band the switches S1, S2, S3, S4 are closed, thus short-circuiting both coils of L2 and L4. The coil L1 is then tuned by C1. The primary is of the high-inductance type, since this renders the secondary tuning much less liable to be affected by changes in the aerial.

The signal developed across C1 is applied to the grid of the RF valve through the 0.0005 μF. condenser C5, the negative grid bias of 1 volt being applied through the 2-MΩ resistance R1. The screen and anode are both fed with the same voltage of nearly 120 volts, common decoupling, provided by R2 of 500 ohms and C6 of 0.1 μF., being used.

The intervalve coupling is tuned grid. This may be surprising because tuned anode needs fewer parts and would seem to work as well. Tuned-anode coupling was actually tried out in the experimental model, but was abandoned for a very good reason — a continuous audio-frequency howl developed whenever the receiver went into oscillation. This made reaction



This rear view with the batteries removed clearly shows how the receiver and speaker are accommodated in the cabinet.

very difficult to control and so largely nullified its advantages.

The howl was due to AF feed-back along the HT supply reaching the detector grid. To avoid it with tuned-anode coupling, AF decoupling of the HT feed to the RF valve is necessary, and the components required for this are more expensive and bulky than those needed for tuned grid.

The mechanism of the feed-back is interesting and can readily be seen from Fig. 2 if C7 is imagined short-circuited and L3 removed. When the detector oscillates its anode current falls, giving a rise in anode voltage which is communicated to the grid of the output valve as a positive pulse. This makes the anode current rise and there is a sudden drop in potential across the internal resistance of the HT battery. This drop in potential makes the anode voltage of the RF valve fall and is communicated as a negative pulse to the detector grid through C8, in spite of the low capacity of this condenser. This negative pulse on the detector grid lowers its anode current further, and the effect is cumulative.

After a time a limiting action occurs and the detector anode current begins to rise again. This also is cumulative and the amplifier oscillates at a frequency determined by the circuit elements.

The Tuned Grid Circuit

With tuned grid the AF feed-back path is interrupted by the tuning coil L3. The impedance of this is so low that it acts virtually as a short-circuit across the detector input at the frequency at which the amplifier might oscillate.

This reasoning was amply justified in practice and on the medium-wave band no trace of howling was found with tuned grid. On the long-wave band there was also no serious trouble, but owing to the higher impedance of the coil L4, feed-back was not so completely eliminated. It proved possible to provoke a howl on this band, but further endeavours were not made to remove this possibility, since it proved in no way troublesome.

Returning now to Fig. 2, after this digression, the coil L3 is tuned by the second section of the gang condenser C2, and the voltage developed across it is applied to the detector through the 0.0001 μF. condenser C8. For efficient detection a 1 MΩ grid leak returned to a point about 1 volt positive with respect to the negative filament lead is required. This is conveniently obtained by using

The Stand-by Three—

two grid leaks of 2 MΩ each; one R4 is returned to the positive filament (+2 volts), and the other R5 to the negative filament.

The detector is an RF pentode of the same type as that used for the RF stage (Marconi or Osram W21). In common with the usual practice when using pentodes for AF amplification, the screen is operated at a low voltage. It is fed through the 0.2 MΩ resistance R3, and a 0.1 μF. by-pass condenser C9 is adequate.

The correct anode circuit resistance for this condition is 75,000 ohms, and this is split into two parts; R6 of 10,000 ohms acts in conjunction with C11 primarily as an RF filter, and R7 of 65,000 ohms is the coupling resistance proper. Reaction is obtained with the aid of the differential condenser C4.

The AF output of the detector is applied to the output pentode through the 0.005 μF. condenser C10, and bias is applied through the 0.5 MΩ grid leak R8. The screen of this valve is taken straight to positive HT, and the anode is fed from this point through the output transformer on the loud speaker.

The Bias Circuit

A condenser, C13 of 0.002 μF., is shunted from the anode of the output valve to the chassis for two reasons. First, it counteracts the tendency for the pentode and loud speaker to accentuate the upper musical register, and secondly it reduces RF feedback on the long-wave band. On this band the filter R6 C11 is inevitably less efficient than on the medium-wave band, and a certain amount of RF energy does reach the pentode. The condenser C13 prevents any appreciable amount being developed on the loud speaker leads from which it might be fed back to the input and so cause instability.

The valve filaments are connected in series-parallel as already explained, and a resistance R11 of 10 ohms is inserted to drop the excess battery voltage. This resistance is mounted on the battery, not on the set, to facilitate its alteration when the battery runs down. S5 is the on-off switch.

The output valve requires 3 volts negative grid bias with respect to its negative filament lead. This point, however, is 2 volts positive with respect to negative LT and the chassis. The grid, therefore, must be returned to a point only 1 volt negative with respect to the chassis.

Bias is obtained by means of the voltage drop across a resistance in the negative HT lead. Assume R10 to be at minimum, so that it is short-circuited, then negative HT is joined to negative LT through the 100-ohm resistance R9. As the total current consumption of the set is 9 mA., the voltage developed across R9 is 0.9 volt.

The grid return of the output valve is taken to negative HT in this condition and is consequently −0.9 volt with respect to the chassis and −2.9 volts with respect to its own filament. This is quite near enough to −3 volts; actually, for this value a non-standard resistance would be needed (110 ohms).

The grid return of the RF valve is also taken to the same point when R10 is at minimum resistance. As the filament of this valve is returned to negative LT, the bias on this valve is only the drop across R9, −0.9 volt.

When R10 is not at minimum, additional resistance is included in the negative HT lead. The bias for the output valve is still that developed across R9, however, but that for the RF valve is the voltage developed across R9 and R10. When R10 is increased to reduce the gain of the set, the current drawn by the RF valve falls, and hence the total current falls. As a result the voltage across R9 falls, and the bias on the output valve is reduced and its anode current rises.

The effect is a minor one, but is mentioned to explain the readings which will be obtained on a milliammeter connected in the various circuits.

(To be concluded.)

PUSH-BUTTON TUNING IN A NEW LIGHT

Some Interesting Possibilities

WHEN discussing the advantages of push-button tuning, emphasis is usually laid on the fact that a completely non-technical person can tune in a station as quickly and accurately as one who is highly skilled and experienced. If careful thought is given to the matter, however, it will be seen that this advantage, great as it is, is not nearly so important as are the enormous possibilities which the system gives of improving the performance of the receiver.

It is well known that in the ordinary receiver there is a great number of what may be called compromise adjustments. As an example, the method of coupling the aerial to the first tuned circuit may be cited. The optimum coupling for receiving a station on 200 metres, for instance, is not, all other things being equal, the same as for bringing in a transmission farther up the medium waveband scale. A different degree of coupling might, indeed, be called for even in the case of stations on the same wavelength in order to vary the signal-to-noise ratio in accordance with the expected signal strength available from each station.

Optimum Coupling—Always

It would theoretically be possible to arrange for the aerial coupling to be varied either continuously or in a large number of fixed steps, but in actual practice the tuning of the set would then become exceedingly complicated. The set maker, therefore, compromises by fixing the coupling so that it gives reasonably good results on all wavelengths covered by the receiver. In the case of push-button tuning, however, it is obviously possible to arrange that the button associated with each station alters the aerial coupling to the most suitable value, such as by the provision of several cams or contacts on the button mechanism or, in cases where a tuning motor is used, by a whole host of other methods which ingenuity could easily devise, even to the extent of using separate motors if necessary.

It is quite easy to think of a very large

number of circuit adjustments which could with advantage be made in order to obtain the maximum receiver performance in the case of each station to which the set is tuned. In the case of some transmissions, for instance, a good deal of interference could be eliminated if an arrangement were available for directional reception by phasing the output from two aerials. Many troubles could also be avoided if provision was made for drastically reducing the gain on very strong signals instead of leaving it all to the over-worked AVC system and so introducing objectionable distortion.

If all these variables were to be fitted in the ordinary set the number of control knobs would be beyond the operating capabilities of even the most hardened professional, and so they are omitted. There would be no great difficulty, however, in arranging to include them in a

Push-button Tuning in a New Light—
push-button set in the manner already indicated. In some cases, of course, remote control would have to be used, a typical instance being where it was desired to obtain optimum signal-to-noise ratio from an anti-interference aerial by including tappings on the transformer at the "aerial" as well as at the "receiver" end of the transmission line.

There is yet another point. Most receivers have one or two auxiliary controls, but these could quite easily be eliminated in the case of push-button sets. A useful instance is the variable-selectivity control which is now available on many receivers. Were it not for the question of interference, this could be permanently left in the minimum position usually adopted for local-station reception. In any particular locality it is known by experience what degree of selectivity is necessary to enable a given station to be received free of interference from other stations. Surely, then, it would be easier to make the push-button adjust the selectivity at the same time as it tuned in the station.

Simultaneously it could be arranged that the characteristic curve of the AF amplifier was varied so as to counteract as far as possible the effect on reproduction caused by the selectivity adjustment, thus doing away with the tone control. There seems, in fact, hardly any limit to the latent possibilities of push-button control in the matter of improving the performance of a receiver and yet simplifying its operation.

RADIO TELEPRINTING

Eliminating Errors Due to Atmospherics

It is well known that ordinary hand-operated morse telegraphy is rapidly being superseded by various automatic printing systems. Not only is much greater speed attained by automatic methods, but still more time is saved by eliminating the necessity for translating the ordinary letters of the alphabet, numerals and other symbols, into morse and then retranslating them at the receiving end.

Unfortunately, the automatic systems used on land-line and submarine telegraphs are not well suited to wireless transmission. In most systems each character to be transmitted is translated into a telegraph code signal consisting of a combination of "marking" and "spacing" elements, this process being reversed at the receiving end. In the case of wireless communication the addition of spurious impulses due to atmospherics or to what is usually called "man-made static" is liable to cause one letter to be changed into another.

Several attempts have been made to develop a method in which this defect is absent. One of the most recent of these is that developed by Le Matériel Telephonique, an associated company of Standard Telephones & Cables, Ltd. The principle on which it works is allied to that used in the facsimile system of transmission, and may best be described as a "scanning" method in which each printed character is analysed into a number of elementary lines, and transmitted in the form of dashes and spaces of varying length, which build up the original character at the receiving end. Using this method, interference cannot change a character into another which is totally dissimilar, the only effect of it being to print small extra elements or to suppress small elements of the received character. Furthermore, the operator at the receiving end is aware of the quality of the transmission and may request a repetition whenever necessary.

All characters are drawn so that they may be built up from a number of elementary lines. These elements are assembled according to the character, and are then scanned or analysed in seven horizontal lines. Each horizontal line is represented by one definite audio frequency. The seven lines are scanned and transmitted simultaneously, thus enabling a relatively high speed of printing to be attained without necessitating very short elementary signals. There is no need to maintain synchronism between the transmitting and receiving mechanisms. A special "start-stop" system is used so that the tape at the receiver does not continue running when signals are not coming in, and the receiving apparatus can, therefore, be left unattended, which is a great advantage.

Excellent results have been obtained in extensive tests over an SW link between Algiers and Paris, a distance of 800 miles. Further extensive tests between the medium-wave transmitter of the French Meteorological Office and a receiving station at Brussels have been carried out under regular traffic conditions, and have confirmed the results obtained on short waves.

PROBLEM CORNER—13

An extract from Henry Farrad's correspondence, published to give readers an opportunity to test their own powers of deduction:—

"Bellevue,"
Hampstead, London, N.W.3.

Dear Mr. Farrad,

The new "all-wave" superhet is a great success, though my wife says I waste too many evenings over it. Still, it is very interesting trying to identify all the curious things that can be heard on the short waves.

There is one thing that ought to be easy, being so near at home, but it has baffled me so far. About a quarter to eleven last evening I came across a station on 22¼ metres giving the usual B.B.C. news bulletin, apparently the same as the one I had heard on the National an hour or two earlier. When it was finished it just ceased without giving any name or other clue. I looked up the B.B.C. Empire programmes and there was no news timed for then on any wave, and in any case there is a gap in the broadcast bands between 20 and 25 metres, and no station near 22¼ looks even remotely likely to be sending out B.B.C. news. I have found the scale very accurate, so think I can depend on the figure pretty well.

As I have heard that sometimes one can pick up a longer-wave station on its harmonic, I had a look through the list. Bournemouth is about nine times the wavelength, but as I can hardly get it on its own wavelength that didn't seem likely! And, anyway, it wasn't giving news; nor were any of the other B.B.C. stations. So it remains a mystery. Can you solve it?

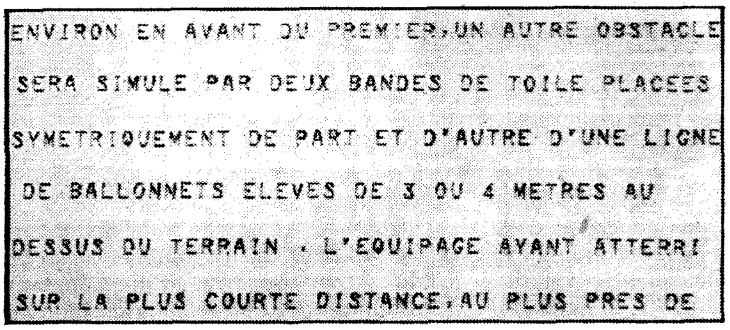
Yours sincerely,
Will B. Keen.

What was the station? *Turn to page. 309.*

DC/AC Inverters for Television Receivers

The gas-filled triode inverter is a very satisfactory method of converting DC into AC at high power ratings, and it has also been used at smaller ratings for operating radio receivers. For television receivers, which cannot be operated directly from DC mains, it would also appear to have possibilities.

Since the output from an inverter is very far from a sine wave, there are likely to be difficulties in providing sufficient smoothing to prevent any traces of ripple appearing on the picture. It is therefore suggested that improved performance could be obtained by locking the inverter, which is usually free-running, into the output of the frame-frequency time-base generator.


ENVIRON EN AVANT DU PREMIER,UN AUTRE OBSTACLE
SERA SIMULE PAR DEUX BANDES DE TOILE PLACEES
SYMETRIQUEMENT DE PART ET D'AUTRE D'UNE LIGNE
DE BALLONNETS ELEVES DE 3 OU 4 METRES AU
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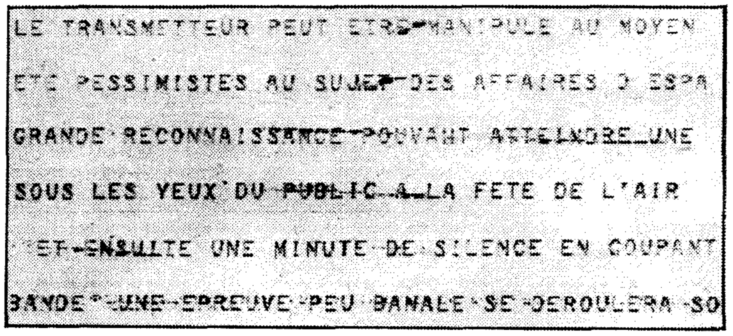
LE TRANSMETTEUR PEUT ETRE MANIPULE AU MOYEN
ETE PESSIMISTES AU SUJET DES AFFAIRES D ESPA
GRANDE RECONNAISSANCE POUVANT ATTEINDRE UNE
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Two specimens of letterpress received by the L.M.T. system. In the example shown on the right the effect of atmospherics and other forms of interference is clearly seen. It will be noticed that, although marred, the text is still perfectly legible. In the case of ordinary systems this amount of interference might have been sufficient completely to change several letters, so leading to grave inaccuracies.

Frequency-Changer Valves

LITTLE-KNOWN EFFECTS ON SHORT WAVES

By
E. G. JAMES, B.Sc., Ph.D.
(Research Laboratories of the G.E.C., Wembley)

IN making the best use of existing valves the set designer is considerably helped by a knowledge of the factors which have been taken into account by the valve-maker. This article should serve to mark some of the more obscure pitfalls associated with the frequency-changer stage.

THE performance and ease of operation of a superheterodyne radio receiver at frequencies above 10 Mc/s (30 metres) is dependent, to a very large extent, on the stability of operation of the frequency-changer valve. The most common types of frequency changers used at the present time are heptodes (or octodes) and triode-hexodes, and in both types the following objectionable effects may be present at short wavelengths:

(1) Interaction between signal and oscillator circuits.
(2) Modulation hum.
(3) "Flutter" effect.
(4) Anomalous tuning.
(5) Frequency drift.

The extent to which the effects are troublesome depends on circuit design and to a very much greater degree on the type of valve used.

The main differences between heptodes and triode-hexode valves are: (a) In heptodes the oscillator voltage is applied to the control grid nearest the cathode and the signal voltage to the outer control grid, while in a triode-hexode the converse is the case; (b) in heptodes the same electron stream is usually used for the oscillator as for the "mixer," while triode-hexodes, as their name implies, employ a separate triode for the oscillator. The arrangement of the grids in the two types is shown in Fig. 1 (a) and (b).

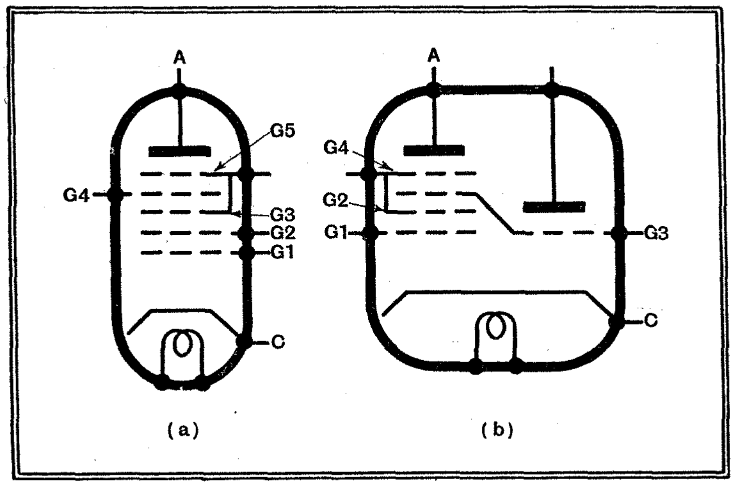


Fig. 1.—Electrode arrangement (a) in a heptode, (b) in a triode-hexode.

In the heptode G1 is the oscillator grid, G2 the oscillator anode, G3 and G5 are screen grids, which are maintained at a fixed potential, while G4 is the signal grid. In the triode-hexode G1 is the signal grid, G2 and G4 are screen grids, while G3 is the oscillator grid. Both valves, of course, may have an extra electrode outside the outer screen to reduce the effects of secondary emission; they then become octodes and triode-heptodes respectively.

If the tuning of the signal circuit of a frequency-changer valve is varied, the frequency of the oscillator is altered, and Fig. 2 shows the results of measurements carried out in the region of 15 Mc/s on the variation of oscillator frequency with signal circuit tuning with the triode-heptode X65. It will be seen that the total change in frequency is 2.2 kc/s, but under working conditions, say, with a 450 kc/s IF, the change in frequency from its normal value is only 0.5 kc/s.

Measuring Interaction

In comparing the interaction between various types of frequency changers, the total change in oscillator frequency can be taken as a measure of the interaction, and Table I gives comparative figures for a heptode, a typical triode-hexode and the triode-hexode X65 valves.

The interaction is greatest for the heptode at all frequencies, and smallest for the X65.

The difference in interaction between heptodes and triode-hexodes depends on their mode of operation. In heptodes the signal grid (G4) has normally a fixed negative bias, so that we have a retarding field between the screen G3 and grid G4. A space charge will therefore be formed between G3 and G4. The potential of the inner grid G1 is varying at oscillator frequency, and therefore the total current flowing through G3, and thus the density of the space charge between G3 and G4, will vary at oscillator frequency. This variation in space charge density will give rise to an induced charge on G4, which in turn generates a voltage of oscillator frequency across the circuit connected to G4. This voltage is fed back through the valve to the oscillator grid G1, and oscillator anode G2, and will cause variations in oscillator frequency which will depend on the phase of the fed-back voltage.

In a triode-hexode, the oscillator

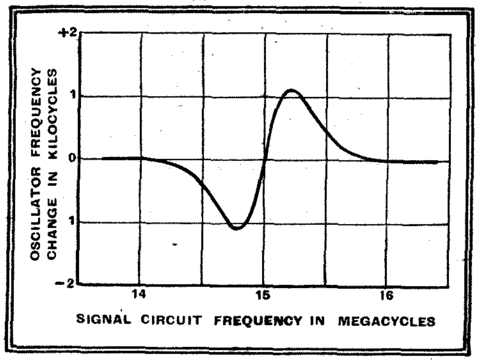


Fig. 2.—Variation of oscillator frequency with signal circuit tuning with the X65 valve.

voltage is aplied to G3 and the signal voltage to G1, and it is found that the coupling, and therefore interaction, is very much smaller than in the heptode. The difference between the X65 and the typical triode-hexode is due to smaller capacities and clearances between the electrodes of the X65. The large voltage of oscillator frequency induced on the signal grid of a heptode reduces the effective conversion conductance, and a considerable increase in gain would result if this voltage could be neutralised.

The voltage induced in the heptode on G4 by the space charge is approximately 180 deg. out of phase with the oscillator voltage on G1, while the voltage induced via the G1-G4 capacitance is in phase with

TABLE I.

Valve	Interaction		
	At 15 Mc/s.	At 20 Mc/s.	At 25 Mc/s.
Heptode	16.8 kc/s.	28 kc/s.	47 kc/s.
Typical triode-hexode	5.5 ,,	9.0 ,,	15 ,,
Triode-heptode X65	2.2 ,,	3.6 ,,	7 ,,

the oscillator voltage. Hence it is possible to neutralise the voltage by increasing the G1-G4 capacitance. However, at frequencies above about 10 Mc/s, the space charge density is not exactly in phase with the oscillator voltage, due to

Frequency-Changer Valves—

the time of flight of the electrons between G1 and G4. Hence complete neutralisation is not possible with a pure capacitance, but neutralisation can be made complete by connecting a resistance in series with the neutralising capacitance. The condition of complete neutralisation, however, only holds for one frequency and one value of the oscillator voltage; if one or both are altered interaction will take place.

In all frequency-changing valves, a change in the voltage of any electrode gives rise to some change in the oscillator frequency, and this dependency gives rise to three objectionable effects in a receiver working on short waves.

Modulation Hum

If the HT voltage to the valve has a 100-cycle ripple, 100-cycle frequency modulation of the oscillator will occur. This frequency modulation will be transformed into amplitude modulation by the IF circuits, thereby giving rise to hum. The effect is worst when the receiver is just "off tune," as then any change in oscillator frequency will cause greater amplitude modulation than if the receiver was "in tune."

If the line voltage of a receiver alters in any way, the oscillator frequency changes. The resulting amplitude modulation is detected and amplified by the AF amplifier causing current and voltage swings in the output valve. In general, the HT source has an impedance, so that the current swings of the output valve produce voltage swings in the HT and hence affect the rest of the receiver. The oscillator frequency will vary in phase with the voltage swings, with the result that low-frequency oscillations are maintained. The effect has been called "flutter" effect and is more pronounced when the receiver receives a large signal. As in the case of modulation hum, it is worst when the receiver is just "off tune."

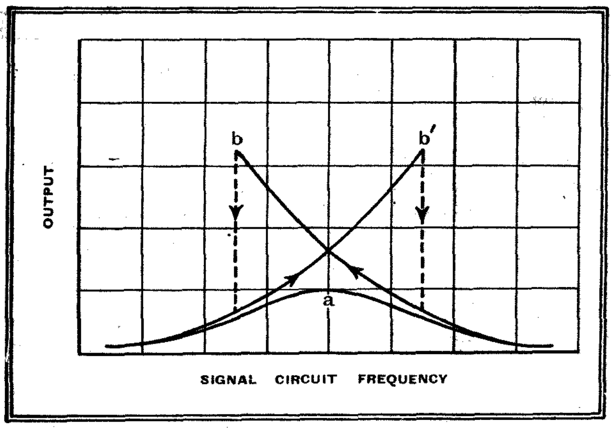


Fig. 3.—Variation of output with tuning due to the effect of AVC bias.

The change in oscillator frequency with grid bias can give rise to anomalous tuning effects at high frequency, in that, as the tuning is varied, the AVC voltage developed changes the frequency from its true value, and the point of maximum output depends on the direction of tuning and is unstable. The effect is shown in Fig. 3, where the output is plotted against signal circuit frequency. For small signals, not sufficient to generate AVC bias, the behaviour is as in curve (a), but for large signals, the behaviour is as in (b) and (b'), depending on which way the set is tuned.

If a receiver is to operate satisfactorily at short waves, the above three effects must be avoided so that the frequency of the oscillator must depend as little as possible on variations in the electrode voltages.

TABLE II.

Circuit	Valve Type	Frequency Change in kc/s.		
		20% change in screen voltage	20% change in osc. anode voltage	Total change with AVC
Tuned grid	Heptode	2.5 kc/s.	5.0 kc/s.	10.1 kc/s.
	Typical triode-hexode	2.0 „	1.6 „	3.0 „
	Triode-heptode X65...	0.23 „	0.1 „	1.1 „
Tuned anode	Heptode	1.1 „	1.55 „	9.6 „
	Typical triode-hexode	0.85 „	1.0 „	1.3 „
	Triode-heptode X65...	0.13 „	0.05 „	0.55 „

The electrodes that have the largest effect on hum and flutter are the screen and oscillator anode, the effect of the main anode being negligible, while the signal grid is the one giving rise to anomalous tuning.

Table II gives the results of measurements carried out at 15 Mc/s on the valves previously referred to, using tuned grid and tuned anode circuits.

With all the valves, the changes in oscillator frequency are smaller with a tuned anode circuit than for a tuned grid circuit. However, it may not always be convenient to use a tuned anode circuit, as the oscillator HT voltage required to generate the same oscillator amplitude is higher than with a tuned grid circuit. It will be seen that, with both circuits, the oscillator frequency changes are much smaller for the X65 valve than for the other two valves.

The largest difference between the triode-hexodes and the heptode is in the change of oscillator frequency with AVC bias on the signal grid. In the heptode, the current to the oscillator anode consists partly of electrons received direct from the cathode, partly secondary electrons from the screen, and partly electrons returned from the space charge between the screen and signal grid. Any change in the bias of the signal grid will therefore affect the current to the oscillator anode, and hence the amplitude and frequency of the oscillator. In the triode-hexodes, the oscillator anode does not lie in the same electron stream as the signal grid, so that the above effect is absent. The bias on the signal grid of a triode-hexode does, however, control the number of electrons in the vicinity of the oscillator grid, and as the negative bias on the signal grid is increased, the number of electrons collected by the oscillator grid when it swings positive decreases, so that the oscillator self-bias is reduced slightly. This effect is very much smaller than in the case of the heptode, so that the change in frequency with bias is smaller.

Although in most respects a triode-hexode is superior to a heptode for frequency changing at short wavelengths, it can give rise to one troublesome effect unless care is taken in the design.

In the hexode section the electrons are retarded beyond the screen G2 by the voltages on the oscillator grid G3, and under working conditions a fraction, depending on the oscillator voltage, will come to rest and then return through G2 towards G1. If the time these electrons take to travel between G3 and G1 is comparable with the period of the oscillator, it can be shown that some of the electrons will absorb sufficient energy to enable them to land on the wires of the signal grid, and hence cause a current to flow in the circuit connected to G1. If the bias is applied to the grid through a high resistance, this current gives rise to an added negative bias, thereby reducing the gain, while if the resistance is common to other stages, as in some AVC systems, it will affect the bias on these as well. The current increases as the frequency and oscillator peak voltage are increased, and decreases with increase of negative bias.

In order to keep the current as low as possible, the transit time of the electrons between G3 and G1 and the oscillator peak voltage must be kept small. This has been done in the X65 valve; the oscillator voltage necessary to fully modulate the valve is only 6 volts peak, while there is no grid current at the minimum bias, at 30 Mc/s. The gain of the valve will, therefore, be the same at 30 Mc/s as at 1 Mc/s.

When a receiver is switched on, the cathodes of the valves may reach a steady temperature in less than half a minute, but it may take half an hour or more for the whole electrode system to do likewise. Changes in the internal capacities of the valves therefore take place, the rate of change being rapid at first and then more gradual until the valve attains its steady state. The effect of these capacity changes is to change the oscillator frequency, and becomes more troublesome the higher the frequency.

TABLE III.

Valve	Heater watts	Change in oscillator grid-earth capacity
Typical triode-hexode	4.8	0.25 $\mu\mu$F.
Triode-heptode X65...	2.0	0.1 „

As a general rule, the lower the heater wattage of a frequency changer the smaller are the capacity changes and therefore the frequency drift of the oscillator with time. This is demonstrated by a comparison of the change in the oscillator grid-earth capacitance of the valves previously considered when the valves are heated up.

Light-storage in Television

ITS APPLICATIONS TO CATHODE-RAY RECEPTION

AT the transmitter the principle of light-storage has long been used in cameras of the Emitron and Iconoscope type, but hitherto it has been lacking in the receiver. The application of this principle to the receiving cathode-ray tube has now been carried out and in this article the fundamentals of the system are explained. The development has been carried out by Manfred von Ardenne, and is described in an article which appeared in "Telegraphen-Fernsprech - Funk und Fernseh - Technik," November, 1938.

IN transmitting cameras light-storage is effected by permitting the image of the scene to be scanned to rest continuously upon the mosaic of photo-electric material. The potential of each individual element of the mosaic builds up to a value dependent on the amount of light falling on it, and the whole of the period between frame scans is available for this building-up process. The potential is made use of during the exceedingly rapid discharge of the capacity associated with each element, which occurs when the scanning beam passes over it.

In the case of the ordinary receiving tube, the picture is made visible by the fluorescence of the screen under the impact of the electrons of the scanning beam. The fluorescence can be allowed to persist for only a short time at any appreciable brilliancy, since it must have ceased within the interval of one frame.

It is, however, obvious that if the fluorescence could be made to persist for very nearly the time of one frame and then die away very rapidly in readiness for the succeeding frame, nearly the whole area of the screen would be continuously illuminated. A great increase in brilliancy would be secured and a lower frame frequency could be used without flicker. There would, in effect, be light-storage at the receiver.

It is just this action which is accomplished by the new development described in this article. The fluorescent screen, however, is abandoned, and its place is taken either by a screen of variable opacity or of variable reflecting power. A separate light source is used, and the light from it is passed through or reflected from the screen of the CR tube and is projected on to a viewing screen.

Instead of fluorescing from point to point under the action of the scanning beam, the screen of the tube varies its opacity or its reflecting power. The acquired properties of the screen remain more or less constant for nearly a frame period and are then wiped out in readiness for the next frame, thus giving the light-storage effect. The cathode-ray tube, therefore, becomes a form of light-valve, instead of being a light-source as usual.

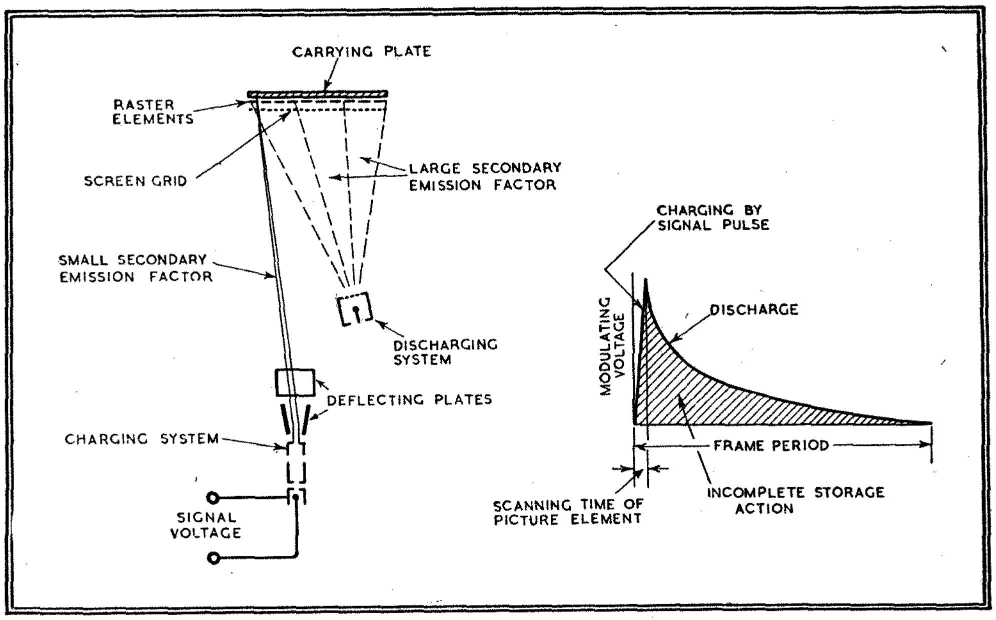


Fig. 1.—In this diagram is sketched the arrangement of a simple storage system with secondary-emission modulation.

The general arrangement of the system is sketched in Fig. 1. A screen consisting of a mosaic of insulated elements is used, and it is upon this that the raster is built up. It is marked "raster elements" in Fig. 1. A screen-grid consisting of a very fine mesh of wire is placed on the inside of it in order to prevent the charges on the raster elements from affecting the scanning beam.

The screen is scanned by a high-velocity electron beam which is focused to small dimensions and which is modulated by the picture signal in the usual way. As a result of the impact of the electrons of this high-velocity beam, the raster elements are charged and their potentials become highly negative with respect to the anode, and proportional to the beam current at any instant. The picture is thus built up in variations of potential of the raster elements.

In the arrangement of Fig. 1, the discharge process begins immediately after the charging process and is carried out by a system which irradiates the raster uniformly and permanently by low-velocity electrons. The electron current of this discharging system is made of such value that the number of electrons falling on any element are just sufficient to effect its

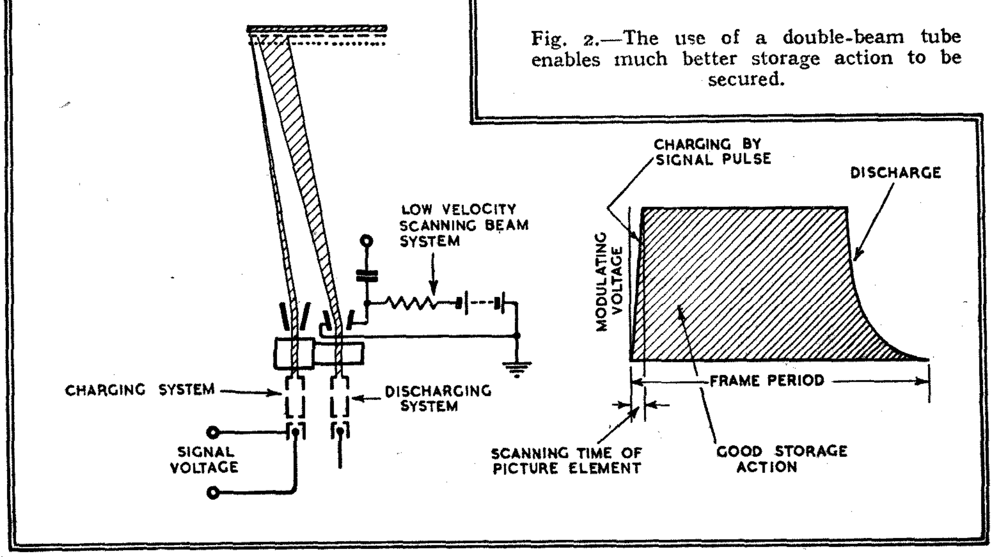


Fig. 2.—The use of a double-beam tube enables much better storage action to be secured.

Light-storage in Television—

complete discharge within one frame period.

On the right of Fig. 1 a graph is shown which illustrates this alternate charging and discharging of the elements. It is clear that the element is rapidly charged during the scanning process and slowly discharged during the remainder of the frame period. The form of the discharge is not good, however, since it is initially too rapid.

A more desirable state of affairs is shown in Fig. 2, and here the graph indicates that the elements remain charged for nearly the whole frame period and are then rapidly discharged in preparation for the next frame.

This is accomplished by using a double-beam cathode-ray tube. One beam is sharply focused and of high-velocity electrons. Modulated by the picture signals it carries out the charging process in the manner already described. The other beam is focused to a larger spot and is of low-velocity electrons.

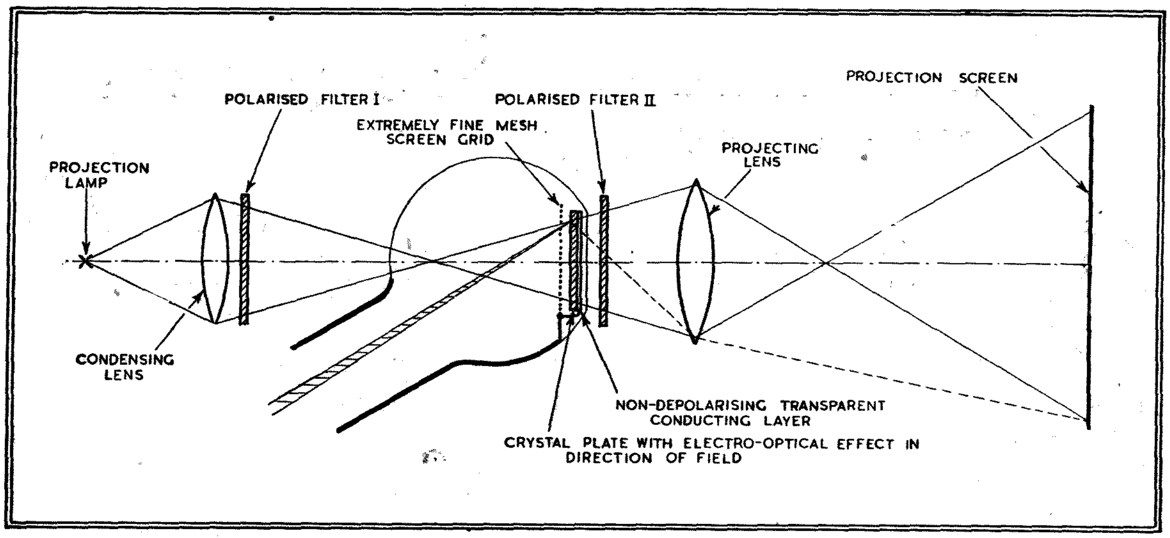


Fig. 4.—The light system is illustrated here for a transparent crystal screen.

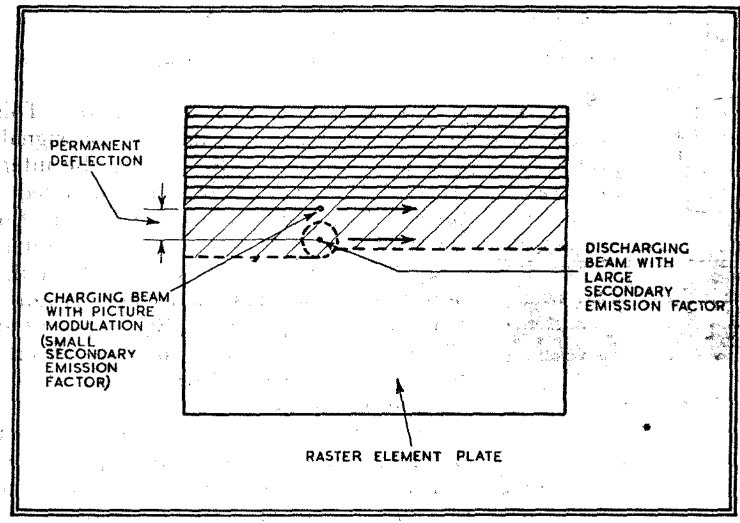


Fig. 3.—This diagram illustrates the scanning process with the double-beam tube.

The two beams scan the raster together, but the low-velocity beam is always a little ahead of the high-velocity one, and it thus discharges the raster elements just before they are due to be recharged in accordance with the signal by the high-velocity beam. The scanning paths of the two beams are illustrated in Fig. 3.

As an alternative to the use of a double-beam tube it is quite possible to employ only a single beam for both charging and discharging. A rather complicated associated electrical system is needed, for the beam has then to perform the discharging process during the normal line fly-back period.

After scanning a line from left to right in the usual way, the anode voltage is lowered to give a low-velocity beam which returns from right to left below the previously scanned line to discharge the elements of the next few lines. At the left-hand side of the picture the anode voltage is raised again so that the beam becomes of high velocity and it then scans the next line. Owing to the great increase in deflection sensitivity with anode voltage a large part of the motion of the scanning spot can be made automatic.

Having obtained in one of these ways the picture as a dimensional series of charges on a raster plate it is necessary to convert it into variations in light. The potentials obtained are of the order of 100,000 volts./cm., and there are various ways of making the potential variations visible.

One method is sketched in Fig. 4. The raster element is built up of transparent and insulated crystal layers which have an electro-optical effect in the direction of the electric field. The raster-plate is set at an angle to the electron-beam, as in a transmitting camera, and polarised light is passed through it by the optical system shown. Light modulation is effected because there is a deformation of the electron arrangement in the crystal under the influence of the high field strength which changes its light-polarising properties. The greatest effect is secured with zinc-blende.

Double-Reflection

A better arrangement is shown in Fig. 5. Here the metallic coating of the screen of raster elements is made reflecting and the light is passed twice through the crystal layer. The polarising effect is thus doubled and the operating voltage is correspondingly reduced.

Experimentally it has been found with this method, and using zinc-blende for the crystal layer, that a potential of 4,500 volts is enough to give a brightness of 85 per cent. of the polarised light flux. The working voltage on the tube was 8,000-9,000 volts.

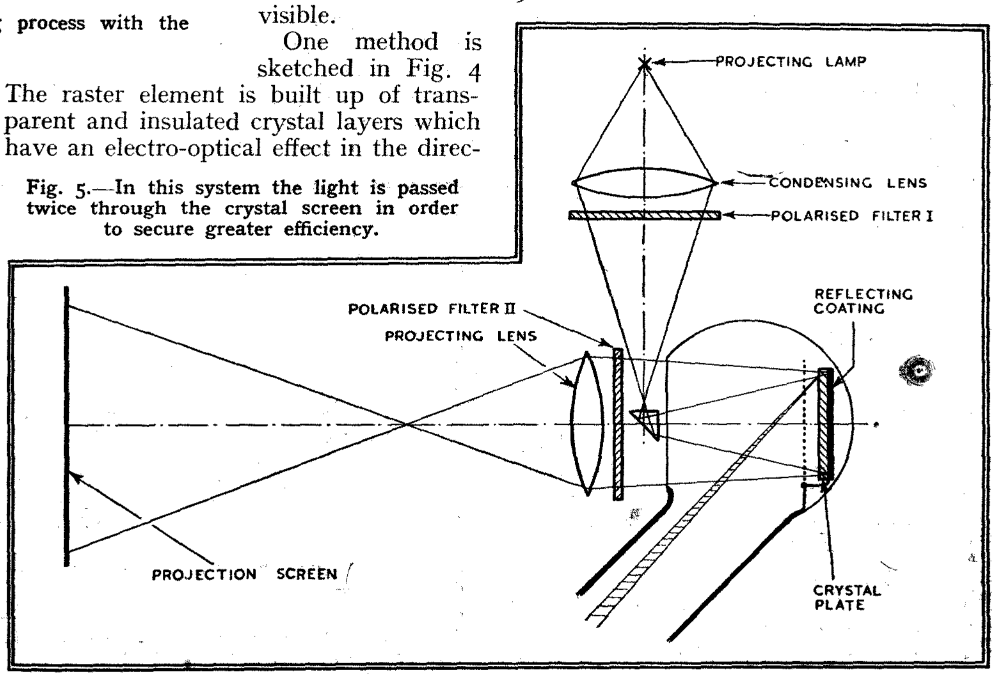


Fig. 5.—In this system the light is passed twice through the crystal screen in order to secure greater efficiency.

The Modern Receiver Stage by Stage

Part V.—GANGING AND SWITCHING

FOLLOWING upon the discussion of the RF and frequency-changer circuits the questions of ganging and waveband switching are dealt with in this article. The choice of intermediate frequency from the points of view of adjacent channel selectivity and image interference is also touched on

BEFORE proceeding further with the receiver we have to consider the problems of ganging, and we shall first of all deal with the two signal-frequency circuits alone. Each circuit must at all times be tuned to the same frequency as the other within close limits.

Basically, this will be achieved if both tuning condensers have exactly equal capacities at all settings, the stray circuit capacities are identical, and the inductances are the same. In practice, the matching of the sections of the gang condenser is taken care of by the manufacturers, and the assembly is supplied matched within certain limits. Similarly, the coils are matched by their makers to be of equal inductance, again within certain limits.

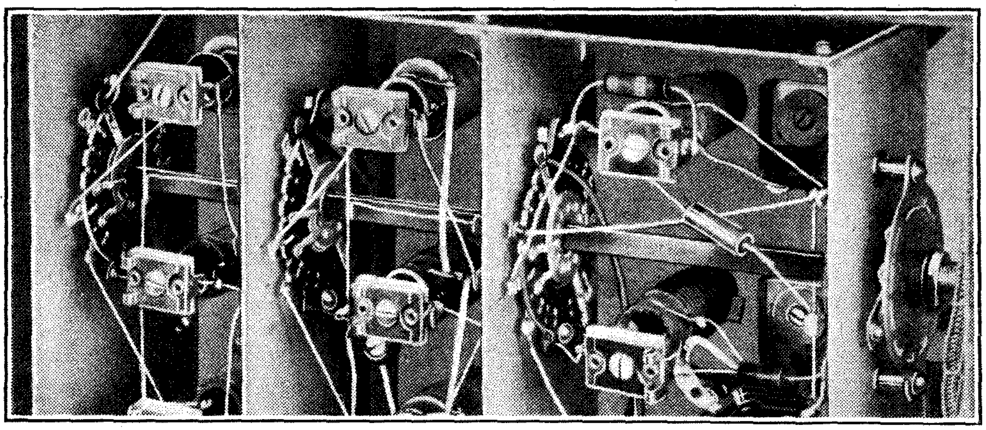
All the user has to do, therefore, is to match the stray capacities in the different circuits, and this is done by means of parallel trimmers. Incidentally, at the particular frequency at which they are adjusted they also correct for any mismatching of the coils and gang condensers, but only at this one frequency.

The Aerial Circuit

Perfect ganging is not obtainable even when these conditions are met, however, because we have to take into account the effect of the primary circuits. Only if these are also identical can perfect ganging be achieved. In practice, however, one primary circuit is inevitably different from the others, for it is the aerial.

When the primary winding is of low inductance the effect of it, together with the aerial, is to change the effective value of the secondary inductance by an amount which varies with the frequency. When the primary is of high inductance, however, the primary circuit changes the secondary inductance by an amount which is nearly independent of frequency. It can, therefore, be very nearly corrected by a change in the secondary inductance, and as the correction is not very greatly affected by the aerial characteristics, it can be done by the coil maker.

The arrangement of the early circuits thus takes the form of Fig. 10, where C1 and C2 are two sections of the gang condenser, and C3 and C4 are trimmers. Their adjustment is easy, for if the apparatus has no defect in it the circuits only differ appreciably in their stray capacities. A signal is found, therefore, on a suitable frequency, or one is provided by a test oscillator, and C3 and C4 are adjusted for maximum signal strength. They are, in fact, treated exactly as though they were the separate controls of an unganged receiver. The best results are obtained when the adjustment is carried out at a fairly high frequency, because the trimmer capacity then forms a larger proportion of the total circuit capacity. It is consequently easier to set the trimmer accurately. The standard frequency for adjustment on the medium waveband is 1,400 kc/s (212 metres).



Waveband switching as employed in the "Three-Band AC Super."

The Oscillator

Now let us turn to the oscillator. This circuit must not be tuned to the signal, but to a frequency different by the intermediate frequency. We have assumed a tuning range of 1,540-550 kc/s for the signal-frequency circuits. If the intermediate frequency is 465 kc/s, then the oscillator circuit must tune over the range 2,005-1,015 kc/s or 1,075-85 kc/s, and at all settings of the tuning control it should be higher or lower than the signal frequency by 465 kc/s.

In practice the lower frequency cannot be used, because the frequency ratio is much too great to be covered by a single coil in conjunction with a variable condenser of the same capacity as the others. The higher frequency range is, therefore, always used.

Now the ratio of maximum to minimum signal frequencies is 2.8-1, so that the capacity ratio is 7.8-1. In the oscillator

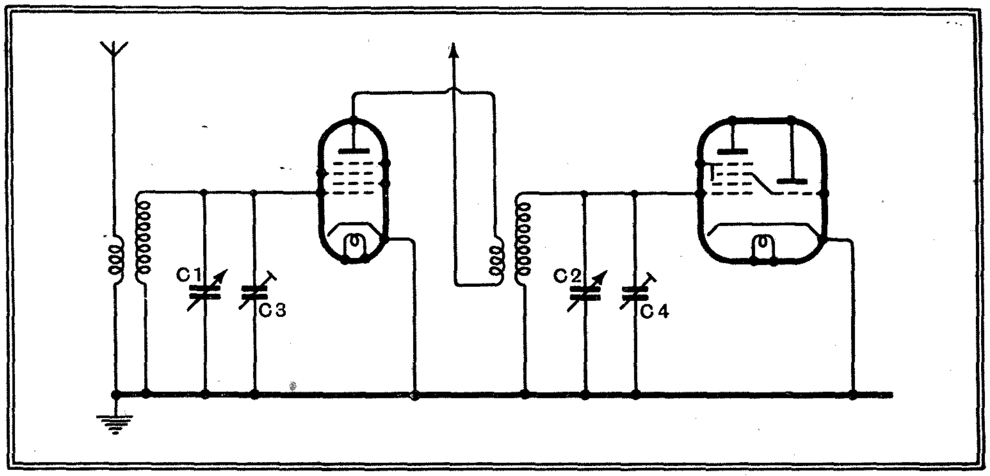


Fig. 10.—This diagram shows the basic circuit of the RF stage. The parallel trimmers are C3 and C4.

The Modern Receiver Stage by Stage—

the frequency range is $2{,}005/1{,}015 = 1.975$, and the capacity ratio must be 3.9-1.

Obviously, we can obtain the correct capacity ratio either by increasing the minimum circuit capacity or by reducing the maximum. The former can be done by using a much larger parallel trimmer on the oscillator circuit than on the signal circuits—rather more than double the capacity in this case. The maximum can be reduced by inserting a fixed condenser in series with the variable.

In either case, the inductance will have to be reduced so that the circuit will tune to the higher frequency range. It will have to be reduced much more with the parallel trimmer than with the series condenser, however.

Neither of these methods is satisfactory, for, although the correct frequency ratio is obtained, and the correct frequency coverage, the difference between the frequencies of the signal and oscillator circuits is not constant. At only two frequencies can the correct frequency difference be secured. The results to be expected are sketched roughly in Fig. 11, which shows the frequency difference between the circuits plotted against signal frequency.

What is done in practice is to use a com-

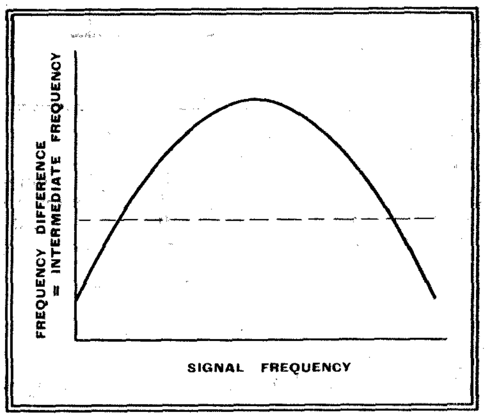


Fig. 11.—This curve illustrates the ganging errors likely when the oscillator is " ganged " only by changing the inductance and either the maximum or minimum capacity of its tuning condensers.

bination of both methods. The parallel capacity is increased and a series fixed condenser is used; this gives the correct capacity ratio. The inductance is then reduced to obtain the correct actual frequencies.

This method is not perfect, but it is much better than either of the others, for there are now three points at which correct ganging is secured. The error curve is of the form shown in Fig. 12, and it is clear that the discrepancies are much smaller.

As the selectivity of the signal circuits increases at the low-frequency end of the tuning range, and as it is these circuits which become mistuned if there are errors, the best results are not obtained with a symmetrical error curve. The effect of ganging errors depends on the selectivity of the circuits which are mistuned, and with the curve of Fig. 12 the errors are of equal magnitude at both ends of the band. It is better to choose values so that the errors are smaller at the low-frequency

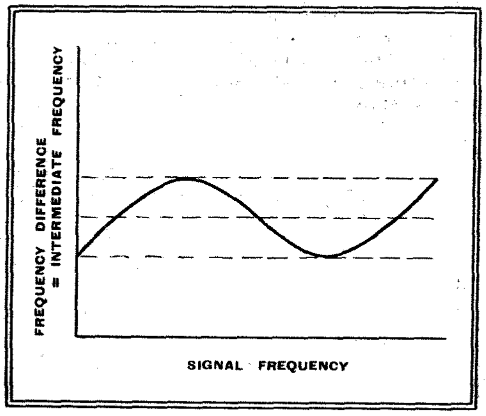


Fig. 12.—A typical ganging curve ; the oscillator inductance and both the minimum and maximum values of the tuning capacity are altered.

end and larger at the high-frequency end. In this way the effect of the mistuning is kept roughly constant.

Knowing the constants of the signal-frequency circuits, it is not difficult, but is rather tedious, to calculate values for the oscillator circuit, which takes the form of Fig. 13. Here C1 is the tuning condenser and C3 the parallel trimmer; C2 is the series condenser, usually called the padding or tracking condenser. The value of C2 depends on the other circuit constants, but is usually about 500 $\mu\mu$F. for the medium waveband; it is smaller on the long waveband and larger on short waves.

Accuracy of Ganging

In adjustment the parallel trimmer is correctly set, together with the signal-frequency trimmers, at the high-frequency end of the band, usually at 1,400 kc/s. The padding condenser, however, is adjusted at the other end of the band, say, at 600 kc/s. The precise method of carrying out the adjustment varies somewhat with different receivers and depends on the test gear available. It is, however, dealt with in the constructional articles.

It should be realised that the ganging errors obtained are inevitable and their magnitude depends solely upon the tuning range and its relation to the intermediate frequency. The narrower the band covered in any one range and the lower the intermediate frequency, the smaller are the errors.

The theoretical ganging errors thus diminish as the operating frequency increases, and are smaller on short waves than on medium, and on medium than on long, for the same coverage on each band. They are also smaller with the old intermediate frequency of 110 kc/s than with the present one of 465 kc/s.

As the selectivity of the IF amplifier is much greater than that of the signal-frequency circuits, it takes charge of the tuning. In other words, the oscillator will always be set so that the intermediate frequency produced agrees with the peak frequency of the IF amplifier. If the ganging is not accurate, therefore, it is always the signal-frequency circuits that are mistuned.

This will obviously reduce the sensitivity somewhat and also the adjacent channel selectivity. This will be only small, however, as most of the selectivity is provided by the IF circuits.

Image Interference

The main effect will be to reduce the power of rejecting image interference and similar effects. It will be remembered that there are two oscillator frequencies which can be used for the reception of any station; similarly, for any oscillator frequency there are two signal frequencies which can be converted to the intermediate frequency.

For the reception of a station on 1,000 kc/s, we set the oscillator at 1,465 kc/s to produce the desired beat of 465 kc/s. A station on 1,930 kc/s is also 465 kc/s different from the oscillator, however, and will also be converted to the intermediate frequency, where it will interfere with the wanted signal.

The interference occurs from a station on a frequency higher than that of the wanted signal by twice the intermediate frequency, and the only protection against it is the selectivity afforded by the signal-frequency circuits. Their power of discriminating against image interference depends on their inherent selectivity, the accuracy of ganging and the ratio of the frequencies of the wanted and image signals.

Now it is clear that the higher the intermediate frequency the more remote from the wanted signal is the image frequency, and hence the less important is image interference likely to be. With a frequency of 110 kc/s the image signal is 220 kc/s higher than the wanted one, whereas with

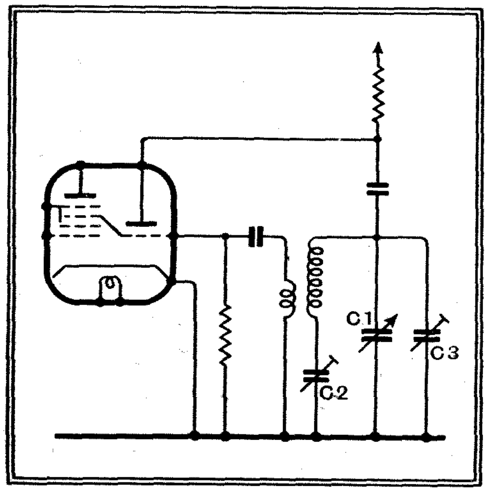


Fig. 13.—The oscillator circuit showing the parallel trimmer C3 and the padding condenser C2.

a frequency of 465 kc/s it is 930 kc/s higher. With the lower intermediate frequency a station on 820 kc/s may cause interference with one on 600 kc/s, but

The Modern Receiver Stage by Stage—
with the higher frequency the interfering signal would have to be on 1,530 kc/s.

The result is that, in spite of the somewhat lower accuracy of ganging with the higher intermediate frequency, the effective image rejection is much greater. This is especially the case on short waves, where very little image rejection at all can be secured with a low intermediate frequency. It is not good with 465 kc/s, but is much better than with 110 kc/s.

It may be asked why a still higher frequency is not used. The answer is that the adjacent channel selectivity would be too low. Actually, it would be possible to use a frequency of some 600-700 kc/s with advantage were it not that this frequency lies within the medium waveband, over which the receiver must tune.

If the frequency is to be appreciably higher than 465 kc/s, it must be of the order of 1,600 kc/s; and this is too high from the point of view of adjacent channel selectivity—at any rate, at the present time.

Waveband Switching

Turning now to waveband switching, the method adopted is to change the coils, trimming and padding condensers for each waveband. The complete circuit showing this was given in Fig. 1, but the basic switching arrangements are shown in Fig. 14.

The switches are shown here, but only one set of coils, those for the medium waveband, and the DC circuits are omitted. The diagram is self-explanatory, C1, C2, and C3 being the three sections of the gang condenser, and C4, C5, and C6 being the three parallel trimmers.

Instead of being connected across C3, C6 is joined across the oscillator coil for convenience, the difference in its effect being negligible. C7 is the oscillator padding condenser.

The resistances R1 and R2 are for the purpose of maintaining the amplitude of oscillation nearly constant over the waveband. In the Three-Band AC Super, R1 has a value of 1,200 ohms, and R2 is 30,000 ohms.

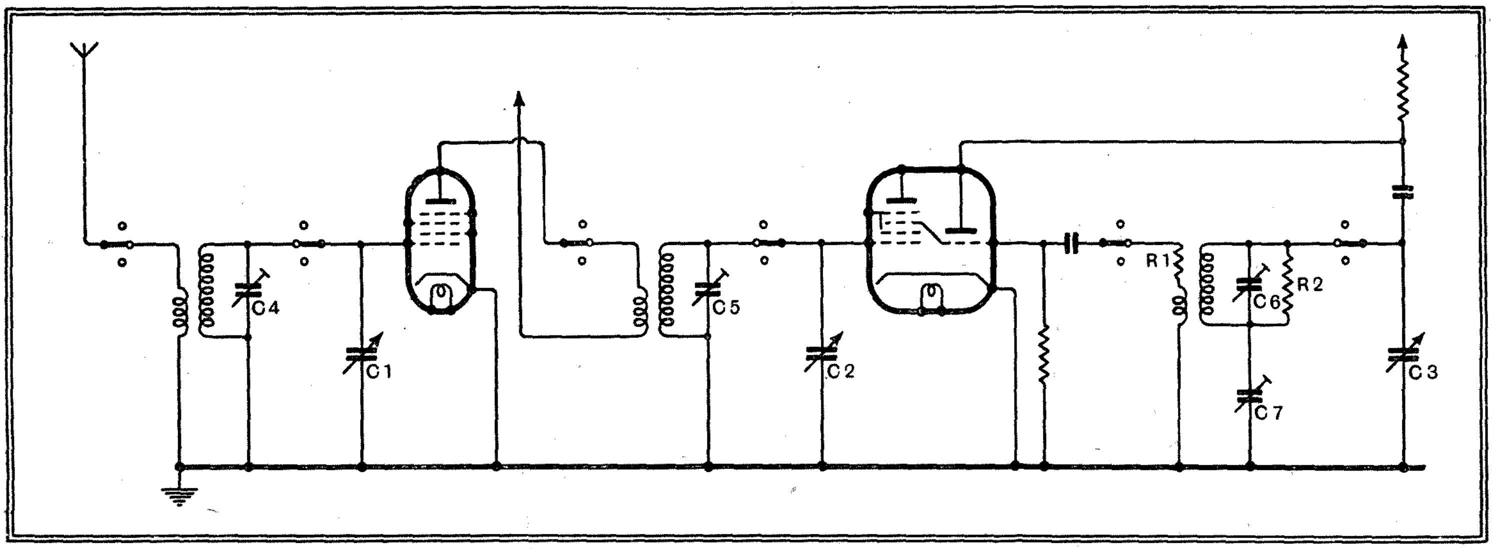


Fig. 14.—The circuit of the receiver including the frequency changer and showing the switching and the ganging arrangements.

TELEVISION PROGRAMMES

Sound 41.5 Mc/s — Vision 45 Mc/s

An hour's special film transmission intended for demonstration purposes will be given from 11 a.m. to 12 noon each weekday. The National or Regional programme will be radiated on 41.5 Mc/s from approximately 7.45 to 9 p.m. daily.

THURSDAY, MARCH 30th.

3, " La Chauve-Souris." **3.30,** Gaumont British News. **3.40,** 229th edition of Picture Page. **4-4.10,** Boat Race Training. O.B. from Putney.

9, Charles Heslop in " Pick-me-up " with Phyllis Monkman and Queenie Leonard. **9.30,** British Movietonews. **9.40,** Cartoon Film. **9.45,** 230th edition of Picture Page. **10.15,** News.

FRIDAY, MARCH 31st.

3, " Grandfather's Further Follies," from Grosvenor House. **3.30,** British Movietonews. **3.40,** Cartoon Film. **3.45,** Animal First Aid; a veterinary surgeon demonstrates how to treat a sick dog.

9, " Someone at the Door," a comedy thriller. Cast includes Jack Melford and Nancy O'Neil. **10.30,** News.

SATURDAY, APRIL 1st.

10.45-11.25 a.m., The Boat Race. Viewers will see the start of the Oxford and Cambridge Boat Race at Putney and the last half-mile and finish as seen from Mortlake Brewery. The middle of the race will be illustrated by an animated chart.

3-4.10, Niall MacGinnis and Belle Chrystall in the film, " The Edge of the World."

9, Comedy Cabaret including Harry Tate and Charles Harrison; compèred by Cyril Fletcher. **10.15,** British Movietonews. **10.25,** Cartoon Film. **10.30,** News.

SUNDAY, APRIL 2nd.

3, Charles Heslop—" In the Barber's Chair." **3.10,** Film. **3.20-4,** " Leviathan," a survey of sea monsters, past and present. The subject will be discussed by Lt.-Commander R. T. Gould and Mr. Seth-Smith.

8.50, News. **9.5-10.35,** D. A. Clarke-Smith in " Caesar's Friend," a play on Pontius Pilate by Campbell Dixon and Dermot Morrah.

MONDAY, APRIL 3rd.

3-4.30, Oliver Goldsmith's play " She Stoops to Conquer." Cast includes Morris Harvey, Renée de Vaux and James Hayter.

9, Guest Night No. 6. **9.25,** Boxing O.B. from the National Sporting Club at Earl's Court. **10.20,** News.

TUESDAY, APRIL 4th.

3, Koringa, the woman fakir. **3.15,** British Movietonews. **3.20,** Cartoon Film. **3.30,** Henry Hall and his Orchestra.

9, News Map, No. 14. **9.25,** Koringa. **9.40,** Gaumont British News. **9.50,** Pas Seul. **10.5,** Film. **10.15,** " In the Barber's Chair " (as on Sunday at 3 p.m.). **10.25,** News.

WEDNESDAY, APRIL 5th.

3, O.B. from Bull's Cross Farm—Work for April. **3.20-4.50,** " Caesar's Friend " (as on Sunday at 9.5 p.m.).

9, The Ambrose Octet. **9.25,** Lord Samuel, Speaking Personally. **9.35,** British Movietonews. **9.45,** Cartoon Film. **9.50,** Tom Walls in " The Van Dyck," a one-act comedy by Cosmo Gordon Lennox. **10.15,** Film. **10.20,** Irene Rustad, pianoforte. **10.30,** News.

NEW OSRAM VALVES

Additions to the 6.3-volt Range

THE range of Osram valves with 6.3-volt heaters and the American octal base has been extended by the addition of three new types. These valves differ from others in the range in having British-type characteristics rather than American.

The KT61 is an output tetrode with a heater taking 0.95 ampere and rated for operating at 250 volts on both anode and screen with a grid bias of −4.4 volts. The anode and screen currents are 40 mA and 7.5 mA respectively, and the output into a load of 6,000 ohms is about 4.6 watts.

The DL63 is a duo-diode-triode with a 0.3 ampere heater. The triode section has an AC resistance of 22,500 ohms with a mutual conductance of 1.6 mA/v.

There is also a new RF tetrode with pentode-type characteristics. This is the KTW61, and it is rated for 250 volts anode potential with 80 volts applied to the screen; the anode and screen currents are 8 mA and 2.2 mA respectively, and at −3 volts grid bias the mutual conductance is 2.9 mA/v. In view of the high ratio of mutual conductance to cathode current, a good signal-noise ratio is claimed.

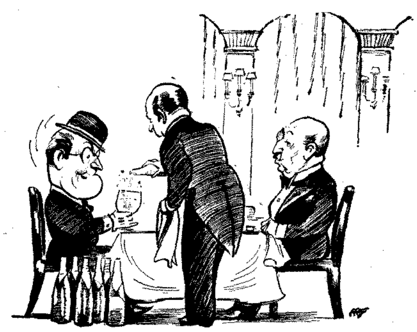
UNBIASED

By FREE GRID

A Nerve-shattering Proposal

I WAS very surprised the other day, to say nothing of being suspicious, at receiving an invitation from a well-known wireless manufacturer to dine with him in his private suite at a West End hotel which has a world-wide reputation for sumptuousness. I have, of course, dined with manufacturers before, but our rendezvous has generally been the humble coffee stall, and this ostentatious display of wealth made me very suspicious that I must have paid more for my wireless set than it was worth.

Arrived at the hotel I was first asked what I would care to drink, and my request for a pint of half-and-half was received by the waiter with a contemptuous sniff, and a magnum of champagne was placed before me with a lordly gesture. By the time I had despatched a few of these I was feeling in a distinctly better frame of mind and more inclined to listen with a sympathetic ear to the tale of woe which my host put before me on behalf of himself and his fellow manufacturers, and I must state here and now that this unfortunate class of men have a lot more to put up with than I had hitherto suspected, and I have promised to do what I can to help them in a new venture upon which they are embarking.



I was feeling better.

The evolution of the wireless set, I was told, has followed very closely upon that of certain other domestic applications of scientific knowledge and research. When wireless sets were first marketed they were very erratic from the point of view of reliability, being, in fact, consistent in only one thing, namely, in their unreliability. Then, as a result of painstaking research work, manufacturing technique was so greatly bettered that things were improved beyond all recognition, and for the last half-dozen years sets have been so free from the troubles of old age that listeners are loath to replace them by more up-to-date ones.

Although the average set owner may feel very pleased that his old set lasts so many years, he is in the long run not benefiting, for if he does not buy a new receiver every three years or so, manufacturers are getting no cash to spend in research work to produce a much better value-for-money-set for him when he does at long last want a new one. In addition, even manufacturers have to eat, and if old sets are not scrapped periodically in favour of new ones, the set user will find that when his old music mauler does eventually die there will be no new receivers for him to buy.

The average listener either does not or will not realise these facts, and so certain manufacturers have, according to my informant, evolved a scheme to force him to do so, and I must confess that I am very much in favour of it. In brief, it is proposed to build sets with the very best materials and workmanship so that first-class results will be obtained. Normally, such a receiver would have many years of life absolutely free from breakdown, but in each of these new sets is to be concealed a small receptacle containing a solution of carbon bisulphide and phosphorus, there being an air hole in the container of such dimensions that it will allow the carbon bisulphide to evaporate completely in approximately three years. I need not, I think, dwell upon what will happen when it does.

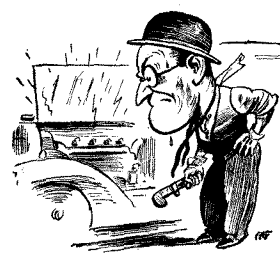
Carostat λ Revealed

I AM very gratified to be able to inform you that I have at last obtained some reliable technical data on the subject of car-stopping wireless waves, or carostat rays, as I suppose we ought to call them if we wish to be thought scientific. By the kindness of a reader who is a member of a well-known firm which makes X-ray gear and similar stuff I have not only been provided with the wavelength and power required but, in addition, this reader has offered the services of his firm in constructing the necessary apparatus for me. Since the power required is round about one megawatt, the cost is going to be rather prohibitive, and I trust that you will see your way clear to joining with me in a co-operative effort.

The wavelength used for this car-stopping business is of the order of 2,500 Angstrom units or, in our language, 0.000000002500 metre. According to my informant the principle on which the ray works is that it ionises the air in the neighbourhood of the plugs of a car and thereby shorts them out. Its action is limited to comparatively short distances—a few feet, in fact—although, as with everything else in life, with greater power one could do more.

This information has been of the utmost value to me since it has succeeded in revealing to me what can only be regarded as a growing menace to us motorists. You will, of course, already have realised that 0.000000002500 metre is in the waveband of ultra-violet rays, and when you consider the growing use of these, not only in hospitals but also in the home in the form of artificial sunlight lamps, you will realise that the day is not far distant when their combined output will be sufficient to cause wholesale stoppage of cars all over the country.

Already I fancy that I myself have been a victim of some of the more powerful of these ultra-violet ray installations, and probably you have also. I daresay, in fact, that if you search your memories there is not one of you who has not, at some time or another, experienced one of those annoying car breakdowns when the engine stops for no apparent reason, and no matter how assiduously you poke at it with a spanner it refuses to restart, and you have to suffer the ignominy of being towed into a garage. When next it happens have a look round at the neighbourhood and it is ten to one that you will find yourself outside a so-called health clinic, or some place of that nature.



It refused to restart.

I daresay several of you have read of the perfectly just complaints which many hospitals have voiced in the Press concerning the great expense to which they are put owing to the large number of victims of car accidents in their neighbourhood who are rushed into them for attention. Strangely enough, it is highly probable that the hospitals themselves are primarily responsible for the expense of which they complain. It is obvious that if the carostat rays involuntarily emitted by the ray therapy department of the hospitals result in wholesale stoppage of car engines, accidents are bound to occur, since the rays do not affect all engines equally owing to differences in design. It is clear that if two fast-moving cars are passing near a hospital, one on the tail of the other, and the engine of the leading one suddenly stops, trouble is bound to occur.

The New Secondary Emission Valve

SOME APPLICATIONS OF THE ELECTRON-MULTIPLIER PRINCIPLE

By E. S. VILLER

ONE of the problems in the design of wide-band amplifiers for working at very high frequencies is the relatively low input resistance of the valves used. A case in point is a "straight" vision receiver in a television set, where all the pre-detector amplification has to be obtained at 45 Mc/s.

In such amplifiers, where the highest load obtainable is very much lower than the anode AC resistance of the valve and capacities are reduced to a minimum, the general way of improving gain is by improving the mutual conductance of the amplifying valve.

Unfortunately, for valves of similar construction the input conductance (the reciprocal of resistance) increases linearly with the mutual conductance, a two-to-one increase in slope practically halving the input resistance. The grid conductance also varies as the square of the input frequency,[1] so that a two-to-one increase in working frequency means a four-to-one decrease in input resistance, and so on until the mutual and grid conductances become equal. At this point, since the gain of a stage may be taken as the product of slope and load impedance, the amplification of identical stages in sequence, where the anode load of one stage is the input resistance of the next, cannot be greater than unity.

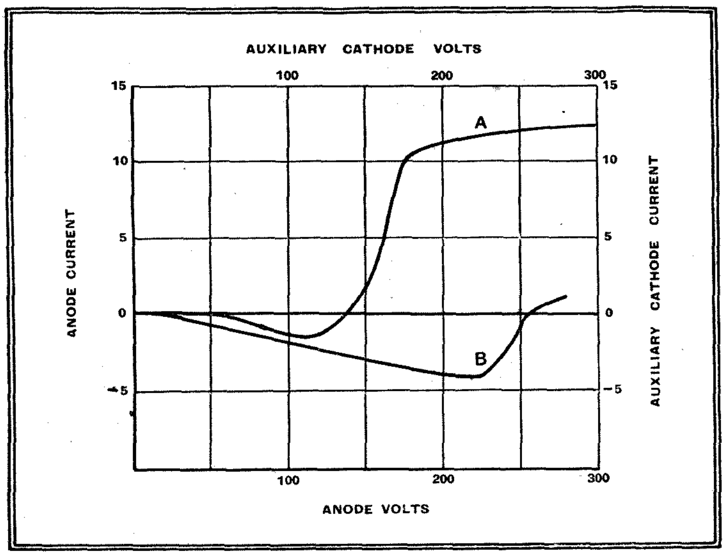


Fig. 1. Curve A shows the anode-volts-anode current characteristic of the secondary - emission valve and Curve B the auxiliary cathode volts and current.

This point has been taken as a measure of goodness of the valve. That is to say, the farther away a valve is at its working frequency from giving $gR_{IN}<1$, where R_{IN} = input resistance and g = mutual conductance, the more gain it is likely to give.

The grid-controlled electron-multiplier valve makes it possible to obtain, among other things, a slope of about three times that of a pentode with the same input impedance. This means, in effect, that where input impedance would become a limiting factor if it were possible to increase the pentode slope to equal the secondary emitter, and where the internal capacities are not appreciably different in the two cases, the secondary emitter is capable of giving three times the stage gain of the pentode.

A reason for this increase in slope without increase in grid conductance appears in the fact that only a proportion of the total anode current change takes place at the grid. From the point of view of the electron the secondary emitting electrode, called the auxiliary cathode, comes *after* the control grid, and if this electrode has a secondary to primary ratio of, say, 3, then the slope at the grid of the valve is only one-third of the slope between grid and anode. This leaves a grid conductance, even with the same type of construction, of the same order as a normal pentode type valve with one-third of the mutual conductance.

IN this article two interesting applications of the secondary emission valve are described. It lends itself to use as a simple frequency-changer and as a VF stage it can provide two outputs in opposite phase.

Fig. 1 shows the anode-volts-anode-current characteristic of the electron multiplier (curve 1) and also (curve 2) auxiliary-cathode current against volts with fixed voltages on the other electrodes. The anode current-volts characteristic is similar to that of a tetrode and presents the same disadvantage of restricted output, but the auxiliary cathode shows a long, fairly straight portion of negative resistance up to and past the normal working voltage of 150. The actual value of the resistance measured from the curve is approximately 50,000 ohms, so that a tuned circuit arranged as a load for the auxiliary cathode, and with a tuned impedance numerically greater than 50,000 ohms would oscillate, since where Z is the tuned impedance and (–R) the auxiliary cathode impedance, when $Z > (-R)$ then $Z(-R)/(Z-R)$ becomes operative. This straightway leads to its use as a frequency-changer.

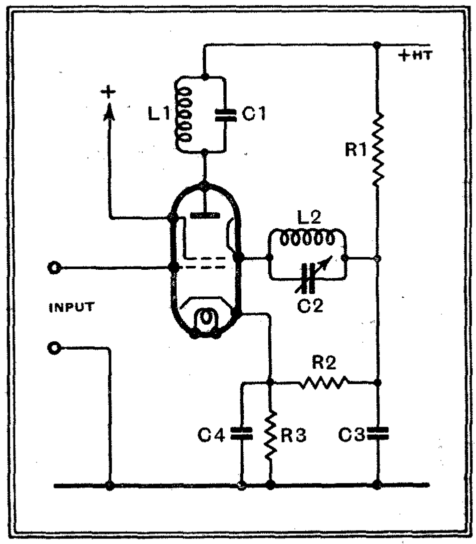


Fig. 2. As a frequency-changer the valve needs only a tuned circuit L2C2 connected in the auxiliary cathode lead.

Frequency Changing

Fig. 2 gives the basic diagram of such a frequency-changer, L1C1 being the first IF coupling in the anode circuit, L2C2 the variable oscillatory circuit in the auxiliary cathode, R1R2 the potentiometer feeding the auxiliary cathode and R3 the normal cathode bias resistor. It is difficult to find any frequency-changer to work at low or high frequencies which has a conversion conductance of more than 1 mA/v. Few of the multi-electrode valves have a higher slope than this, while an "oscillating detector" type of frequency-changer, in use before the heptodes and triode-hexodes were developed, could only go up at the most to 2 mA/v.

The electron multiplier, when tried at 52 Mc/s in a superheterodyne vision receiver with a 7 Mc/s intermediate frequency, gave a conversion slope of not less, in the optimum case, than one-half of the straight slope, which is between 10

[1] W. R. Ferris. Proceedings of the Institute of Radio Engineers, January, 1936.

The New Secondary Emission Valve—

and 12 mA/v. It has, moreover, the advantage of substantially isolated input and oscillatory circuits, and consequently little effect on the one of tuning the other. The oscillatory circuit is, of course, simply an untapped coil and a variable condenser, or some series-shunt arrangement of condensers to give a tuning reduction. The only drawback lies in the fact that

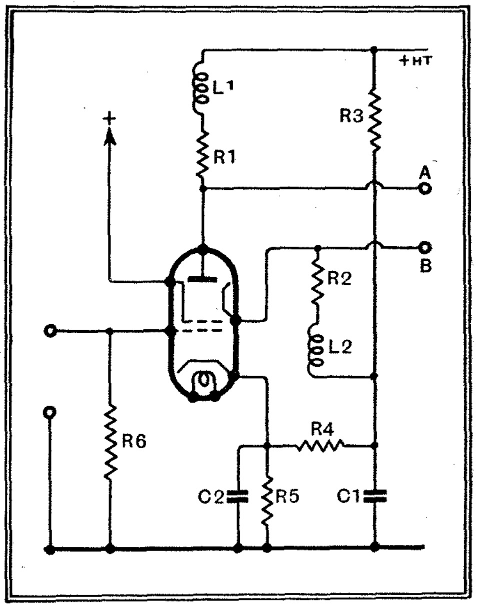


Fig. 3. Used for a VF stage the output to the sync separator can be taken from the auxiliary cathode in opposite phase to the output at the anode, which is fed to the CR tube.

the whole circuit, including variable condensers, is about 150 volts positive with respect to negative HT, which is usually joined to chassis and earthed.

What does become important, however, is the influence of the anode circuit on the oscillator. This might be considered as a transference of the coupling between oscillator and input, which occurs in the normal type of mixer, to coupling between oscillator and anode circuit. The difference in the latter case, however, is that the frequency separation is very much greater, making it easier to adjust the anode circuit impedance to the intermediate frequency. Generally speaking, it is not necessary to adjust the IF circuit without influencing the oscillator, and once these have been set up their effect on the oscillator is to reduce amplitude in certain parts of the band or in the worst case, where, of course, changes in design have to be made, to stop the oscillator. Even in this last case it may be possible, without serious disadvantage, to introduce a little coupling between the auxiliary cathode and grid circuits, by returning C3 to cathode instead of ground, and work the oscillator without any alteration to the IF or conversion slope.

Suppose we consider the working of the valve itself without any external loads, then it is clear that as the grid volts rise, or become more positive, the anode current rises in a positive direction by an amount depending upon the valve slope. In order for this to be possible in a secondary emitter valve, the auxiliary cathode, which is supplying the anode with electrons, must release more electrons, and so the current flowing to the auxiliary cathode must increase. In other words, as the grid volts rise the auxiliary cathode current rises, but in a negative direction, giving a negative slope between the grid and auxiliary cathode at the same time as a positive and somewhat larger slope between grid and anode. Measured independently, the approximate values for the slopes are 12 mA/v between grid and anode and −8 mA/v between grid and auxiliary cathode.

VF Amplification

This characteristic can be used in a great variety of ways, but perhaps the most useful and interesting so far is its application to VF amplification in a vision receiver.

Both the anode and auxiliary cathode are provided with loads, R1L1 and R2L2 (Fig. 3) to vision frequencies. These take the usual form of resistances with small compensating inductances to preserve a flat response up to 1.5-2 Mc/s, and the grid is fed in the usual way from a detector which has a load resistance R6. When the anode of the diode detector feeds the grid, picture signals appear on it in negative phase with the synchronising pulses in the positive direction. These signals are amplified and inverted in the anode circuit so that the picture becomes positive at A and ready to modulate the cathode ray tube. At B in the auxiliary cathode circuit the signals are in the same sense as those on the grid of the valve and only slightly less in amplitude than those on the anode. Thus two signals are delivered by the valve, the one inverted with respect to the other and both at a stage gain of the order of 40. The one at B with positive synchronising pulses is applied directly to an anode-bend amplitude filter valve in the time base, which is probably the most satisfactory type of single stage selector. In general, however, where there is only one stage of selection in the time base in all, it is advantageous to have the synchronising pulses supplied from the vision receiver in this sense.

For the Manufacturer

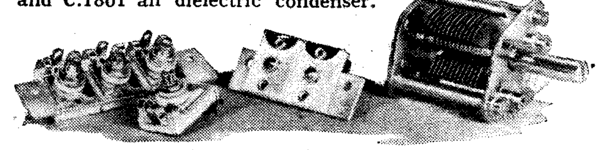
New Polar Trimmers

IN the Type S.11 mica dielectric trimmers recently introduced by Wingrove and Rogers, Ltd., 12, Dartmouth Street, London, S.W.1, the screw stems are locked into frequentite bases by a "star" washer, and adjustment is by means of a frequentite bush under pressure from a nut and washer. The action is smooth and shows a considerable improvement over earlier types. The nuts, which are suitable for adjustment by either a box spanner or a gapped screwdriver, lend themselves to easy sealing.

The range of the normal element is 4-40 mmfd., but alternative capacities of 2.5-30 and 40-80 mmfd. are available, and they may be made up in gangs up to eight.

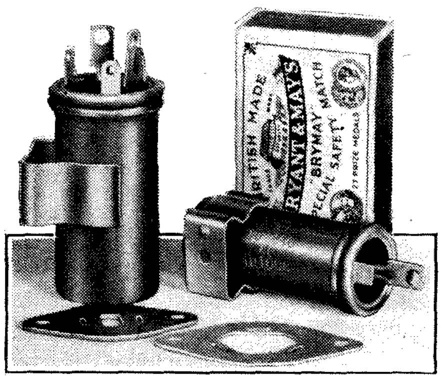
Another new product is the 100 mmfd. air dielectric condenser (C.1801). This is a small and remarkably rigid assembly in which the fixed vanes are supported on two small conical ceramic insulators. The minimum capacity is 5 mmfd. The front bearing is conical and a single bronze ball-bearing is fitted at the rear. Three lugs tapped 6BA are used for mounting, and the construction is in nickel-plated brass throughout.

Polar S.11 mica dielectric trimmers and C.1801 air dielectric condenser.



Mallory Type FP Dry Electrolytics

THESE condensers, which are at present for manufacturers only, are obtainable in this country through Frank Heaver, Ltd., Bush House, Aldwych, London, W.C.2. They are remarkable for their small size in relation to the capacity and working voltage. For example, a 10-mfd. 450-volt condenser measures only ⅞in. diameter and 2in. high. A dual 10 mfd. of the same rating is housed in a can of the same height but 1in. in diameter.



Mallory Type FP single and double 10-mfd. 450-volt dry electrolytic condensers.

An ingenious method of marking connections by means of a standard code of terminal shapes has been adopted and the condensers may be supplied with bakelite washers for vertical chassis mounting or clips for horizontal mounting. When mounted vertically they are quickly secured to the chassis by twisted lugs, a special tool being supplied for the purpose.

The FP condensers are designed to work at temperatures of the order of 60 to 85 deg. C., and their high capacity/space factor is achieved by a new composite anode material (not etched) giving a 10 to 1 increase of capacity compared with plain foil.

The range of capacities is from 5 to 50 mfd. and the working voltages, depending on the type, are from 25 to 450 volts.

A system of standardisation of capacity voltage and container sizes has been evolved, with tables from which the designer can readily choose the appropriate type or types to fit his chassis.

NEWS OF THE WEEK

SUNDAY TELEVISION

Theatre Grievance Settled in the House

"THE compilation of programmes for both the television and sound broadcasting services is a responsibility of the governors of the British Broadcasting Corporation, and I do not see my way to interfere with their discretion in regard to the inclusion of plays in television programmes on Sundays."

This statement from Sir Walter Womersley, Assistant Postmaster-General, in the House of Commons, marked the anti-climax of an agitation started by a letter in *The Daily Telegraph* and subsequently maintained in the columns of that paper.

Views were expressed by a number of West End managers, amongst them Mr. Basil Deane, who has done a great deal to further the cause of broadcasting and television.

He made the grievance clear, when he said that if television is to deal in plays from the theatre on Sunday, it should at least be subject to the same restrictions as are imposed on Sunday cinemas. "I was the first to televise an entire play," he said, "that is what I think about television, but the theatre should have equal rights."

The brief manner in which the question was disposed of in the House of Commons last week might be taken as a fair indication of the respect with which the Government regards the manner in which the B.B.C. discharges its affairs.

TELEVISION AND THE CINEMA

Odeon-Scophony Negotiations

THE report that negotiations are in progress with a view to Odeon taking a business interest in Scophony is confirmed by Mr. Sagall, of Scophony.

Plans for the installation of Scophony big-screen projectors in a number of Odeon cinemas are under discussion, and it is hoped that the Derby will be shown on a 12ft. by 10ft. screen at the Odeon, Leicester Square.

Scophony apparatus was used for the third time for the benefit of a paying audience at the Monseigneur News Theatre, Marble Arch, last week, when the normal cinema programme was interrupted and the audience, without any extra charge above the ordinary admission prices, saw by television the arrival of the French President at Victoria Station. Arrangements have been made for the Boat Race transmission to be shown in the Monseigneur on Saturday.

GREENWICH MEAN TIME

New Clock for the Observatory

DR. SPENCER JONES, the Astronomer Royal, reviewing the work of the Royal Observatory in a lecture at the Royal United Service Institution last week, referred to clocks and time service.

He said that one of the clocks by which it was expected to get time accurate to about a thousandth of a second a day was almost ready for the Observatory.

He told how, having determined the time, the Observatory made it available to the public several times a day. A time-signal is sent to the Post Office every hour for the purposes of "TIM," and a signal is sent out automatically by direct line to the B.B.C. every fifteen minutes so that the six "pips" could be broadcast four times an hour if necessary. Signals are sent out from Rugby twice a day to ships all over the world.

ELECTRIC SHOCK

Death by Electrocution

FOLLOWING the recent death by electrocution of Ross A. Hull, one of America's leading amateur research workers, comes news of a similar fatality to another prominent member of the U.S. amateur organisation. Phil C. Murray, W9VYU, was killed while adjusting his transmitter at Minnesota.

It was suggested in *The Wireless World* on February 16th that over-confidence engendered by familiarity and failure to provide proper screening for high-voltage apparatus is largely responsible for such tragedies. The danger of becoming careless with electrical equipment is being stressed in the United States, where transmitting enthusiasts have been advised to adjust their transmitters with one hand.

WEATHER REPORTS

AIR MINISTRY and Imperial Airways officials were recently conducted over the French steamer *Carimare*, which has been fitted out as a floating meteorological station. From a position midway between New York and the Azores she will transmit weather reports, not only to the shore but to aircraft and shipping.

Her equipment includes small pilotless balloons which, by means of midget wireless transmitters, will radiate thermometer and barometer readings at various altitudes up to their "ceiling," which is 60,000 feet.

CZECH BROADCASTING

Germany Takes Over

BROADCASTING stations in the new German Protectorates, Moravia, Bohemia and Slovakia, have been taken over by the German Post Office, although the programme organisation remains independent.

These acquisitions have placed Germany in an elevated position in the ether, for she has taken over seven medium-wave broadcasting stations, with a total aerial power of 298.5 kW, and a short-wave station. Moreover, she has acquired three more exclusive wavelengths, at present used by Prague, Melnik and Brno, bringing her total to fifteen.

The total aeriel power of Germany's medium- and long-wave stations, including the latest acquisition, Memel (10 kW), is 1426.25 kW.

CANADIAN BROADCASTING

Expansion Plans

THE Canadian Broadcasting Corporation's two new 50-kW stations, CBA, at Sackville, New Brunswick, and CBK, at Saskatoon, Saskatchewan, will open on April 8th and June 1st respectively. Both stations will give C.B.C. sustaining network programmes for sixteen hours daily and will not include local commercial programmes.

The C.B.C. is working on a plan to build a more powerful station at Vancouver than the present 5-kW CBR, and also to build a number of subsidiary stations in the interior of British Columbia to give a more adequate coverage.

Commercial programmes now occupy 30 per cent. of the C.B.C.'s sixteen-hour daily service. It is interesting to recall that the C.B.C. do not allow the mention of the price of advertised products in their programmes.

GERMANY'S NEWS

Indication of B.B.C. Success

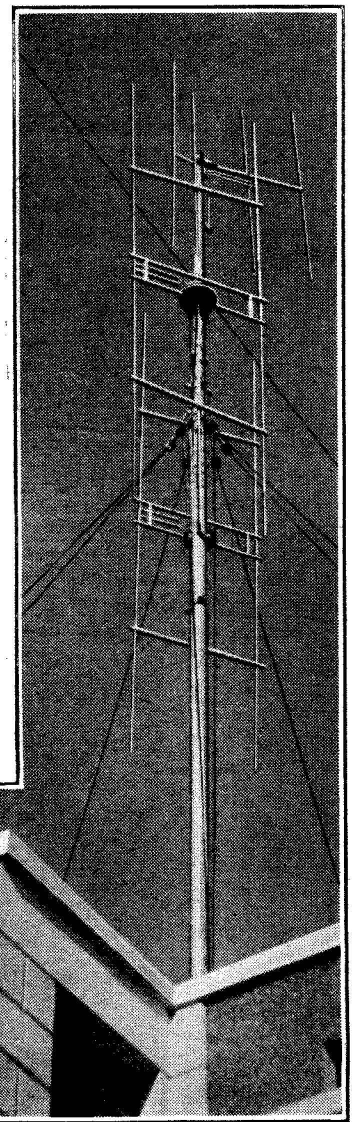
BROADCASTING HOUSE is not vexed by the English transmissions from Cologne and Hamburg. Rather the reverse, for the German "reply" to the nightly B.B.C. bulletins is an indication that these are reaching their mark, viz., the German "man-in-the-street." This is despite the fact that Germany is operating stations at 100 kW as compared with the 70 kW of the British transmitters.

The English news bulletins broadcast from Cologne and Hamburg are supplied from the Drahtlose Dienst, a department in the German Ministry of Propaganda. They are specially prepared for British listeners and have little semblance to the German bulletins broadcast from these stations.

According to our Berlin correspondent, broadcasts in foreign languages may soon be extended; probably introducing Arabic.

AMERICAN TELEVISION

ANOTHER television aerial has made its appearance in America. It has been developed



AN IMPOSING AERIAL ARRAY has been erected by Mr. F. T. Bennett, a radio engineer in Guernsey, Channel Islands, for the reception of the Alexandra Palace television transmissions. It is 73ft. high and nearly 400ft. above sea level. Although the aerial is still experimental, excellent reception of A.P. is reported. Weak signals believed to be the Eiffel Tower transmissions have also been received.

News of the Week—

by General Electric for its 10-kW station, W2XB, which is being erected in the Helderberg Hills some 12 miles from New York at a point 1,50cft. above sea-level. The aerial, which will radiate a horizontally polarised wave, is made up of eight hollow copper bars which form a tube. The elements of the aerial are each 4 inches in diameter and approximately 7ft. long.

Programmes for re-radiation by W2XB will be received by wireless from the low-powered experimental transmitter, W2XH, which G.E. has erected at the top of its studio headquarters in Schenectady.

TELEVISION "DOUBLES" STAGE PERFORMANCE

THE enactment of a scene in the Alexandra Palace studio to the accompaniment of sound from a London theatre was carried out successfully last Monday (March 27th) during the televising of "Magyar Melody." Half-way through this musical comedy occurs a duelling scene enacted in twilight. The stage being so darkened that it would have been impossible to transmit an adequate picture, it was arranged to "double" the act in the television studio by means of an additional cast.

The duel scene was performed before cameras at Alexandra Palace and synchronised, by means of a play-back speaker, with the sounds coming from His Majesty's Theatre.

CREATOR OF BEAM WIRELESS

Mr. C. S. Franklin Retires

BY avoiding the waste inherent in "all-round" radiation, the beam system probably contributed more than anything else in finally establishing wireless as an economical and practicable means of long-distance point-to-point communication. Charles Samuel Franklin, who retired last week from the Marconi Company, which he joined in 1899, will always be regarded as the creator of the system, though as he modestly pointed out to a *Wireless World* representative, "beamed" short-wave transmission is as old as wireless itself.

What Mr. Franklin described as the short-wave revival started in 1917, when he accompanied Marconi to Italy to carry out experiments on waves that would even now be described as short. Development proceeded steadily, and was not entirely interrupted by Mr. Franklin's period of service in the Navy, as his work at Portsmouth was connected with short waves for special naval purposes. Successful results at Caernarvon, Inchkeith and with the Hendon-Birmingham and England-Holland telephone links decided the Marconi Company to proceed with a big-scale experiment. An aerial with a large reflector was erected at Poldhu, and its transmissions, starting at 100 metres and working down the spectrum, were received on board Marconi's yacht *Elettra* in various parts of the world.

Enough had been done to prove the worth of beamed short waves, and to render the gigantic and costly long-wave stations obsolete. A contract was obtained from the Post Office, and in 1925 Mr. Franklin embarked on working designs for the stations.

Fittingly enough, his working career was rounded off by work in the newest of short-wave applications; the A.P. television aerial is of his design. Readers will join with us in wishing a happy retirement to one who has contributed so much to wireless.

Mr. C. S. Franklin.

APRIL MEETINGS

Wednesday, 5th, 6 p.m. I.E.E. Wireless Section, Savoy Place, London, W.C.2. "Radio in Aviation," N. F. S. Hecht.

Wednesday, 19th, 7 p.m. Television Society, at the I.E.E. "Electron Optics," L. M. Myers.

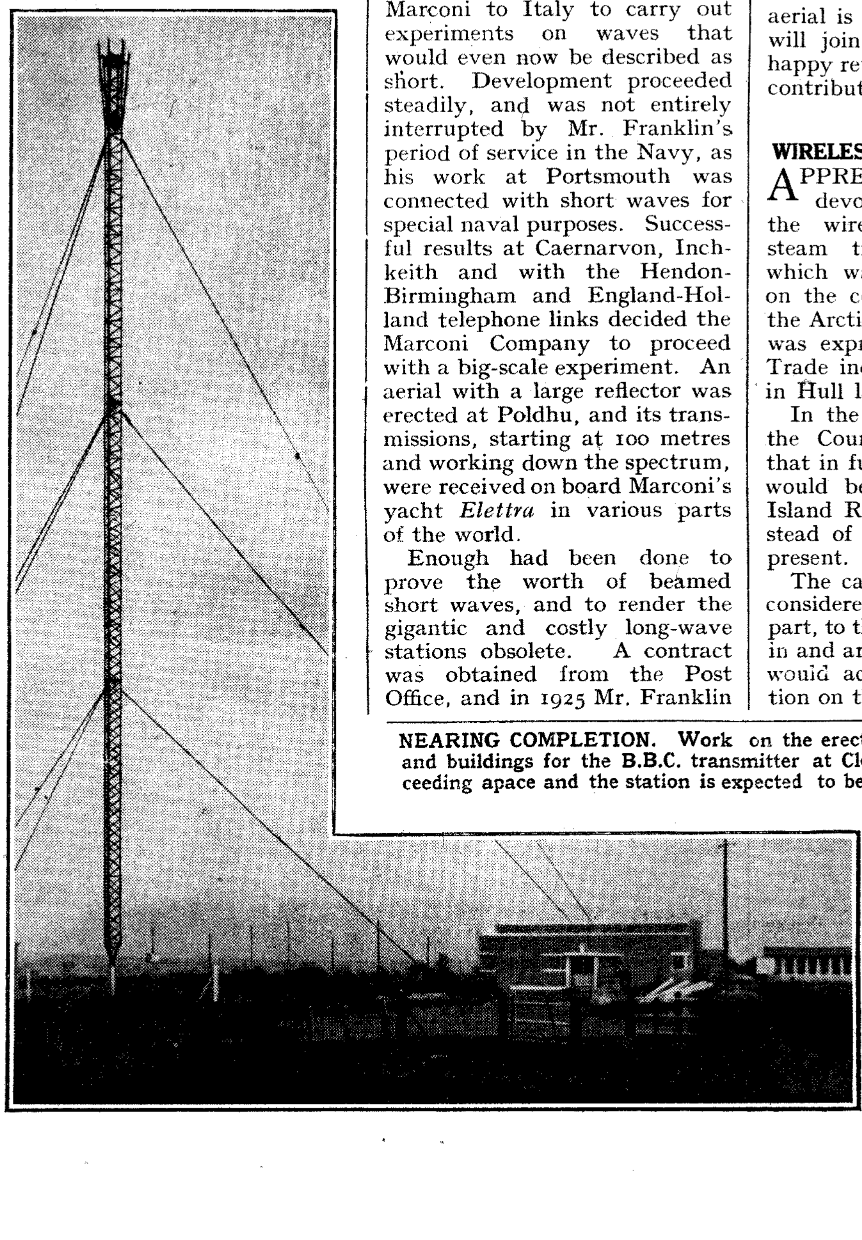
Friday, 28th, 6.45 p.m. R.S.G.B. monthly meeting at the I.E.E. "Communication Receivers," Dr. C. G. Lemon (G2GL).

WIRELESS OPERATOR PRAISED

APPRECIATION of the great devotion to duty shown by the wireless operator of the steam trawler *St. Sebastian*, which was lost with all hands on the coast of Bear Island in the Arctic Circle last September, was expressed at the Board of Trade inquiry which took place in Hull last week.

In the course of the inquiry, the Court expressed the hope that in future directional signals would be sent out from Bear Island Radio Station hourly instead of at long intervals as at present.

The cause of the disaster was considered to be due, at least in part, to the magnetic disturbance in and around Bear Island. This would account for some deviation on the trawler's compass.



NEARING COMPLETION. Work on the erection of the mast-radiator and buildings for the B.B.C. transmitter at Clevedon, Somerset, is proceeding apace and the station is expected to begin test transmissions at the end of April and to start on its regular service in mid-June. This station, working on 203.5 metres, will come into service at the same time as the new Start Point station and transmit the West Regional programme to the area not served by Start Point.

FROM ALL QUARTERS

Manchester Television

THAT nearly a quarter of the licence holders in Great Britain would be served by a television transmitter in Manchester is claimed in the campaign for television in the North which is being sponsored by two Manchester newspapers, *The Daily Dispatch* and *The Evening Chronicle*.

National Field Day

THE eighth annual R.S.G.B. National Field Day has been arranged for the twenty-four hours from 18.00 G.M.T. on June 3rd. Transmitters, which will be operated from tents, will use CW only on 1.7, 3.5, 7, and 14 Mc/s. The rules governing this event are published in the March *T. and R. Bulletin*.

1.7 Mc/s Contest

NEARLY 300 different stations were logged by the 97 competitors who entered for the recent 1.7 Mc/s contest organised by the R.S.G.B. Stations abroad which were logged included five Americans, two French, one Danish, one Canadian, and one Irish.

Have You Logged It?

AN expedition organised by the Government of Venezuela for the exploration of the regions along the frontiers of Guiana and Brazil is equipped with a 1-kW transmitter which uses the call "YV9AB Expedicion de la Gran Sabana." It begins transmission at 12 noon G.M.T. and uses 7.221, 7.285, 14.122, and 14.125 Mc/s.

New Birmingham Headquarters

ESTIMATES have been passed and plans are being prepared for the new Midland Regional Broadcasting House at Birmingham.

Police Pocket Wireless

THE Home Secretary was asked in the House of Commons last week whether, in view of the great service derived from the use of pocket wireless by provincial police forces, he was considering its use in the suburban districts of the Metropolitan Police area. In reply Mr. Geoffrey Lloyd said that the Commissioner of Police was watching closely the development of pocket wireless apparatus, but at the present stage of development the equipment available could not be effectively used for police purposes in the Metropolitan area.

Miscellaneous Advertisements and Easter

SLIGHT alterations are necessitated in our printing arrangements with the approach of the Easter holidays, and miscellaneous advertisements intended for the issue of April 13th must therefore be received not later than first post on Thursday, April 6th.

NOTES ON THE Multivibrator

Details of Construction and Operation

By H. HARRIS (*Burndept Ltd.*)

THE advantages of the multivibrator as an aid to alignment of superheterodyne receiver circuits were discussed in "The Wireless World" of February 23rd, where a circuit diagram of a multivibrator unit was given. Practical problems in the construction and use of the unit are treated in this supplementary article.

CONSIDERABLE interest seems to have been aroused by the ganging multivibrator recently described, and in this article the writer will endeavour to clear up all doubtful points in order that no difficulty may be experienced by those who undertake the construction of the unit.

As much experiment was necessary in order to get the best results, it can be assumed that the values of components as recommended are best, and they should be closely adhered to. Similarly, the type of valve used was found to influence both the fundamental frequency generated and the production of harmonics; hence it is advisable to use the same type of valve as indicated—the Mullard 354 V.

A desirable addition to the original circuit is a 0.0005-mfd. condenser connected between the "live" side of the locking transformer primary and HT –. The omission of this condenser, which is preferably of the silvered mica variety, will not prevent the instrument from working, but will considerably reduce the output at very high frequencies.

The HT is shown as a 400 V supply. This voltage was used, first, because such a supply was readily available and, secondly, because, due to the valves in the multivibrator being heavily self-biased, a high anode voltage was necessary in order to obtain a sufficient output power. A lower HT supply will result in too weak an output at very high frequencies. It need not be elaborately smoothed because a 50 c/s frequency is used to lock the circuit at 500 c/s, and therefore a little ripple in the supply will only help the locking. Too much ripple, however, is to be avoided. A 24-mfd. electrolytic condenser and one of 0.4-mfd. are shown shunted across the supply, these being not so much for smoothing as to prevent any signal from the multivibrator getting back into the supply, as it can cause a highly objectionable form of interference to reception on a receiver working close by on the same mains. As most electrolytic condensers have a rather high RF resistance, the 24-mfd. condenser is shunted with a smaller value of lower RF resistance. HT current will be 15-20 mA.

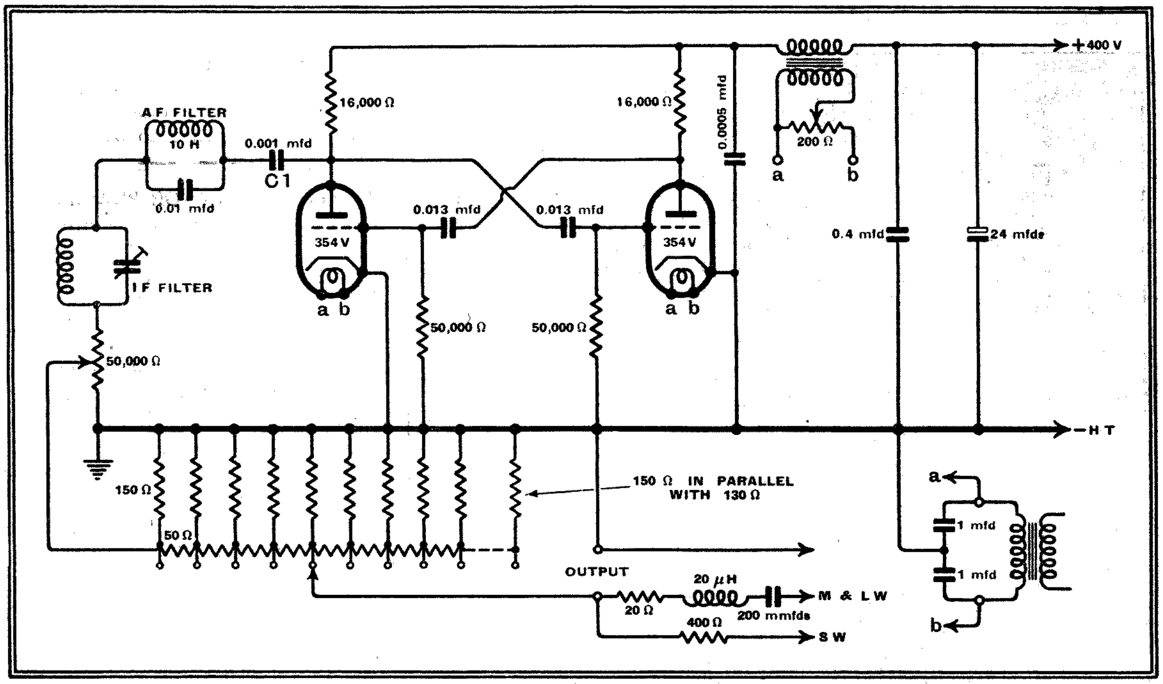


Fig. 1.—Amended circuit diagram of the multivibrator, showing extra condenser mentioned in the text.

The 4-volt LT supply can be derived from either a separate transformer, as shown, or from a winding on the transformer supplying the HT rectifier. Here, again, the supply is shunted by condensers and centre-tap earthed to HT – in order to avoid feed back into the supply mains.

The locking transformer is fed with 50 cycles from the LT supply via the potentiometer. A step-up is needed from supply volts to that required to lock the multivibrator at 500 c/s. The transformer used gave a 40:1 step-up and the potentiometer was used to adjust the input to give the required output. As the HT current passing through the secondary is 15/20 mA the winding must carry this without breakdown, hence an AF transformer with fragile secondary winding, as suggested by some readers, would not do. The primary need not be designed for exactly four volts, as actual transformer efficiency is not important here.

A transformer of the type usually fitted nowadays to loud speakers seems to be the nearest thing amongst ready-made components likely to be at hand. These have ratios of anything from 15:1 to 50:1; the primaries will carry a fairly large current, and they are inexpensive. If one of these be used the low impedance (secondary) winding is connected to the potentiometer and the high impedance (primary) connected to the HT supply. The transformer used, however, should not be from a speaker used in a battery receiver as the primary will probably not carry the current. The potentiometer used is a wire-wound one of 200 ohms, but is not critical in value. Too low a resistance should not be used, however, as it may heat up.

The potentiometer should be adjusted to minimum at first and the note given by the multivibrator listened to on a receiver. It will be a very "rough" kind of note but will have a distinct pitch of some kind. On adjusting the potentiometer to allow some locking voltage to be injected into the HT supply a distinct change in pitch will be noticed at a certain point not far from the start. This is where the locking occurs. Further adjustment of the potentiometer will not change the pitch of the note until an excessive locking voltage is injected. When this happens the signal is changed in a very marked manner and badly "chopped up," and sounds very much like extremely bad electrical interference. So only just sufficient adjustment of the

Notes on the Multivibrator—
potentiometer is required to ensure that the signal is locked.

The signals generated are of all frequencies that are multiples of 500 c/s; i.e., signals spaced at 500 c/s intervals cover the entire band from 500 c/s itself, up through the audible frequency, supersonic, IF, HF and VHF bands.

As is evident from Fig. 2, the output falls off considerably with increase of frequency; that is inevitable in the case of a simple multivibrator such as that under discussion.

It is easy to see that although all frequencies are present in the input to the signal-frequency tuned circuit, the circuit itself will magnify one frequency more than the others by the effective Q of the circuit, and it will be this magnified signal that will give the largest IF beat when heterodyned by the correct oscillator frequency. This is true of the majority of properly designed signal-frequency input circuits. But the multivibrator was tried out on a large variety of receivers and certain types were found to behave in an uncertain manner during alignment. On the shorter waves, although the multivibrator signal could be heard in the output of the receiver, the signal-frequency circuits did not appear to tune to any particular signal and adjustment of the oscillator frequency did not appear so critical, nor did the circuits actually align themselves in the correct manner. It was found that these few receivers that did not behave as they were expected to were ones in which there was no RF amplification before the frequency changer, and in which the input circuits were arranged in a certain manner so as to cause either an AF or IF from the multivibrator to be applied to the grid of the frequency-changer.

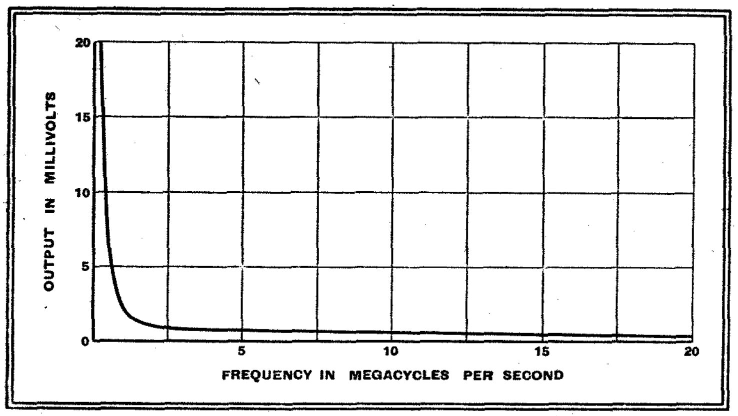


Fig. 2. — Showing how the output of the instrument falls off with increase of frequency.

Need for Filters

These circuits were as illustrated in Figs. 3 (a) and 3 (b) and were either a band-pass circuit, capacity coupled, or an ordinary aerial transformer in which, in both cases, the aerial winding was directly connected to the bottom of the tuned secondary winding and GB or AVC voltages fed through a high resistance at the bottom end which was connected to the earth line via a capacity C. Thus, with no AF or IF filters in the feed to the attenuators in the multivibrator whatever AF signals there were in the attenuator output were applied across C, and thus to the grid of the FC via the tuned circuit; these signals were greater if a 400-ohm resistance only was used as a dummy aerial on short waves.

As the multivibrator output to the attenuator is considerably greater at low frequencies than at high and the reactance of C is greater at low frequencies also, it was found that AF signals of greater strength than the RF signal (even after magnification by the tuned circuit) were being applied to the FC grid and these were beating with the oscillator frequency. An example will make this clear. Suppose the signal-frequency circuits are tuned to 10 Mc/s, then a signal of this frequency from the multivibrator will be tuned in. The correct oscillator frequency to beat with this to produce the IF of, say, 473 kc/s is 10.473 Mc/s. But perhaps the oscillator circuit is out of alignment and oscillating at, say, 10.475 Mc/s.

Then, if strong AF signals from the multivibrator are present, the oscillator frequency of 10.475 Mc/s, when heterodyned by the 4th harmonic of 500 c/s, will give rise to a difference frequency of 10.475-0.002 Mc/s=10.475 Mc/s, which is that required to beat with the 10-Mc/s signal tuned in by the signal frequency circuits and the IF frequency will thus be produced, although the oscillator frequency and signal frequency are not in the correct relationship. Similarly, the 1st, 2nd, 3rd and higher order harmonics of 500 c/s will do the same and the oscillator circuit will not appear to respond to trimming or padding, because, whatever frequency it is oscillating at, over wide limits, will be heterodyned by the 500-c/s signal or harmonics and therefore produce a frequency that will beat with whatever frequency the signal circuit is tuned to. Hence it is essential that the AF signals from the multivibrator are not offered any high impedance between control grid and cathode of the FC, across which to generate any appreciable voltage, or else they must be filtered out in the multivibrator itself.

Where the primary windings of the aerial transformer are directly earthed this trouble does not arise. Similarly, a receiver with an RF stage before the FC does not suffer in this way.

Spurious IF Signals

It was also found that, with the input circuits described, the IF signals which are also in the multivibrator attenuator output and of greater strength even than the AF signals (due to decreasing reactance of C1 in Fig. 1), also caused the same difficulty, as any that got through to the FC grid were amplified straight away by the FC as a straight amplifier and they often swamped the IF due to smaller RF signals.

So, although the multivibrator will function perfectly well on normally well-designed receivers without either of these AF or IF filters, it was thought desirable to indicate where they may be placed in order that if difficult receivers are encountered their effect may be tried.

If there are no faults otherwise in a receiver and adjusting the signal or oscillator trimmers apparently has little effect on the signal, then it is likely that the lower frequencies in the multivibrator output are getting on to the FC grid in the manner described.

Therefore, if necessary, some sort of filters should be incorporated. Proper high-pass filter networks could be used

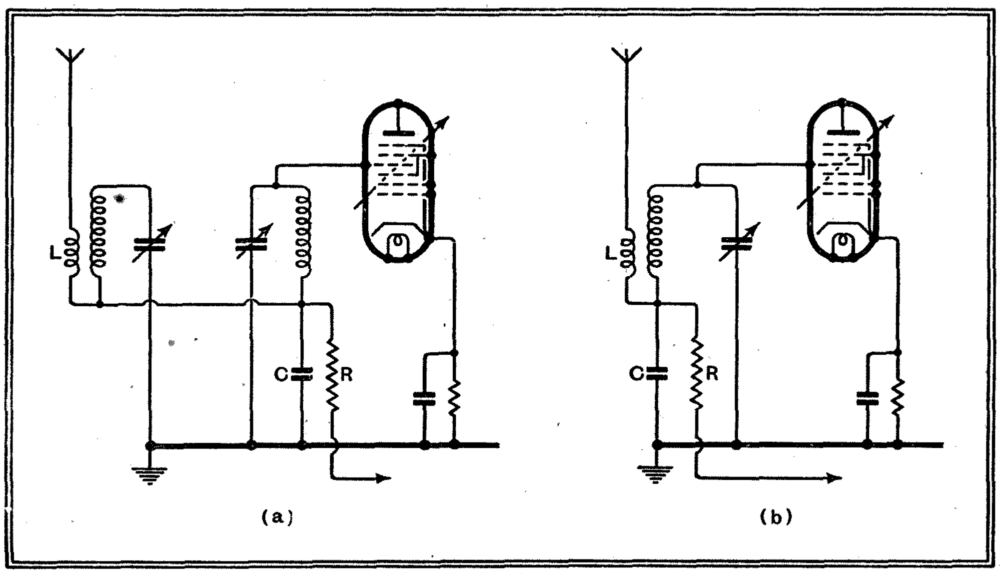


Fig. 3.—Receiver input circuits with which the multivibrator does not work satisfactorily unless AF and IF filters are included.

Notes on the Multivibrator—

but are complicated and expensive, and in practice it was found sufficient to use a broadly tuned circuit for the AF filter. A 5-10 henry inductance tuned by 0.01 mfd. worked quite well. An old AF transformer primary with most of the iron removed would suffice. As long as the capacity is kept large various inductances could be tried experimentally.

The IF filter could consist of part of an IF transformer. The capacity tuning it should be fairly large compared with the inductance. To arrange this a few turns (say, 10) could be removed from the coil and a larger condenser than the normal trimmer substituted (say, a 0.0002-mfd. variable). The reason for this is to avoid undue attenuation of the higher frequencies. The filter would, of course, be tuned to the IF of the receiver being aligned. The lower inductance and the larger

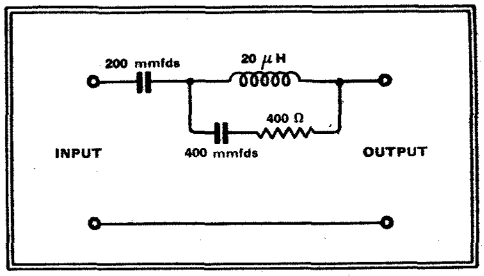


Fig. 4.—Standard all-wave dummy aerial.

capacity would also enable all IFs of, say, 400-500 kc/s, to be covered.

With regard to the attenuator, a 50-000-ohm potentiometer, which may be of any of the usual continuously variable types at present used in receivers or may be of a tapped type, is used to adjust the input to the attenuator proper.

Now the output of the multivibrator itself drops off fairly rapidly at very high frequencies, and this seems to be due chiefly to the anode/cathode capacity, which may present a shunt impedance across the 10,000-ohm anode resistance of only 1,000 ohms at 20 Mc/s. Thus the slider of the 50,000-ohm potentiometer has to be turned well up towards the high-potential end on the very high frequencies. As the addition of a very low resistance attenuator to the circuit would reduce the output still more, and as a very high resistance attenuator is undesirable, a compromise has to be struck. The actual attenuator used was one of approximately 130 ohms impedance, consisting of series elements of 50 ohms and shunt elements of 150 ohms, the last shunt element being 150 and 130 ohms in parallel. At least 12 sections are required for adequate attenuation at the lower frequencies. The sections were connected between studs of a multi-stud switch, and should be composed of non-inductive resistances. The signal is then tapped off at the various studs (instead of between them as shown in previous diagram).

It may seem to be an elaborate affair, but is of great help in enabling attenuation to be done in definite steps, and by calibrating it in arbitrary units a definite basis of comparison between one receiver and another is obtained.

It would be quite possible, of course, to use a continuously variable 200-ohm potentiometer instead if the above advantage is not required.

In Fig. 1 the output is shown as taken through a standard dummy aerial or, alternatively, through a 400-ohm resistance. The standard dummy aerial consists of 20 ohms in series with 20-microhenry inductance and a 200-mmfd. condenser, and is used on long and medium wavelengths, while the 400 ohms is for use on short waves.

The purpose of these dummy aerials is to provide proper impedance relationships between receivers and the generator, and also to load the input circuit of the receiver to simulate an actual aerial, so that trimming carried out on the generator will hold on a real aerial. If no proper dummy aerial is available, simply a 200-mmfd. condenser in series with the output on medium and long waves could be used, and 200 mmfds. and 400 ohms in series on the 5 to 30 megacycle band.

Connections to the Receiver

A dummy aerial approved by the I.R.E. of America is shown in Fig. 4. This covers all wavelengths in use in receivers. It will be seen that on medium and long waves the effective portion will be the 200-mmfd. and 20-microhenry section, while on short wavelengths the effective portion comprises 200 mmfds. in series with 400 mmfds. and 400 ohms.

The output lead should be of screened conductor, the screening being earthed to HT− and case of the multivibrator.

The multivibrator itself should be well screened in a metal box and the box well earthed to avoid radiation and for safety.

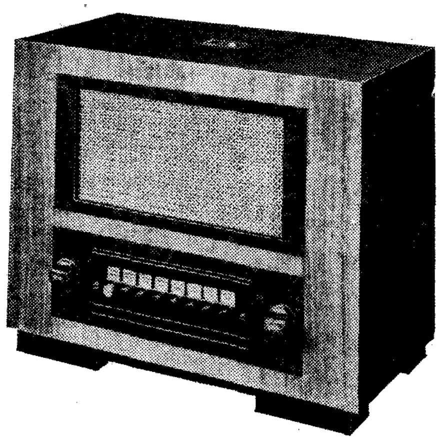
This is such a simple piece of gear that absolutely no difficulty should be experienced in getting it to work, but as a precaution the condensers and resistances should be tested before inclusion in the multivibrator, as if, for instance, one of the grid condensers were o/c the circuit would not oscillate, no biasing voltage would then be generated, and the valve would be badly overrun. The 16,000-ohm resistances should be of 2 watts dissipation, the grid resistances 1 watt, and the 0.013-mfd. condenser of 1,000-volt working. The odd capacity may be made up of two or more condensers in parallel, say, a 0.01 mfd. and 0.003 mfd.

H.M.V. Model 1100

A New AC Superhet for Push-button Tuning Only

By omitting the usual variable tuning condenser and its associated dial and slow-motion mechanism the Gramophone Co., Ltd., in their latest receiver, have not only made it attractive in price, but have produced a remarkably neat and compact instrument which should appeal to those who want a few selected stations with the minimum of fuss.

The cabinet, which is finished in two shades of walnut, measures 13½in. high × 16in. wide × 11in. deep. The only controls other than the push buttons are tone and volume, and of the seven push buttons five may be used for medium-wave and two for



In the new H.M.V. Model 1100 control is simplified by the omission of manual tuning and waverange switching.

long-wave stations. Pressing any station button automatically switches the set on, and it is switched off by a separate button on the left.

A four-valve (plus rectifier) superheterodyne circuit is employed, and there is provision for connecting external loud speakers and a record player. The set may be worked either from an external aerial or from an internal connection to the mains wiring.

Push-button adjustment is effected by removing the escutcheon and setting the trimmers thus revealed with a small screw-driver, which is kept in the recess behind the escutcheon plate.

The price of the Model 1100 is 9½ guineas.

HENRY FARRAD'S SOLUTION

(See page 294)

Mr. KEEN has overlooked one B.B.C. station, only a few miles away from him—the television station. When his receiver is tuned to 22¼ metres (13.5 Mc/s) the oscillator is working at a frequency about 470 kc/s higher, 13.97 Mc/s. Its third harmonic is three times this, 41.91. As the sound wave of the television station is 41.5 Mc/s, the difference, 410 kc/s, is approximately the intermediate frequency, which would be passed on through the receiver (allowing for a slight error in the wavelength given and in the assumed IF the difference might easily be exactly the IF). Such a strong signal as would be obtained at Hampstead could easily work its way to the frequency-changer sufficiently to give strong reception. The programme reported by Mr. Keen agrees with the television station schedule, which at about that time is usually giving a record of the 9 p.m. news bulletin on the sound wave only.

(Some of the wavelengths on which it may be possible to hear television sound (IF = 470 kc/s):—

Mc/s	Metres	
20.52	15.62	2nd harmonic
20.05	14.97	
13.52	22.20	3rd ,,
13.21	22.71	
10.02	29.95	4th ,,
9.79	30.65	
7.92	37.90	5th ,,
7.74	38.75	

Generally, one in each pair, if audible at all, is much weaker than the other.)

Random Radiations

By "DIALLIST"

Too Optimistic

SOME of the lay papers, I observe, are running a campaign for the erection of a television transmitter in the North of England. Assuming a service area with a 50-mile radius, they claim that a high-definition station at Manchester would cover most of the large towns in Lancashire and the West Riding of Yorkshire and supply the television programmes to a part of the country which contains 2,000,000 holders of wireless receiving licences. But can you assume a 50-mile radius, or anything like it? I'm pretty sure that you can't. Between the Western Plain, in which stands Manchester, and the Vale of York on the east there's the Pennine Chain, which seems to be rather in the way. The country, too, in which many of the big West Riding towns stand, is very much of the hill-and-valley kind, which doesn't make for a large ultra-short-wave service area. Choosing the site for a television station isn't quite such a simple business as some lay writers imagine. There's more in it than just taking a map and making a pencil dot somewhere about the middle of a thickly peopled district.

Useful Customers

HAVE you ever thought of the tidy little sum that we wireless folk pay to the electricity supply undertakings each year for the current which runs our sets? The figures are rather staggering when you work them out. The total number of receivers in use in this country is some 10,000,000, of which we shan't be far out if we take 7,000,000 as mains-operated. Allowing 1,000 hours of use annually for each of these at an average load of 50 watts, we arrive at a current consumption of 50 units per set, or 350,000,000 in all. It's not so easy to strike an average for the amount paid per unit; not only do the charges vary greatly in different parts of the country, but there are also so many "flat rate" and other systems of reckoning them. Using current for lighting and wireless only and paying on a flat-rate basis, I find that my current costs me about 3½d. a unit for the whole year. Some people pay less than that; some a great deal more. Is 4d. a unit a fair average for the country as a whole—for domestic purposes only, of course?

Running Costs

The true figure is almost certainly rather higher; hence, if we adopt 4d. a unit as a basis for calculations, we shall not err by exaggeration. At that price the electricity bills paid by owners of mains receivers for current for their sets tot up to 5.83 million pounds a year, which means that as a body we are pretty useful customers. Nor is that quite the whole story, for at least 2,500,000 owners of battery sets obtain their filament current ultimately from the mains, and the number of HT accumulators in use is considerable. Probably, then, our total contribution to the coffers of the electricity supply undertakings is at least six million pounds a year. On these figures the average yearly cost of running a mains set is 16s. 8d., or five hours for a penny. Add ten shillings for the receiving licence and £3 for repairs, renewals and depreciation, and the total cost of wireless entertainment with a mains receiver comes out at almost exactly a penny an hour on a basis of 1,000 hours a year.

Hum

SOME makers of the lower-priced receiving sets are not paying as much attention as they should to the elimination of hum in their mains models. Lately I've heard several whose purring background got on my nerves pretty badly. I suppose that the designers work on the assumption that the receivers will be used for the greater part of the time to bring in one or other of the local stations and that their transmissions will be strong enough to drown hum. That's all very well, but it mustn't be forgotten that many people make a good deal of use of Continental stations, particularly on Sundays. And there are those who can't rely on Droitwich for the National programmes because of long-wave interference. They must get these programmes from one or other of the medium-wave nationals, which often means advancing the volume control considerably and bringing up the hum to a highly unpleasant level. I don't see how you're going to persuade a man that a 1939 model is in every way superior to his old set if you offer him something with a background that sounds like the passing of a not very distant aeroplane!

Button Tuning

THOUGH I still stick to my original contention that it would have been far better to reserve press-button tuning for sets more or less in the luxury class, I must confess that I've been favourably impressed by, at any rate, one of the methods employed in receivers that certainly don't fall into this category. This is the lever-and-cam system. Mounted on an extension of the tank condenser's spindle are a number of heart-shaped cams, each operated by a lever attached to the kind of key that you see in typewriters or cash registers. When a particular key is depressed the lever moves the cam and the spindle to which it is attached to exactly the right position for bringing in the wanted station, which comes in instantly; there's no waiting for a motor to do its job of work. Should any cam slip, it's an easy business to readjust it. The system, in fact, works admirably—or, rather, it would but for two factors. The first is that cams and levers may soon show signs of wear if they're not of first-rate material; the second, that no kind of automatic tuning is much fun if a set suffers from oscillator creeping.

It Has Possibilities

Given automatic frequency control, to take charge both of small amounts of wear and of slight mistakes in adjustment and a thoroughly stable oscillator, cam-and-lever tuning appears to have not a few merits, not the least of which is its utter simplicity. But you can't have AFC and stability of the oscillator in very cheap receivers. Which goes to show that there is something in my view that button tuning ought to have been kept as a feature of *de luxe* receivers. It occurs to me that the cam-and-lever movement could fill a want in communication receivers and others not intended for press-button tuning. You know what a bore it can be after you've searched from the bottom to the top of a wave-range to have to turn the pointer back again to zero by means of a knob with slow-motion gearing? I was using a set the other day with which *thirty* complete turns of the knob were needed to do this! Wouldn't long-distance men bless a receiver whose tuning could be turned instantly to zero by just depressing a lever? I'm sure they would.

Short-Wave Snobbery?

MR. T. J. E. WARBURTON is perhaps a little unkind in accusing short-wave listeners of snobbery. There are very good reasons why we read in the lay and other papers of the effects of magnetic storms, whether or not they are accompanied by manifestations of the aurora, on short-wave transmissions and find no word about results of their activity observed on the medium-wave band. The first of these is that such disturbances are responsible for far more spectacular goings-on among short-wave transmissions than among those on the medium waves. Most of the medium-wave stations that we hear during ordinary listening hours are pretty strongly received and their bearings lie betwen N.N.E. and S.S.E. Their radiations don't follow paths that pass anywhere near the North Magnetic Pole. In the northern hemisphere the most intense area of magnetic disturbances, or, anyhow, those that give rise to auroras seen far south of their normal limits, seems to be in the neighbourhood of this magnetic pole. The transmissions coming to us whose paths pass nearest to the North Magnetic Pole are those from Canada and North America.

Times and Seasons

On the short waves you can normally expect to hear U.S.A. stations at almost any time provided that you select the right waveband for the time of day. Hence, when there is an aurora and North America becomes dumb or fluttery, thousands of short-wave enthusiasts have first-rate opportunities of observing what a magnetic disturbance can do. But to see how it is affecting the medium waves you have to sit up into the small hours. It happens that I did so sit up on the night of the February aurora, and exactly what I expected to happen did happen. In other words, it was a South American night; the North American medium-wave stations just weren't there. If Mr. Warburton cares to keep a chilly vigil when the next aurora comes along, I'm open to bet him two to one in wander-plugs that he has a very similar experience. I believe that whether your transatlantic bag on any particular night consists mainly of U.S.A. or of South American depends chiefly on magnetic conditions. If these are "quiet," you'll pull in large numbers of North Americans; but when they are reported as "moderately disturbed" or "greatly disturbed," South America will furnish most of your captures.

British News Abroad

A FRIEND who has just returned from "furrin parts" tells me that he found the B.B.C.'s German news bulletins very popular in the Fatherland. Strictly speaking, listening to them is *verboten*, but thousands of people do so regularly because of their obvious genuineness. Listeners like their calm, straightforward presentation of facts without any embroidery in the way of propagandist opinions or appeals. In Germany and in many other European countries

Random Radiations—
the medium-wave broadcasts are well received; but there are places in which the 60-70-kilowatt output of the B.B.C. stations is not enough to provide good reception. The "all-wave" receiver is not so common in some countries as it is here; hence those who do not find the medium-wave stations too good cannot always make use of the alternative transmissions from GSE on 11.86 megacycles (25.29 metres). Quite apart from the desirability of their being able to make their voices properly heard abroad when necessary, the raising of the output of all the Regionals to 100-120 kilowatts is an urgent necessity.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

Reducing Ignition Interference

I READ with interest the article by Mr. Strafford in *The Wireless World* of February 9th last.

Having worked for some time on the make of car the engine of which is illustrated on page 131, may I point out that interference, so far as it affects the usual type of car radio, can be practically eliminated by the simple expedient of removing the ignition coil from the scuttle-dash and fitting it to the crankcase or cylinder block. The effect of thus removing the actual "chassis" from the HT circuit may be either a decrease in its radiating properties or an alteration of emitted frequency.

Perhaps Mr. Strafford may care to experiment on these lines on the television frequencies.

CECIL R. PILL
Leeds, 4. Radio Officer.

Foreign Relays and Quality

IN answer to the "Quality Lover's" query I should like to point out that relays from the Continent now come via the new screened cables that were laid a year or two ago which have nothing like the same high-note attenuation as ordinary telephone cables. This accounts for some of the difference, but the trouble is even more deep-seated than that.

The B.B.C. still use the old carbon mike technique in their studios, placing the mike near to the sound source. With the carbon types it is necessary to pick up as high a voltage as possible so that the comparatively low amplification that follows does not magnify the hiss of the polarising current too much. When a mike is operated under these conditions it is not sensitive enough by comparison to reproduce the echo needed for liveliness. The newer ribbon type mike does not suffer from hiss and could be used a great deal farther away from the sound source than is done by the B.B.C. This, in fact, is done in some of the Continental stations, with the result that considerably higher amplification is needed and the echo, not heard before, comes into its own, greatly enhancing reproduction.

The B.B.C. studios are not so lifeless as many folk imagine. A good proof of this is to be found when, as sometimes happens, a singer sings with a "dead" mike in error and the sound is, perhaps, only picked up by a different mike some distance away. If advantage of this be taken to adjust the volume to normal it will be noticed that reproduction is really good until, with a bang, in comes the "home" mike and quality becomes flat and uninteresting again.

I am confident that much of the improved quality of television sound is due to the necessity for keeping the mike out of sight from the camera.

I expect I shall be accused of talking through my hat, so may I say I have a receiver with variable selectivity; 6-7 watts output; and a speaker that really speaks at 10,000 c/s.

Incidentally, as I laid down my pen after writing the above I switched on, and another "down the pipe" relay from Germany was on, and once again the sparkling quality was very pronounced.

"ANOTHER QUALITY LOVER."

THE remarks by "Quality Lover," of February 23rd, *re* the quality of transmission from Germany recently, are very interesting and I personally endorse them.

The relay of Henry Hall's orchestra was particularly fine, and was actually the only occasion I can recall having enjoyed listening to it. Compared with transmissions of this orchestra from the B.B.C. studios, the balance seemed greatly improved.

Cricklewood, N.W.2. A. E. THORN.

Auroral Effects

I WAS very interested in the report in your issue of March 2nd in Mr. H. West's remarks about interference with television during the Aurora Borealis display. I had exactly similar results, and, furthermore, I happened to be viewing last year when the Aurora was in evidence, and results were then exactly the same. As Mr. West observed, hum, varying in intensity, accompanied the sound, and slight shadows flitted across the screen in sympathy. But interference on the vision was much less noticeable than on the sound.

ALAN G. SPICER.
Worthing, Sussex.

The Wireless Industry

THE power wire-wound resistances illustrated in our last issue are the subject of a technical bulletin (R339 15-17) which has just been issued by the Dubilier Condenser Co. (1925), Ltd., Victoria Road, North Acton, London, W.3.

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The word "Mains" was inadvertently omitted from the title of the firm producing the tuner unit mentioned in the article entitled "Designing an Individual Receiver" in our issue of March 9th. The correct title of the firm is Mains Radio Development Company of 4-6, Muswell Hill Road, London, N.6.

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In the reference to "Unitran" transformers in this column on March 9th, a cipher was omitted from the figures relating to frequency response. The range over which the characteristic is flat is from 30 to 20,000 cycles.

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B.T.H. sound-amplifying equipment has been installed in the new Spa Pavilion at Felixstowe. Velocity ribbon microphones are employed, and after passing through a 15-watt rack-mounted amplifier the sound is distributed through two multi-cellular horn loud speakers on opposite sides of the stage.

Club News

Croydon Radio Society

Headquarters: St. Peter's Hall, Ledbury Road, South Croydon, Surrey.
Meetings: Tuesdays at 8 p.m.
Hon. Pub. Sec.: Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

Mr. S. F. Webster gave a demonstration of high-fidelity reproduction at the last meeting of the Society. He used three RC stages on the LF side, the second being employed for tone control. The output comprised two ACQ valves in Class AB. Twenty-five watts were fed to the loud speaker. On the HF side the receiver employed an HF pentode, followed by an infinite impedance detector, based on *Wireless World* designs.

On April 4th Mr. H. G. Salter will conclude the session with a musical programme using records.

Edgware Short-wave Society

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

The Club now has 50 members, including 14 fully licensed transmitters and 10 with artificial aerial licences. The library now contains 12 technical books.

On March 1st Messrs. Moxon and Adams, of Murphy Radio, Ltd., lectured to the Club on their firm's products. On March 16th a round-table discussion was held on the transmitters belonging to members.

Invitations are extended to all amateurs to be present at the Club's first guest night on April 12th.

Slough and District Short-wave Club

Headquarters: 35, High Street, Slough, Bucks.
Meetings: Alternate Thursdays at 7.30 p.m.
Hon. Sec.: Mr. R. J. Sly, 16, Buckland Avenue, Slough.

At the last meeting Mr. J. H. White lectured on "Microphones and Amplifiers." Later in the evening the meeting was adjourned for a demonstration of television arranged by Messrs. Hickie and Hickie, of Slough.

At the next meeting Mr. F. J. Tuckfield will lecture on "The Short-wave Receiver."

We are compiling a register of wireless clubs and societies and should be glad if secretaries who have not communicated with us recently will let us know if any alteration has been made in the particulars concerning their club.

World Friendship Society of Radio Amateurs

Hon. Sec.: Mr. A. H. Bird, 35, Bellwood Road, Waverley Park, Nunhead, London, S.E.15.

This Society, which was founded in April, 1935, is a world-wide organisation. There is no entrance fee or subscription, but members are required to sign a simple pledge. Certificates of membership are issued to all accepted applicants.

The objects of the Society are to promote and foster good will and friendship and to enrol all amateurs irrespective of nationality or creed. In addition, letters of good cheer are written to invalids and cripples. Donations will be gratefully received.

Applications for membership should be sent to the Hon. Secretary or to Mr. A. Larty, 23, Altham Road, West Derby, Liverpool, 11.

Romford and District Amateur Radio Society

Headquarters: Y.M.C.A. Red Triangle Club, North Street, Romford, Essex.
Hon. Sec.: Mr. R. C. E. Beardow, 3, Geneva Gardens, Chadwell Heath, Essex.

Recently lectures have been given by Mr. Townsend, of the Hivac Valve Co., and Mr. Betteridge, of the Marconiphone Co., the subject in both cases being "Cathode-ray Tubes." Each lecturer dealt with a different aspect of the subject. At a later meeting a demonstration was given of the Evrizone amateur receiver.

Ashton-under-Lyne and District Amateur Radio Society

Headquarters: Commercial Hotel, 86, Old Street, Ashton-under-Lyne, Lancs.
Meetings: Alternate Wednesdays.
Hon. Sec.: Mr. K. Gooding, 7, Broadbent Avenue, Ashton-under-Lyne, Lancs.

Tickets for the "hamfest" which will be held at the George Café, George Street, Ashton-under-Lyne, on April 2nd cost 3s. 6d. each. All local amateurs, including non-members, are asked to support this event and to communicate with the Secretary immediately. It has been decided to co-operate with the Derby Society in the matter of field days. A panel of listening stations is being drawn up to provide a practically full-time listening service in connection with organised tests. G5PX, G6TL and G3BY, who work every Sunday on 56 Mc/s, would appreciate reports.

City of Belfast Y.M.C.A. Radio Club

Headquarters: City Y.M.C.A., Wellington Place, Belfast.
Meetings: Third Wednesday of each month at 8 p.m. Junior Morse Class Mondays and Fridays at 8 p.m. Senior Class at 9 p.m. Experimental section, Tuesday evenings at 8 p.m.
Hon. Sec.: Mr. J. Gallaugher, 90, Somerton Rd., Belfast.

The Club has had a very successful season, and membership is growing. There has been great activity throughout the winter. The Club library now contains copies of the latest edition of the Amateur Call Book and other magazines. Subscription is 5s. per year for seniors and 3s. 6d. for juniors.

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.

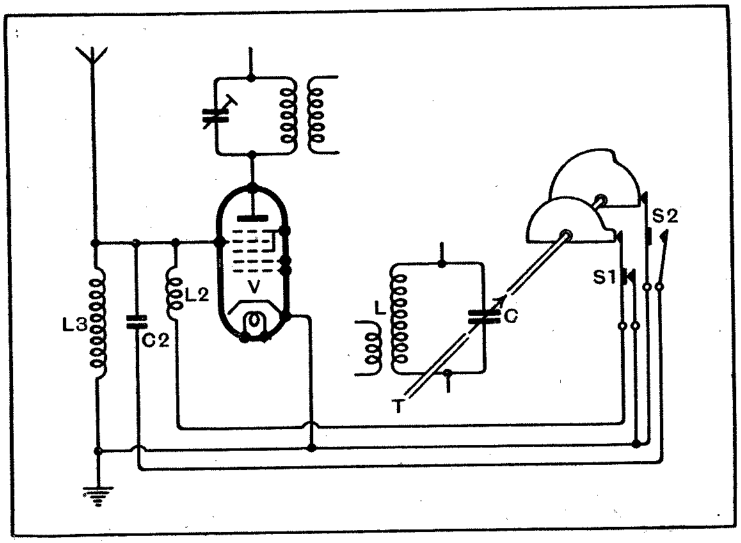
Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

SUPERHETERODYNE RECEIVERS

RELATES to a highly selective receiver of the kind in which there are two "mixing" stages, the first producing an intermediate frequency of the order of 3,000 kc/s, and the second one of the order of 1,700 kc/s. The first stage is made structurally separate from the rest of the set, and may be remotely controlled.

The Figure shows a method of tuning such a set through a continuously variable condenser C, which is in the local-oscillator circuit L of the first mixing valve V. As the shaft T rotates, the switches S1, S2 are brought into operation, one after the other, by means of suitably shaped cams mounted on the shaft. In this way a parallel inductance coil L2 in the input circuit is first short-circuited, and then a condenser C2 is shunted across the primary coil L3, so as to increase the accepted waveband in successive steps. The input inductances and capacities may be arranged to form a bandpass filter.

G. von Schaub. Convention date (Switzerland), March 21st, 1936. No. 497830.



Cam-operated switches providing automatic extensions of waverange.

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INTERFERENCE SUPPRESSION

SUDDEN surges of interference are prevented from affecting a wireless receiver by providing in the circuit a storage device (such as a condenser) which builds up a voltage proportional to the amplitude of the signal. The storage element is normally isolated from the main amplifying channel, and so does not affect signal reception until such time as an interfering impulse of undesirable strength arrives.

When this happens, a bias is automatically developed on the grid of the valve controlling the storage condenser, so that the latter comes into action to supply the grid of the low-frequency amplifier with what is equivalent to the incoming signal voltage. This serves to mantain the continuity of reception at normal strength, and at the same time to suppress the disturbing effect of the interfering impulse.

Marconi's Wireless Telegraph Co., Ltd. Convention date (U.S.A.), May 21st, 1936. No. 497646.

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DEAF-AID SYSTEMS

SPEECH or music is distributed through a cinema or theatre by a wiring system which is fed with low-frequency currents from a power amplifier. The supply is not, of course, normally audible, but those members of the audience who are "hard of hearing" are provided with a small portable set which is fitted with a pick-up coil. This can be used to receive and amplify the field radiated from the wiring system at any point in the building.

The supply wires are preferably laid in a series of loops, which are alternately reversed, so that the inductive field does not spread beyond a given area and so cannot be picked up outside the theatre. In a sports arena, for instance, the windings may be arranged so as to concentrate the field around the margin of the arena where the audience is located. The portable set may be fitted with a microphone, and can then be used as a deaf-aid appliance for conversation with another person similarly equipped.

J. Poliakoff and O. B. Sneath. Application date, July 5th, 1937. No. 498468.

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PRODUCING "INCANDESCENT" PICTURES

RELATES to television receivers of the kind in which the usual fluorescent screen is replaced by a very thin sheet of metal, on which the picture details are reproduced in incandescent light of sufficient intensity to stand up to considerable magnification. The temperature changes are produced by the impact of the scanning stream of electrons, and it is difficult to make these sufficiently clear cut to preserve the picture details and at the same time to prevent the heat, once it is produced, from spreading beyond the breadth of the scanning line so that it causes "blurring."

According to the invention, the scanning stream is first focused on to an auxiliary screen, which is coated with an emissive substance and is preheated to a critical temperature, so that the impact of the stream causes it to emit secondary electrons at a rate which varies from point to point with the light and shade of the original picture. These secondary electrons are then projected on to an incandescent screen, which is coated with a thin layer of lampblack covered by a film of finely divided tungsten. The resulting picture shows the highlights in white incandescence, with very little lateral "spread" of the heat.

Marconi's Wireless Telegraph Co., Ltd., and L. M. Myers. Application dates, May 14th and August 25th, 1937. No. 495646.

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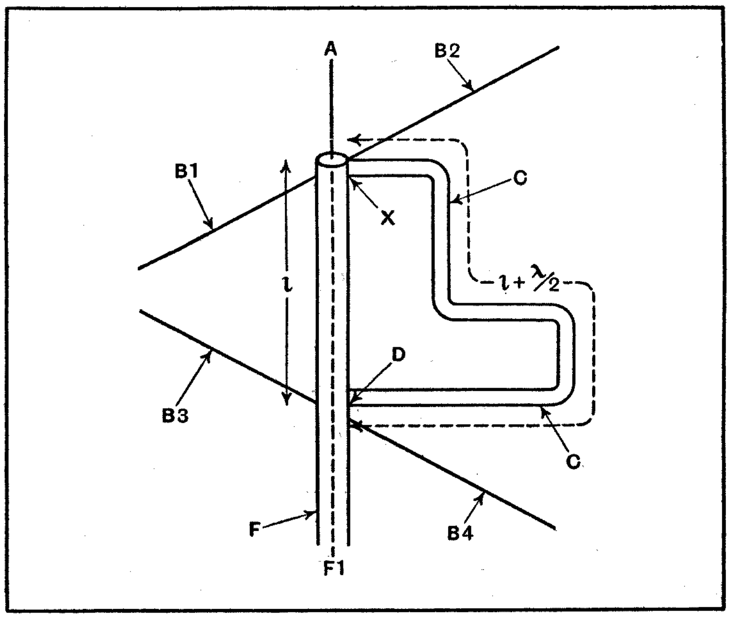
SHORT-WAVE AERIALS

RELATES to means for eliminating interfering signals picked up by the feeder connecting a short-wave television aerial to the receiver. In the figure, the dipole aerial A is coupled at its lower end to a concentric feed-line F, F1, and the arrangement shown is designed to prevent undesired signals, picked up by the outer sheath F, from reaching the aerial.

In the first place, two pairs of quarter-wave conductors, B1, B2 and B3, B4, are connected to the outer sheath so that they extend outwards at right angles to each other. These conductors, in combination with the length of feeder between them, act as a rejector circuit to the undesired waves. In addition, an auxiliary conductor C is branched out as shown, so that its overall length is half a wavelength longer than the section of the feeder which it bridges. Undesired waves travelling upwards along the feeder then divide at the point D and come together in phase opposition at the point X, where they cancel out. The conductor C may be arranged in zig-zag fashion across the feeder, in order to give a more symmetrical arrangement.

E. C. Cork and J. L. Pawsey. Application date June 23rd, 1937. No. 495489.



Cancelling out interfering impulses picked up by an aerial feeder.

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TUNING INDICATORS

WHEN a cathode-ray tube or neon lamp is used to indicate resonance, it is generally mounted at some fixed point which is not always in the same "line of sight" as the indicator needle of the station or wavelength scale, so that the eye has to move from one indicator to the other in order to decide when a desired station is correctly tuned in.

According to the invention, the resonance-indicating tube is mounted on a cursor which is traversed by chain or other gearing from the tuning-control knob, so that it moves bodily along the wavelength or station-indicator scales. Both critical readings are thus shown at the same point. Preferably the visual indicator is of the type in which resonance occurs when the "light" contracts to a single line. This "line" will then serve as the indicator needle for the wavelength scale.

C. Metcalfe. Application date May 5th, 1937. No. 495066.