Wireless World

RADIO • ELECTRONICS • ELECTRO-ACOUSTICS

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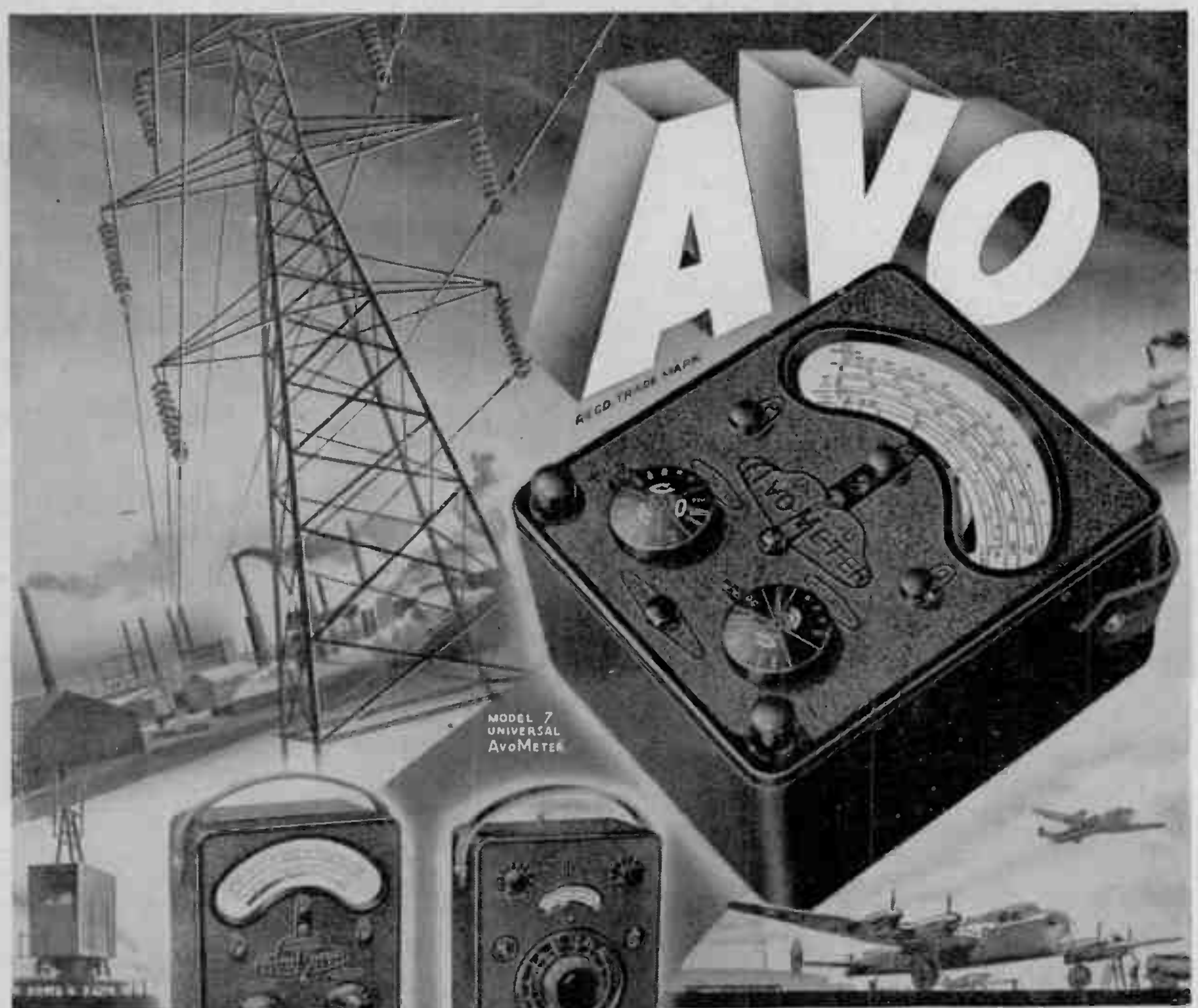
IN THIS ISSUE: WARTIME "QUALITY" AMPLIFIER



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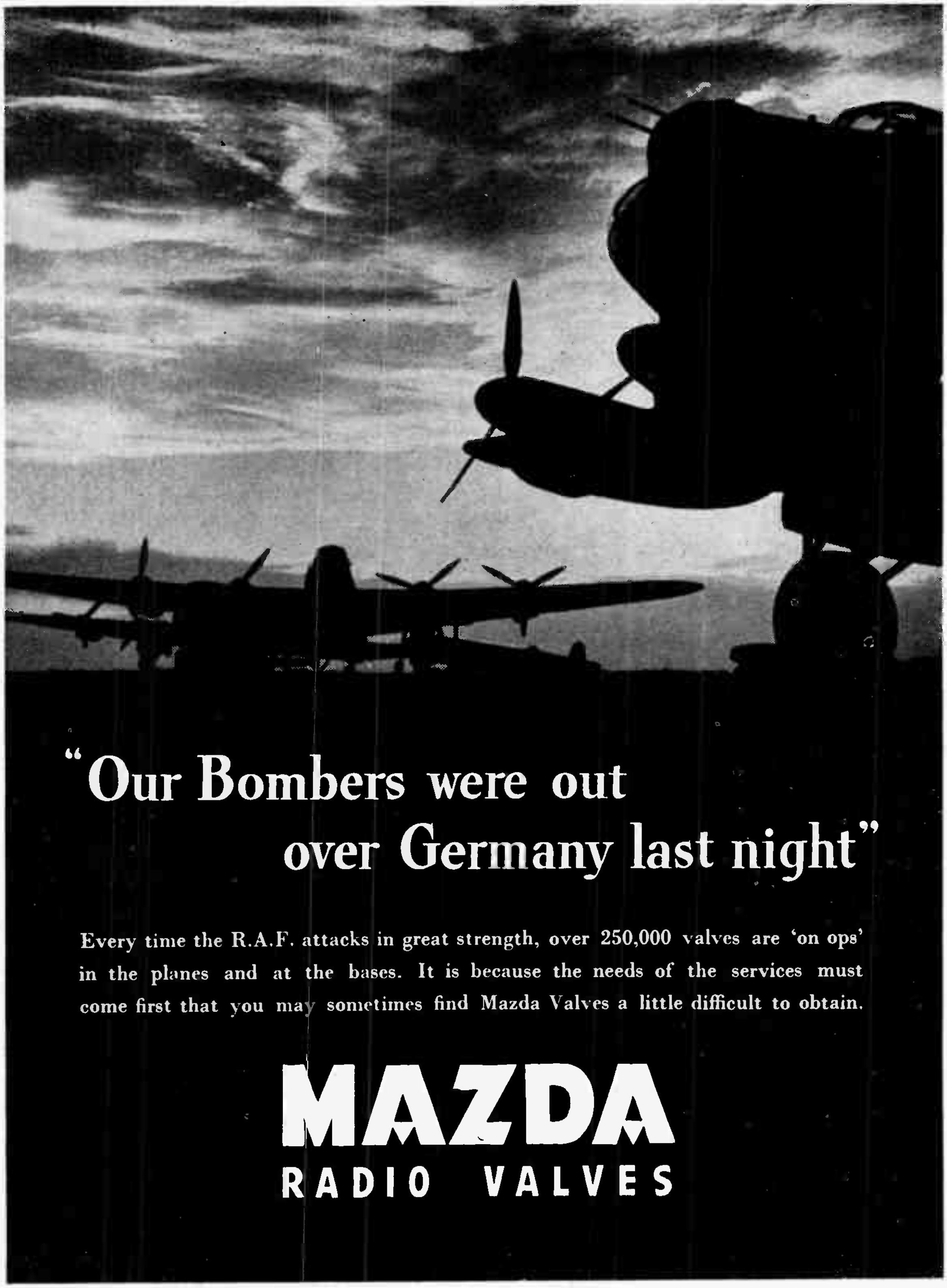
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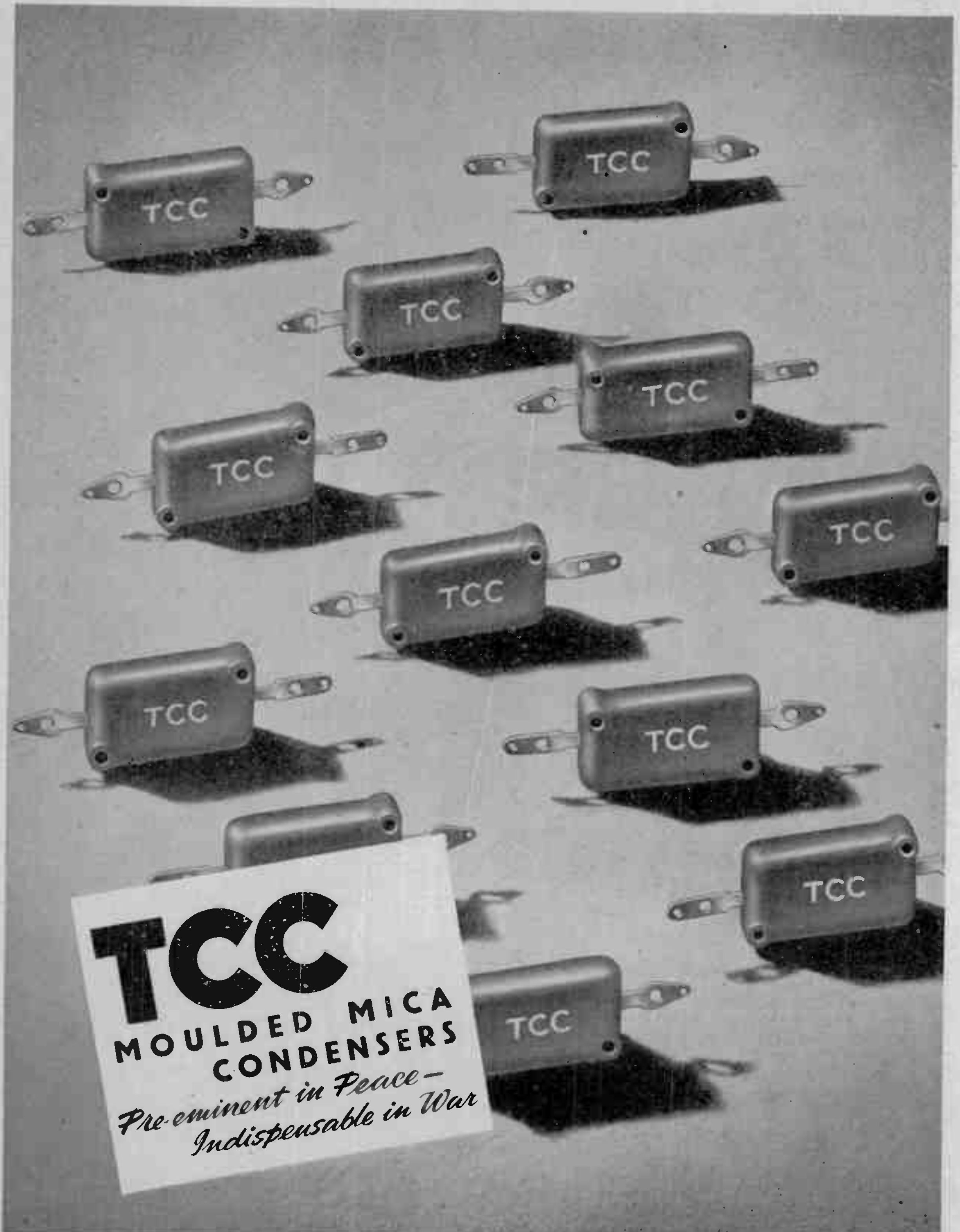

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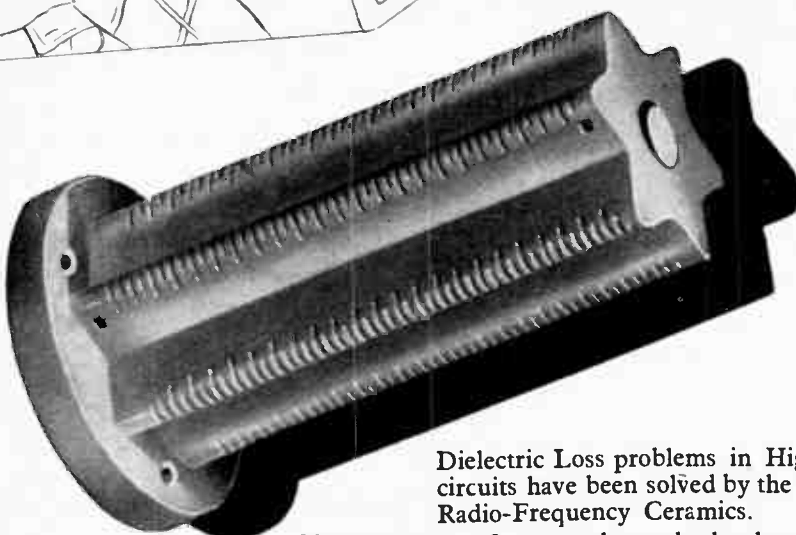

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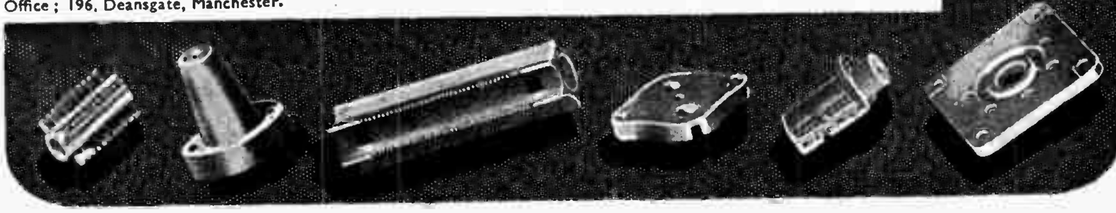

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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Radio • Electronics • Electro-Acoustics

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Reorganising Broadcasting

Some Drastic Proposals Examined

EVER since the middle of the summer, when the Minister of Information invited Parliament to conduct "a complete examination of the whole set-up of the B.B.C.," many suggestions have been made for changing the constitution of British broadcasting. Many of the proposals put forward bear the stamp of "B.B.C.-baiting," with which we are all too familiar, but a few truly constructive suggestions have been made. At a time when the B.B.C. is celebrating its 21st birthday it seems to be almost lacking in good taste to spoil the party by drawing attention to schemes that in at least one case would spell the virtual demise of the Corporation. But, although the B.B.C. Charter does not expire until 1946, it is obvious that, if sweeping changes are decided to be necessary, they must at least be ready to be put in train as soon as the war ends. Without full knowledge of plans for the future it would be impossible to formulate a rational programme of post-war broadcast receiver production, to say nothing of many other aspects of the matter.

As long ago as 1938 *Wireless World* put on record its opinion that the basic weakness of British broadcasting lay in the lack of competition. While freely admitting that, wrongly applied, competition might introduce waste and even worse abuses, we have long maintained that it would provide an essential stimulus. The competitive principle seems at last to be more generally accepted, and, if we agree it is desirable, the basic problem now seems to be the devising of means for putting the principle into practice. On the following pages is printed the gist of two proposals that, in greater or lesser degree, provide the element of competition.

The first plan, worked out in considerable technical detail by members of the Cossor research laboratory staff, is a comprehensive one for the nation-wide distribution of both sound and vision broadcasting. It is proposed that the B.B.C. shall continue home medium-wave and overseas short-wave broadcasting as well as television transmission on the present monopolistic basis, but that, in addition, the country shall be covered by a number of frequency-modulated ultra-short-wave sound broadcasting stations operated entirely by independent bodies.

Slightly higher definition standards and carrier frequencies than those of pre-war are suggested for the television transmissions, which, it is argued, would enable us to "approach a virtually perfect monochromatic service without an additional change of system." What we are chiefly concerned with here is the proposal for establishing hundreds of independent FM stations which would, it is suggested, be licensed to commercial concerns, educational bodies, etc. Although advertising would be permitted, it is expected that not all the stations would be "dominated by advertising interests." One is tempted to speculate on who would, in fact, tender for the right to operate such stations; also, on what basis, and by whom, licences would be granted. Would any sufficiently powerful interests arise to acquire the group of 12 stations necessary for covering the whole country? Unless complete national coverage is assured we are not convinced the independent stations, working separately, would ever gain a sufficiently wide audience to influence the B.B.C. by the spur of competition. If we have a criticism of this part of the scheme, it is on the basic grounds that it savours of regionalism or even of parochialism. It runs counter to the true spirit of broadcasting, which is not the proper medium for serving local audiences or sectional interests. But these weaknesses are not inherent in the scheme of competitive FM stations; indeed, the whole plan does, in fact, provide answers to many broadcasting problems.

Exit the B.B.C.?

The second proposal, put forward by a writer in *The Economist*, is more drastic. As will be seen from our published extracts, it is suggested that three competing programme companies be given the right to broadcast, presumably over three networks of equal nation-wide coverage. The companies would derive their funds in part from equal shares of the licence revenue; in addition, an extra

Reorganising Broadcasting—

share of the licence fee would be voted by the individual listener to his favourite company. Such a system certainly introduces the element of competition in full measure, but, in spite of any safeguards that might be devised, we feel that too much would depend on the constitution of the programme companies to justify such a drastic change. The temptation in such circumstances to lower the level of taste of the programmes would be more than any profit-making organisation could be expected to resist. The problem raises political issues that cannot be discussed here, but we doubt if many students of broadcasting organisation would claim that the British system should be under the control of virtually unrestricted commercial enterprise. If that be admitted, we get back to an alternative something like that proposed by this journal in October last year, when we suggested the setting-up of independent and competitive "Programme Boards" on B.B.C. public-service lines. That principle could be combined with some of the features, including the FM network, of the two plans we have been discussing.

PLANS FOR POST-WAR BROADCASTING

Competitive Systems : Television Distribution

BELOW are printed summaries of two distinct proposals for drastic reorganisation of British broadcasting after the war. One deals with television and sound broadcasting, the other with sound broadcasting only. Both raise issues that are highly controversial, but, except for the fact that they both suggest systems introducing the element of competition, they have otherwise little in common.

The first proposal, described as a "Plan for Post-War Broadcasting in Britain," was evolved in the Cossor Research Laboratories, and presented by K. I. Jones and D. A. Bell before the I.E.E. on November 16th. It is a comprehensive and detailed proposal for putting into operation immediately on the cessation of hostilities, though in the first stage work would be limited to the design and production of the necessary transmitters and receivers. As apparatus became available, the plan would become operative area by area.

In broad outline, the essentials of the scheme is that medium- and short-wave broadcasting should still be carried out by the B.B.C., which would also conduct a nation-wide television service. Each area served by a television transmitter would also be served by twelve FM sound transmitters, each covering the whole of that area, as well as by 24 secondary FM sound transmitters able to cover parts of the area. These stations would not be operated by the B.B.C. but by commercial concerns, educational bodies, etc.

Questions of finance are touched upon, and it is suggested that the establishment and operation of a television network by the B.B.C., in addition to its other services, is possible within the framework of the present licensing system. But, to meet the capital cost of equipment, the Corporation, instead of working on its revenue as heretofore, would probably be compelled to borrow. The independent operators of the FM USW stations would in some cases derive their revenue from advertising, but it is claimed that there would be no necessity for all of them to be "dominated by advertising interests." It is pointed out that before the war a 1 kW. FM station, excluding the building and aerial, cost in America between £2,000 and £2,500, and so the acquisition of a station would be within the means of a University or County Educational Committee.

Television Distribution

Technical considerations have been taken fully into account in formulating the plan, and it is concluded that all the populous areas of the country can, in the initial stations, be provided with a television service distributed through 12 stations and only three different frequencies. A definition standard of 525 lines, with interlaced scanning and a frame frequency of 50 (25 complete scans) per second is suggested. (Pre-war standard was 405 lines.) To restrict band-width, the modified form of single-sideband transmission known in America as "vestigial sideband" is proposed; this would require a band-width of about 4 Mc/s. The accompanying FM sound channel, allowing a separation of 5 per cent. and a modulation swing of ±15 kc/s, would require a band of 0.35 Mc/s; say, to be on the safe side, 5 Mc/s for the complete sound and vision channel. Proposed sites of stations are shown on the map on the opposite page.

Each area served by a television station would be allotted a band of 3 Mc/s in addition for the independently operated FM sound transmitters, making 8 Mc/s per area for both forms of UHF broadcasting. The allocation of three of these 8-Mc/s bands between the 12 areas would be made in such a way as to reduce mutual interference to a minimum. Detailed proposals are made, and it is stated that it would be possible to provide 12 primary or first-grade channels and two blocks of 12 secondary channels in each area. In addition, restricted use might be made of the vision channels at times when the television transmitters were inoperative. Allowing these additions, each area would have one television channel, 12 primary and 24 secondary sound channels, and 40 restricted sound channels; a grand total of 924 USW transmissions for the whole country! To accommodate this system it is suggested that the UHF broadcasting band should be extended to cover from 40.5 to 64.5 Mc/s; the television channels would be put at the top of this band so as to secure a better ratio of carrier to modulation frequency.

"THE FUTURE OF BROADCASTING"

THE following are extracts from an article in *The Economist* in which the basic constitution of British broadcasting was examined and proposals made for a drastic change in the present system:—

The great vice of the B.B.C. is timidity. The B.B.C. is a monopoly, but it is in the opposite position to the traditional monopolist. It cannot defy the public; just because it is fair game for everybody, it cannot afford to offend anyone. If the churches want more religion, if the Welsh want more Welsh, if the Tories want less Socialism, if the internationalists want more pacifism, if more Russian and less German music is demanded on political grounds, if each of the United Nations has to have an equal measure of broadcast "salutes"—the B.B.C. must listen to them all. It may not be able to gratify their positive wishes, but at least it can avoid offending their mutually offsetting phobias. The only way by which it can give tongue for 120 hours a week (which is one service only) without dangerously offending anyone is to take refuge in timid mediocrity. The B.B.C., in fact, exhibits all the vices that might be expected from a State-run cultural institution. It should not be blamed; it is doing its best.

This timidity does not emerge solely from the fact that the B.B.C. is a Government body about which questions can (within limits) be asked, and motions made, in the House of Commons. Any monopolist broadcasting body would be in the same position. So long as it cannot, in the last resort, say to its critics, "Programmes are a matter of judgment, and if you don't like our judgment you can listen to somebody else's programmes," it must be a compromising body. Nevertheless, the element of political control, however much diluted, does reinforce this general tendency, and any attempt to increase it would make matters worse. If the B.B.C. were made responsible to the House of Commons, if it were open to criticism by the House on the details of its activities, to which it could reply only through the mouth of a Minister who might, or might not, be sympathetic—in such conditions its programmes would become even more anodyne than they are.

* * *

One obvious question is . . . the financing of broadcasting by advertising. . . . The chief example of this system is in the United States, and American broadcasting has much more to be said for it than might be thought on *a priori* grounds. It certainly has life and more variety than the B.B.C., and the advertiser's influence does not drag the programmes down to the lowest common denominator. But, on analysis, the virtues of American broadcasting are not due to its advertising sponsorship (except perhaps in respect of the ample funds that are thereby made available to the programme-builder) so much as to the fact of competition. The four big networks compete most fiercely and directly for the listener's and the advertiser's favour, and both liveliness and variety are due to that. Competition might achieve them without advertising—advertising without competition certainly would not.

The future basis for British broadcasting should, therefore, be one of licence-financing combined

Map showing proposed location of stations for providing a television service for the more densely populated areas of the country. Each television zone would also be served by a group of FM sound broadcasting stations.

Plans for Post-war Broadcasting—
with competition, thus including the best features of both the present British and American systems. If licence revenue alone cannot provide adequate funds, then (and then only) a certain minimum of advertising might perhaps be admitted in off-hours. But the essential thing is to secure competition, which would not only rescue the B.B.C. from its present exposed position and remove the causes of timidity but compel attention both to life and to variety.

This result would not be difficult to achieve. Let the State own the physical apparatus (whether by radio wave or by wire) and apportion its use to the competing broadcasters on an equitable basis. Let, say, three competing programme companies be chosen. If more than three otherwise qualified groups offer, let there be a competitive bid for the right to use the physical facilities. Let the contract include conditions which would specify the hours of broadcasting and the number and type of separate programmes to be transmitted. Let 25 per cent. of each listener's fee go automatically to each of the programme companies. And let each listener, on paying his fee, nominate one of the three companies to receive the final 25 per cent. of his fee. These details are, of course, only illustrative of a general principle by which the interests of the State could be combined with a healthy liberty of development for the youngest art.

ULTRA-VIOLET RADIATION

Variation Over the Sunspot Cycle

IN a recent letter to *Nature*[1], J. R. Ashworth gives details of a daily record of visible light rays and of invisible ultra-violet rays of a wavelength not much shorter than that of violet light. His records have been made at a site near Manchester for the past 11 years, and thus extend over a full cycle of solar activity.

The sun's ultra-violet radiations are of significance to radio engineers in that they appear to be the principal agency in the production of the layers of ionised gas lying in the high atmosphere which act as a refracting media to short radio waves and thus render possible their use for communication over long distances. As is well known, these layers are much more highly ionised at the sunspot maximum than at the minimum. Sir Edward Appleton has shown, for example, that from the sunspot minimum period of 1934 to the maximum of 1937 the ionisation in the E layer increased by 50 to 60 per cent., and that this implied an increase in the ionising ultra-violet radiation of 120 to 150 per cent.

Violet light is of wavelength 3900 Å[2] and the radiations which perform the work of ionising the atmospheric gases are of much shorter wavelength than this. Ultra-violet rays near in wavelength to those of the visible light are capable of penetrating the gases and of reaching the ground, but those below wavelength 2850 Å do not do so because of absorption by atmospheric ozone. This gas absorbs all the solar radiation down to 2000 Å, and the still shorter waves are absorbed by other gases. Radiations of wavelengths 1250 Å and beyond, towards the far ultra-violet (shorter wavelength), appear to be those responsible for the ionisation of the refracting layers.

At the maximum of the sunspot cycle—when the sunspots and flocculi are much more in evidence on the sun than at the minimum—it would seem that the sun would be in a much more active state than at the minimum and that its radiations of all wavelengths would be stronger. That would account for the big increases in atmospheric ionisation at that period.

But the large variations in the strength of the sun's radiations over the cycle would seem to be largely confined to those of very short wavelength; i.e., those at the far ultra-violet. It has not hitherto been thought that there is much variation in the amount of visible light, for example, over the sunspot cycle, at least at ground level.

Mr. Ashworth's letter states that his measurements—of the daylight and near ultra-violet—do show variations and that they are in an opposite sense, to those of ionisation. For he says that at the last minimum period the rays were of maximum intensity, and decreased to a sharp minimum at the sunspot maximum of 1937, since which time they have again been increasing in intensity. The ultra-violet rays rise and fall over the period more slowly than do the daylight rays. Last year for example, the intensity of the ultra-violet radiation was, in arbitrary units, 720, as compared with 422 nuits in 1937, while the intensity of the daylight radiation was 1,817 units as compared with 764 units in 1937. The intensity of both classes of radiation is still rising as the sunspot minimum approaches.

Impeding the Rays

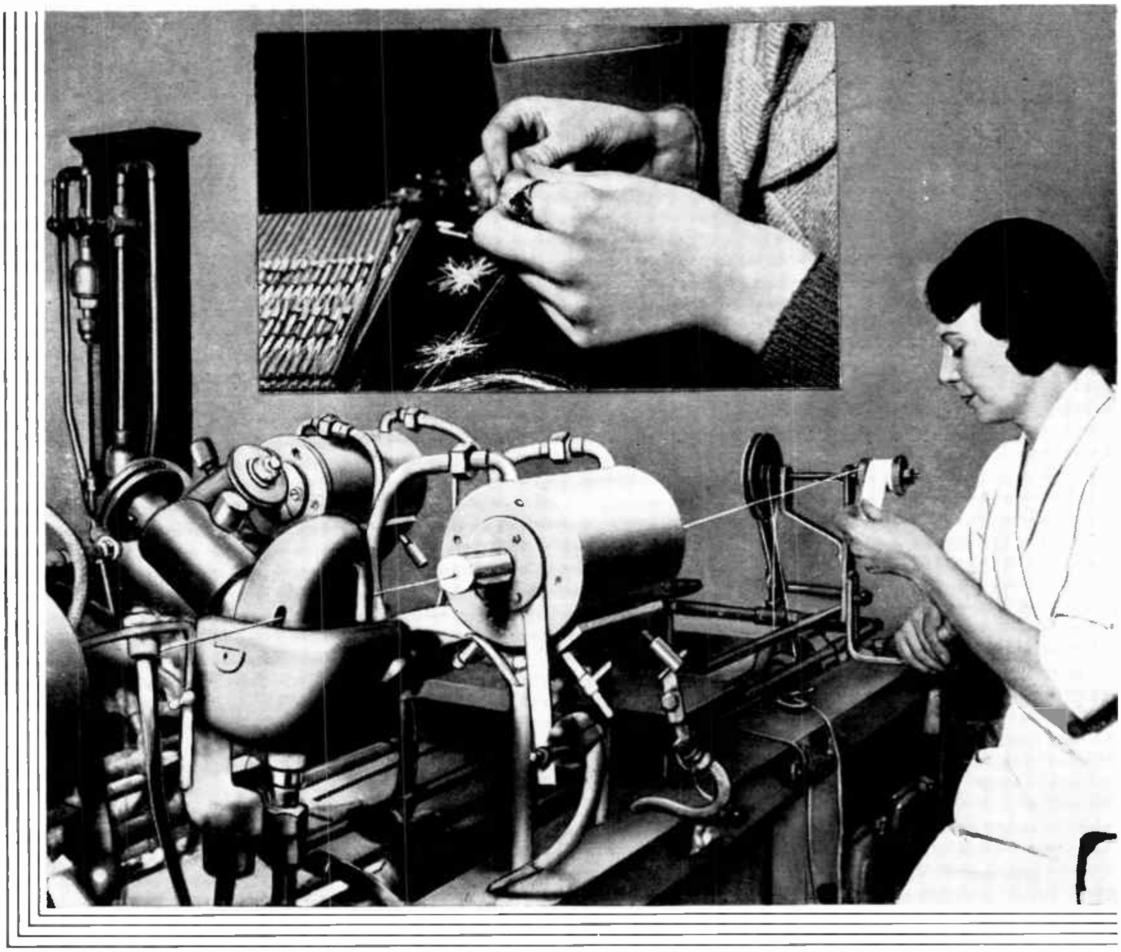
Mr. Ashworth puts forward in his letter a tentative view to account for this apparently anomolous variation in the intensity of the radiations reaching the ground. He says that, though the solar activity may be greater at the sunspot maximum, the rays at that time must be more impeded on their journey towards the earth. And since the atmospheric ionisation is greatest at that time and supposing that the ionisation is, either by itself or by some property of which it is an indication, capable of impeding the passage of the rays, then the reduction in their intensity at sunspot maximum would be accounted for, as also would the increase in the intensity at the sunspot minimum.

In other words, it would seem that effects which accompany the atmospheric ionisation act as a partial shield to the daylight and near ultra-violet rays, and thus cause their intensity at the earth's surface to vary periodically in antiphase to the sunspot numbers and to the atmospheric ionisation itself. T. W. B.

[1] *Nature*, Vol. 152, No. 3855, Sept. 18th, 1943, page 330.

[2] Å = Angstrom unit; 1 Angstrom unit = 10^{-8} cm.

Heater coating



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SIMPLIFYING

THE "QUALITY AMPLIFIER"

Wartime Modifications to a Well-known Design

IN its original form the *Wireless World* Push-pull Quality Amplifier had for its output stage a pair of PX4 valves in push-pull, operated at slightly less than the maker's rating and giving some 4 watts output. They were fed from a penultimate stage having a pair of MHL4 valves in push-pull with resistance-capacity coupling. The power unit was built on the same chassis and arranged for energising a speaker field and running a small receiver for driving the amplifier. No special input system was provided, and the amplifier required an input balanced to earth in the conventional push-pull form. Several feeder units of different types, requiring a single-phase input and delivering a push-pull output, were described for driving the amplifier.

From time to time during the nine years that have elapsed since the amplifier was originally described modified versions have made their appearance. The changes made in these later amplifiers have all fallen into one or other of two categories. Some changes have been made because it has been found that the same performance could be obtained more simply or with an economy of material. Among these, the most notable is the adoption of a common cathode-bias resistance for each pair of push-pull valves, leading to the saving of one resistance and two electrolytic condensers in each stage. Other changes have occurred because valve makers have changed the rating of their valves. PX4 valves, for instance, were changed from a rating of 48mA at 250 volts to 48mA at 300 volts. By adopting the higher rating a considerable increase of output became possible.

Initially the PX4 valves were operated at 250 volts, 35mA apiece. This was adopted chiefly because the maximum current rating of a single rectifier valve at that time was 120mA, and it was desired to have a reasonable surplus current for the rest of the apparatus. It was found, too, that a really undistorted output of 4 watts was obtainable, and this was considered to be ample for nearly all domestic requirements.

At the present time there are many of these amplifiers in existence, and even now one would be hard put to it to design one having a better performance. The purpose of this article, therefore, is not to indicate any improvements that can be made, but rather to stress the simplifications which are possible without affecting performance. This is particularly necessary at the present time because components are hard to get and, in the event of a breakdown, it may be found desirable to rearrange the amplifier to a more economical circuit than the original one.

The amplifier is still based on the PX4 valve for the output

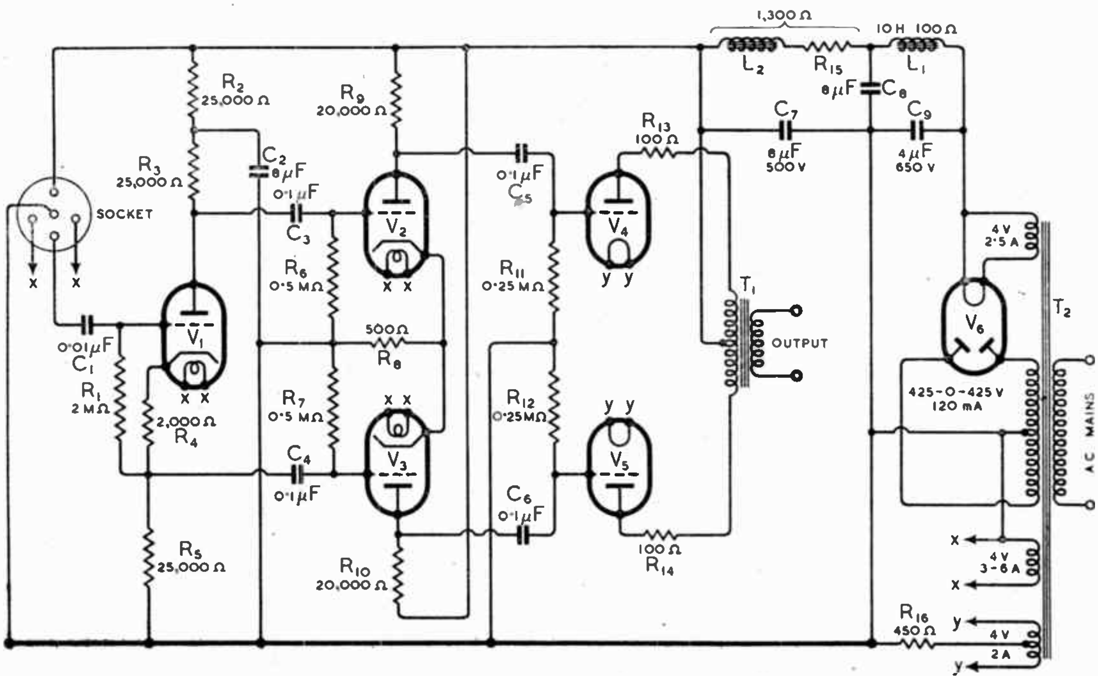


Fig. 1. A wartime version of the Quality Amplifier; complete circuit diagram with values, including phase-splitting input stage. The rectifier valve V6 may be a U12/14 or similar type. Except where otherwise indicated, the voltage rating of condensers should be not less than 350 volts, while resistances can be the usual ½-watt type.

D

Simplifying the "Quality Amplifier"

stage. In the interests of valve life, it is recommended that the original rating adopted for this amplifier of 250 volts, 35mA be employed. The life at the maker's full rating is quite a reasonable one, judged by peacetime standards. But, at a time when one is lucky if one can obtain a replacement at all, this is not good enough, and it is a wise plan to extend the life by under-running the valve somewhat. The anode dissipation at the recommended conditions is only 8.75 watts per valve.

The circuit diagram of the complete amplifier, including a phase-splitting input valve, is given in Fig. 1. If the coupling resistances and valves are balanced, the amplifier in whole and in part is balanced, and feed-back effects do not occur in spite of the lack of decoupling. In practice, even if perfect balance is not achieved, the overall unbalance is not great. The common cathode resistances help here. In a push-pull stage having a common cathode resistance, if one side amplifies more than the other, so that the alternating anode current of one valve is greater than that of the other, there is negative feed-back on the higher gain valve and positive feed-back on the lower gain valve. There is thus an inherent self-balancing tendency in each individual push-pull stage.

An amplifier built to this circuit diagram has been in regular use for the last five years with complete satisfaction. During this time the only repair or replacement needed was to one electrolytic condenser in the smoothing circuit. The original valves are still in use. By adopting this economy circuit, therefore, one need have no fear of any deterioration of performance or reliability.

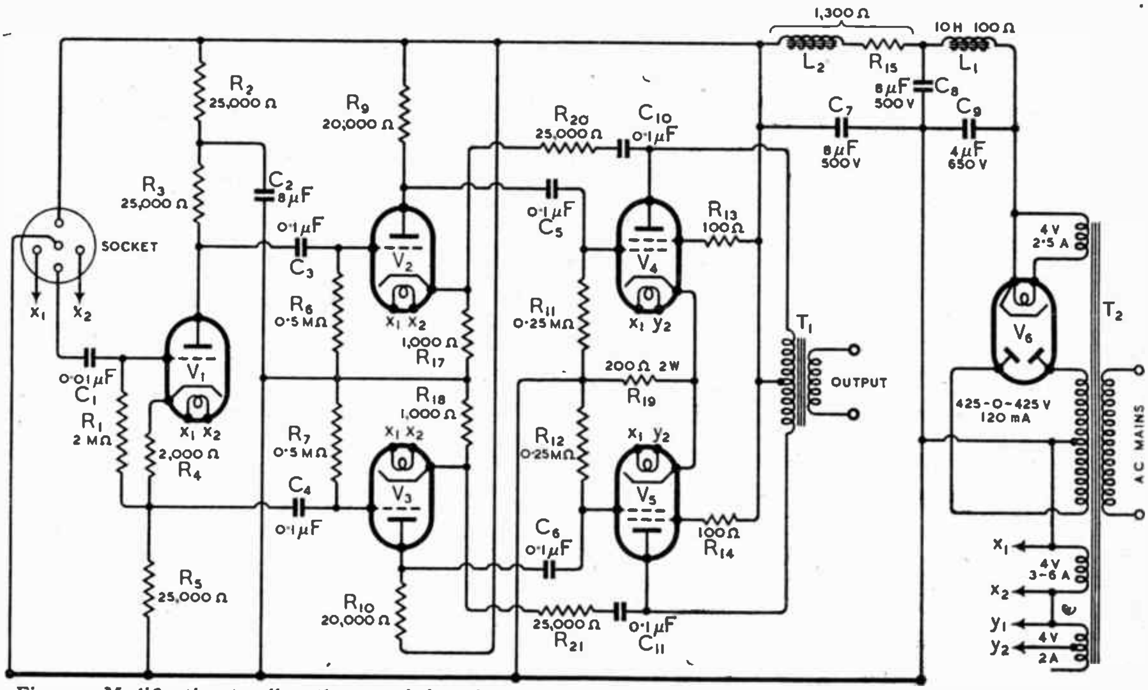


Fig. 2. Modification to allow the use of American-type tetrodes in the output stage, with negative feedback. In this form, the output of the amplifier is about 6 watts. An indirectly-heated rectifier (MU12/14 or similar) should be used in order to obviate undue HT voltage rise.

Leaky Coupling Condensers

A word of warning is advisable in connection with the coupling condensers, however, and this applies to any resistance-coupled amplifier. "New" condensers available to-day are probably old stock, and condensers from the junk box are certainly old stock. If the condensers have not been stored in a really dry place it is quite probable that a certain amount of moisture has found its way inside, with the result that they leak somewhat. An old condenser from a set which has been in regular use is less likely to leak than one which has been stored away in a drawer, because the internal heat in the set will have tended to keep it dry.

If a coupling condenser leaks, it means that a part of the steady anode voltage of the previous valve is applied to the grid of the next, seriously affecting its operating conditions. In the case of the early stages no damage is likely to result, because the various circuit resistances limit the current to a reasonably safe value. With the output stage, however, matters are very different. A leak in a condenser coupling to the grid of an output valve may result in such a heavy anode current that the valve will soon loose emission. When that occurs the other output valve will be under-biased and may also be damaged.

It is, therefore, very necessary to check coupling condensers for leakage. This can readily be done in the amplifier itself. Place a milliammeter in the anode circuit of the valve immediately following the condenser, and note its reading carefully. Then short-circuit the grid leak of that valve. The reading now obtained should be identical with the first; if it is lower, the condenser is almost certainly leaking and should be discarded. The test is somewhat better if the valve immediately preceding the condenser is removed, since a somewhat higher voltage is then applied to the condenser.

If one cannot replace a slightly leaking condenser at once, one should keep a careful watch on it and check it regularly, for small leaks almost invariably become big ones in quite a short time. For instance, if it is found that the current of one PX4 valve drops from 36mA to 35mA on short-circuiting its grid leak, one would have no cause for worry, provided that one could be sure that the condenser would get no worse. The difference in performance caused by such a leak would be negligible, but there is a strong probability that within a few weeks the leakage would so increase that the life of the valve would be seriously endangered.

Considerable latitude is possible in the mains equipment. The transformer rating shown provides sufficient surplus voltage duced to about 350 volts only. This will permit the rating of the reservoir condenser C9 to be reduced to about 500 volts. On the other hand, if a transformer of higher voltage is available, there is no reason why it should not be used provided that the value of R15 and the rating of C9 are increased appropriately.

Substitute Valves

All this is satisfactory as long as one has PX4 valves to use in the output stage. The early stages, including the phase-splitter, are not critical, and while the MHL4 type is recommended, the MH4 or equivalent types can be substituted with but little effect provided that the push-pull pair are of the same type; component values are unchanged.

As the maker's rating of the PX4 valve exceeds 10 watts, even replacement valves are not obtainable without a licence. Even then they are hardly easy to get. It is, however, possible to use the American type 6V6G, and this is shown in Fig. 2. It is necessary to find by trial the correct connections for the "PX4 winding" since the voltage applied to the 6V6G valves will be either 6 volts or 2 volts according to whether the two windings assist or oppose each other. The difference is large, however, and there is no difficulty in deciding by the brightness of the glow of the cathodes which are the correct connections.

The 6V6G is a tetrode. It can be used as a triode by strapping screen and anode. Unfortunately, it is not nearly such a good triode as the PX4, and a pair will not give much more than 2 watts output. Ample output with low valve distortion can be obtained using the valves as tetrodes, however, but, because of their high AC resistance, transformer distortion will be high unless negative feed-back is used.

Feed-back is easily introduced, and the simplest arrangement is shown in Fig. 2. Independent cathode resistances are now used in the penultimate stage, and a

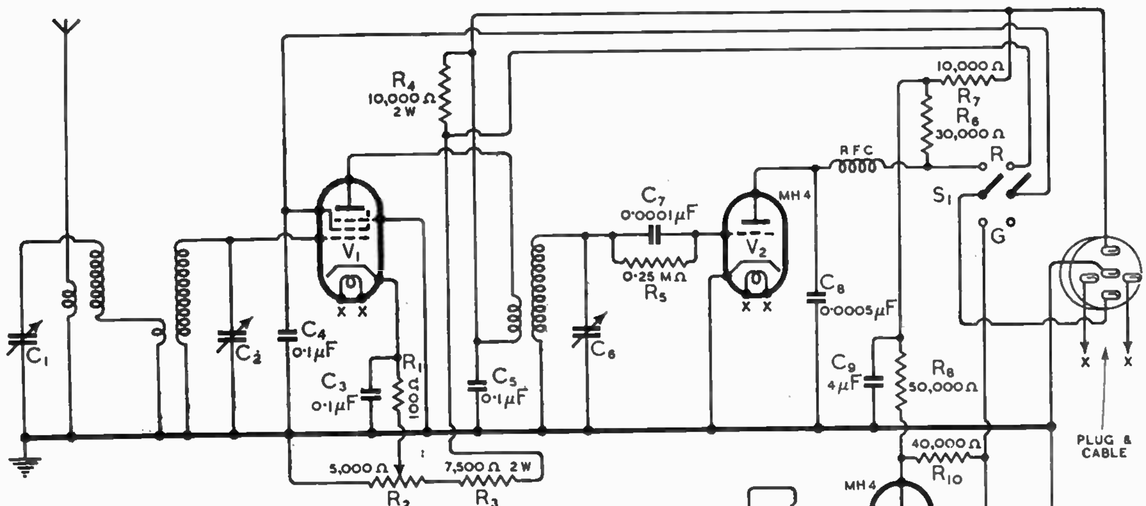
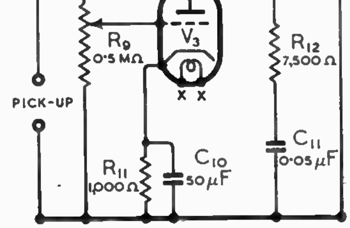



Fig. 3. A radio-gramophone unit for use with the amplifier, to which it is connected by the multiple plug shown. C10 should be an electrolytic condenser of 12 volts rating.

for energising a 1,250-ohm speaker field and sufficient current for a reasonably large receiver to drive the amplifier. The speaker field itself is, of course, connected in place of L2 and R15. If it is not desired to energise a field, these components are needed for smoothing and to drop the voltage to the correct level. Alternatively, and more economically, the resistance R15 can be omitted and the mains transformer winding re- believed to be more readily obtainable. A licence is also needed for this valve.

The 6V6G is an indirectly-heated beam-tetrode with a 6.3-volt heater and an octal base. It is, therefore, necessary to change the valveholders and to arrange for a 6-volt heater supply. This last is easily done, for 6 volts can be obtained by connecting one-half of the "PX4 winding" in series with the 6-A winding, as resistance and condenser in series are connected from each output valve anode to the cathode of the valve feeding it. The values shown give an effective output resistance about equal to that with PX4 valves, and a similarly low distortion level is secured. With 1,000-ohm cathode resistors for the MHL4 valves, the feed-back resistors R20 and R21 should be 25,000 ohms.

Using this arrangement the performance, with one exception, should be the same as that of the original amplifier. The exception is in the input required, which will be nearer 7 volts peak than the original 3.5 volts. The reason for this lies partly in the lower mutual conductance of the 6V6G valves. It is a fortunate circumstance that the 6V6G valves need the same load impedance as the PX4 type under the conditions adopted—namely, 10,000 ohms total—so no change in the output transformer is required.

Turning now to methods of feeding the amplifier, the possibilities are so many that one cannot do more than indicate briefly some of the arrangements. For gramophone, a single-stage pre-amplifier giving bass-boost to correct recording deficiencies is all that is necessary in most cases. Two stages may be needed for an insensitive pick-up.

This arrangement with a simple receiver is illustrated in Fig. 3, where R9 is the gramophone volume control and V3 the pre-amplifier. R12 and C11 give a fixed degree of bass boost, and S1 is the radio-gramophone switch.

The receiver is a simple RF-detector set without reaction and with three tuned circuits. Selectivity is ample for local reception, and the gain is sufficient for short-distance work with even a very poor aerial. The set is not intended for anything but the reception of nearby stations. Gain control is carried out by varying through R2 the cathode bias on the RF valve, which should be of the variable-mu type.

Separate valves are used for the detector and the gramophone pre-amplifier in order to save switching in RF circuits. This circuit was adopted largely because an existing receiver was modified, and it was necessary to avoid altering the panel layout. The extra switching needed to make the detector act as the gramophone pre-amplifier and so save a valve, could not readily be introduced, and it was simpler to use an extra valve than to carry out extensive mechanical alteration of the set. Actually, it is not as uneconomical as it looks.

BOOK REVIEW

Radio Receiver Design. By K. R. Sturley, Ph.D., B.Sc., A.M.I.E.E. Pp. 435+xii. Published by Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 28s.

This book is one-half of a complete whole which is yet to be. On account of the war only Part I has so far been produced, and this deals with receiver design from the aerial to the detector, but not beyond. The AF amplifier, power supply circuits, television and frequency-modulated receivers are to be dealt with in a future volume.

The book opens with a discussion of general principles, in which modulation forms are described somewhat briefly. Valves are then dealt with. This chapter starts by explaining the principles involved, goes on to treat the method of drawing load diagrams on the valve characteristic curves, and concludes with a long and detailed analysis of the effect of valve inter-electrode capacities.

Aerial coupling circuits are very thoroughly treated, and from an eminently practical viewpoint. In common with the rest of the circuit discussion, the treatment is mathematical. The beginner, however, should not be deterred by this, in spite of its apparent complexity—wherever one opens the book one can hardly fail to see at least one equation. Most of the equations can be followed readily with a knowledge of simple algebra, to which is added a smattering of complex numbers. To help the reader who is unfamiliar with the latter, they are simply described in an Appendix on the "j" notation.

RF amplification, and later IF circuits, are dealt with not purely from the circuit point of view, but also taking into account those effects of curvature of the valve characteristics which are likely to result in distortion and cross-modulation. Similarly, in the case of frequency-changers, the treatment is more than elementary. Oscillators and tracking methods are dealt with, and here a minor misprint occurs. On page 254, the last equation should clearly be $G+jB$ and not $+GjB$.

The last chapter is on detection and the diode is accorded place of honour—fittingly so, because it is not only the most widely used detector, but also the most fundamental. Grid and anode-bend detection are treated in the usual way as extensions of the diode.

The book contains a wealth of information which will be extremely useful to the serious designer. Since it is actually only one-half of a book, it has a somewhat incomplete air. There is, of course, no reason why a book covering just this ground—aerial to detector—should not be a complete unity, but this one is unmistakably Volume I. The author gives no indication as to when the second volume may be expected. It is to be hoped that its production will not be long delayed, for, although the discussion of the early circuits in this present volume is actually quite complete, the chapters correlating it into a whole are lacking, and these will doubtless be included in the second half.

W. T. C.

"WAVE GUIDES"

I.E.E. Paper and Discussion

WITH the extension of operating frequencies into still higher regions of the spectrum the notion is gaining ground that a dielectric rather than the usual metallic conductor is the best means of "piping" energy from one point to another. Thin-walled metal tubes in which self-propagating electromagnetic waves are launched and directed are taking the place of paired conductors and concentric cables.

The theory of wave guides is complex and a knowledge of mathematics is necessary in order to assimilate much of the work which has been done on the subject since 1936. The paper which was read by J. Kemp and discussed by the Wireless Section of the Institution of Electrical Engineers on November 3rd filled a long-felt need in giving a readable account of present published knowledge in non-mathematical terms. Practical methods of launching waves in guides, detecting their form and coupling the energy to horn-type radiators were discussed, and it was pointed out that one particular mode of propagation (the H_{01} wave) has the remarkable property of decreasing attenuation, ultimately tending to zero, as the frequency is increased. Unfortunately this property disappears if the cross section of the guide deviates in the slightest degree from a perfect circle.

In the discussion a plea was made for early standardisation of the terms associated with the new technique and in particular those used to define the many possible forms taken by waves in guides.

GOODS FOR EXPORT

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

BASIC FAULT-FINDING

Methods of Training Army Service-men

By E. WILKINSON, Ph.D.
(Loughborough College)

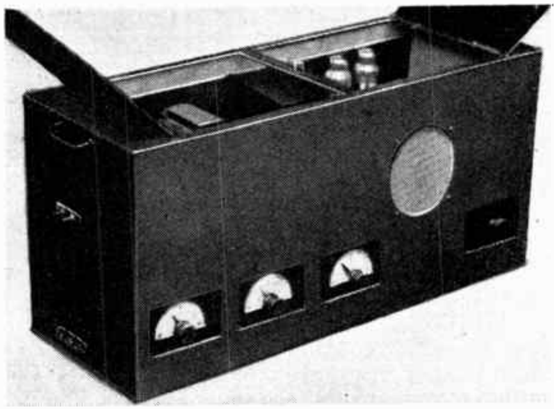
ABOUT a year ago a brief description was published in *Wireless World** of apparatus suitable for organised instruction in fault-finding technique for large groups of Army service-men, now called "Telecommunication Mechanics." At that time the idea was being developed further, and it has now become a fairly complete training scheme dealing practically with the underlying principles of systematic fault location.

Before describing the major additions to and improvements in the method, it may be well to mention briefly how this work falls in line with other training, because it is, of course, only a part, though an important one, of intensive basic training courses.

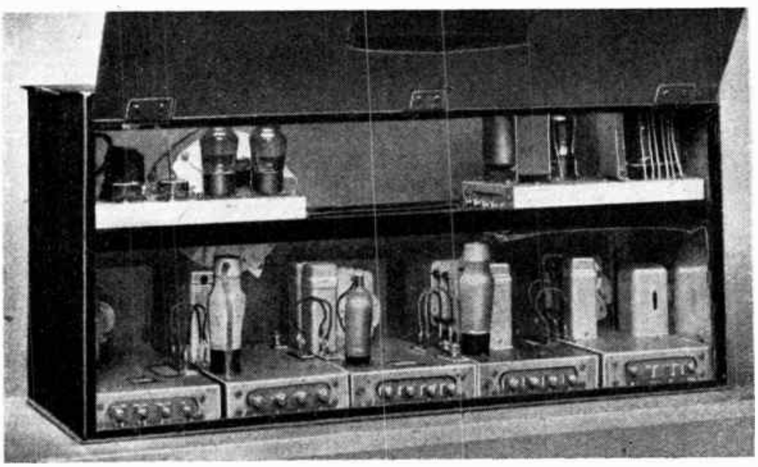
The full training has generally been completed in two stages. Final training is undertaken in military schools, where the actual army equipment is used for instruction and exercise. But before this the trainee will have received a rather longer course of basic instruction. It is longer because the majority of the men have had no previous experience of radio or even perhaps of science or craftsmanship. Their experience in civilian life will have ranged from building mansions to cutting out pearl buttons, and from teaching mathematics to driving omnibuses. The basic courses have been mainly undertaken by the Technical Colleges under civilian supervision. During this part of the training theory is taken through DC and AC up to a good general knowledge of radio, with perhaps particular stress laid on certain circuits that may later be encountered in army equipment, but with the chief emphasis given to a non-mathematical explanation of principles. Parallel with the theoretical training runs workshop instruction and laboratory work designed both to consolidate the theory and also to accustom the trainee to think for himself when his apparatus will not work.

The training apparatus described in this article was made at Loughborough College, and is among that used during the laboratory periods at the College. It consists of three types of training chassis. First there are small metal chassis with a circuit formed by a number of components wired "blind" perhaps and awkwardly situated, intended mainly to give practice in circuit tracing and simple "cold" fault testing. These are not regarded as important in themselves, but they are a useful introduction to the second type of chassis, a single metal chassis incorporating a workable wireless circuit of from one to three valves and intended for "hot" fault finding, i.e., for thoughtful interpretation of symptoms and meter readings instead of a tedious test of every component to isolate trouble. Thirdly, there are seven-stage receivers and four-stage transmitters to give practice in the speedy isolation of a faulty stage on a complete apparatus preparatory to further investigation in that stage.

The first type of chassis gives practice in circuit tracing and recognition of components. All tests on these chassis are "cold"



Front view of the superheterodyne. Note the windows in the front panel of the containing case, through which the controls on individual units appear.



This rear view of the superheterodyne receiver illustrates the unit assembly. Any of the seven stages may be replaced quickly by faulty units, which the trainee must identify and put in order.

* September, 1942.

Basic Fault-finding—

tests, i.e. the circuit is not working while the investigation is proceeding. In fact, most of these chassis are not even intended to work, being merely components linked together in a perhaps unconventional way.

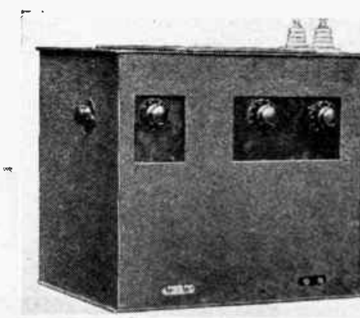
The second type is similar to that described in the previous article. Each set is built on a metal chassis with a sub panel on which most of the smaller components are mounted. Components are soldered, not directly into the circuit, but through short connecting links at either end, as may be seen in the photograph of the transmitter-modulator unit. Up to 15 components may be mounted and one or two spaces are left free for replacements. Faulty components are not removed completely from the set; that would soon result in their loss or destruction since, it must be remembered, any set is likely to be used scores of times. Instead, the faulty component is taken out of the set electrically by unsoldering one or both of the end connectors. A replacement is obtained from stores, soldered into a free position and cross-connected to the outer wiring points, now freed, of the original component. This method of organisation allows a wide variety of faults to be included in different chassis, and also of simple cataloguing. Checking of the correctness of repair requires nothing more than reference to a key of the necessary cross-connections against which the trainee's wiring may be compared. The trainee is restrained from interfering with the circuit external to the sub-panel, though he may take tests at any point. Otherwise the circuit would ultimately be damaged. In order to make this clear, all soldered connections that are not to be touched are lacquer painted, leaving free only the inner soldering tags, normally the terminating points of the connecting links and up to 60 in number. This limitation may appear to be somewhat artificial, but experience shows it is very necessary, and this slight difference from routine field procedure is of little consequence.

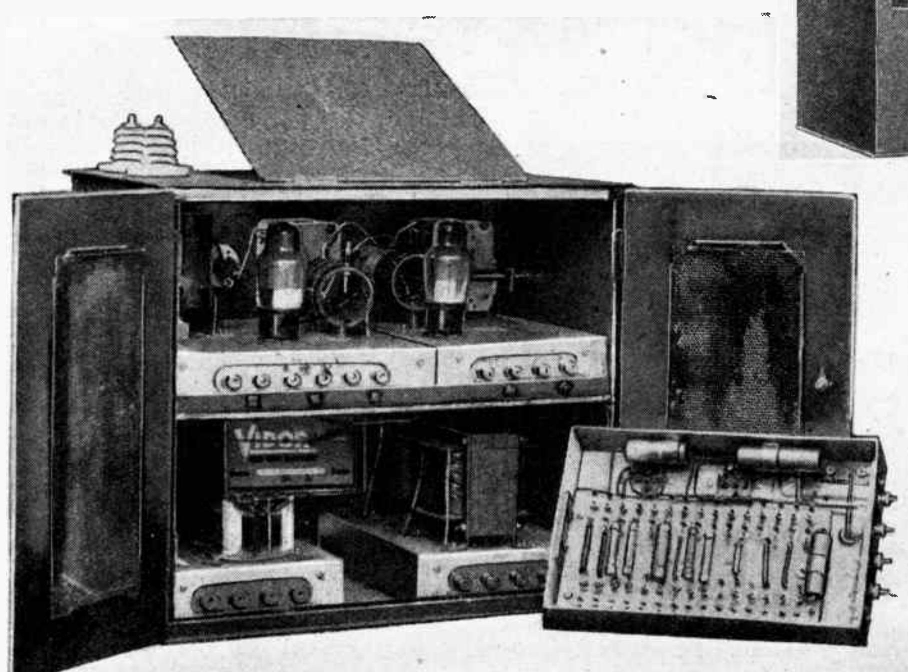
When the repair is completed, the apparatus may be worked and its performance investigated. It is then brought back to its normal, faulty state, merely by returning the links to their original positions; namely, straight across.

Circuits Available

There are about 50 chassis of this kind in use and with those belonging to the complete transmitter and receiver, which may be used as single stages, the number is brought up to approximately a hundred. The circuits include a two-valve super-regenerative receiver, two- and three-stage straight receivers and part circuits such as cathode followers and multivibrators.

The major recent addition has been the building of a seven-stage superheterodyne receiver and of a four-stage transmitter. The stages are separate units that fit together to form the complete apparatus. In the case of the receiver they are band-pass tuner, RF amplifier, triode-hexode or diode mixer, IF amplifier, diode or triode detector, output stage and power pack. These seven stages are inserted in a steel cabinet. Connection between stages is effected by plugs, and power supplies are fed from the power pack through wiring mounted in the cabinet and brought out to spade connections that serve also to locate the stages in position in the cabinet. Tuning and other controls are brought through the front of the cabinet by using false front panels on each such stage. These panels butt up against a suitably shaped win-





The four stages in this transmitter assembly are power-pack, modulator, oscillator and triode power amplifier. An extra modulator unit is shown from underneath to demonstrate the construction of the all-important sub-panel on which the fault corrections are made. Inset is showing the front of the transmitter; on the left are amplitude and frequency controls for the oscillator. On the right are the two tuning controls of the pentode power amplifier stage.

dow in the cabinet. A stage may be changed in a few moments and replaced either by a different type of circuit (if mixer or detector) or replaced by a faulty one. Each stage is built at least in triplicate, one stage being in perfect order, one having a single fault and one having two faults. Since two complete receivers are used simultaneously rather more good stages are required, but the number provided is about sufficient since good stages may easily be produced by cutting out faults. In fact, a few extra good stages have been made in addition to those mentioned. It is interesting to note how many different faulty sets may be built up on the assumption that each stage is available in triplicate. There are seven stages, and a little simple arithmetic will show that if not more than two faulty stages are incorporated then 158 fault combinations may be selected. Extending the limits to include the possibility of three singly faulty stages the number rises to over six hundred. At times the doubly faulty stages are converted to singly faulty ones by correction of one fault. This raises the number of different faulty receivers that may be used to the appreciable figure of nearly fifteen thousand.

However, the apparatus is used, there is at least a great freedom of choice of fault and no chance of what might be termed "illegal" fault location. The complete receiver gives practice in the isolation of faulty stages, and it is required of trainees that they pick out a faulty stage and attempt to find the fault before removing the stage from the containing cabinet for further testing. In this part of the training "cold" testing is regarded as a last resort when "hot" tests have either failed or have isolated the fault as narrowly as possible; for instance, to a dead short appearing across bias resistance and condenser. In order to discourage illogical guesswork in looking for the fault, test sheets are filled in simultaneously with the carrying out of tests, and these should show that a systematic procedure has been adopted. Without going into detail here about procedure, it may be summarised as "work from the back end of the receiver to the aerial" and "test the DC conditions of a faulty stage before AC." Usually a trainee is supplied with a multi-range meter and perhaps a signal generator or a cathode-ray oscillograph as test instruments.

Part of the Basic Training Laboratory at Loughborough College, showing two faulty receivers and one of the faulty transmitters undergoing training repair. A signal generator and a multi-range meter are being used as test instruments with the receivers and an oscillograph with the transmitter.

Four-unit Transmitter

The transmitter is based on the same general layout. It consists of power pack, modulator, oscillator and amplifier stages. The oscillator may be chosen as either a Hartley or Colpitts oscillator, and the amplifier is either a neutralised triode with anode or grid modulation, or else a pentode with suppressor grid modulation. A special additional chassis includes a 100 to 300 Mc/s push-pull frequency trebler.

The general layout of the transmitter may be seen in the photograph, where a replacement stage for the modulator is shown from underneath to give an indication of the sub-panel construction.

The number of these chassis tackled by the average trainee during his course is about seven, in addition to his other experimental work. As to the detailed faults and fault combinations that are incorporated, little need be said, since most possible faults are included in the nearly 100 separate chassis. Faults in large components, such as power supply transformers, appear perhaps less frequently than in smaller components, since organised replacement is not so simple.

It is found that this training not only gives practice in fault location, but also encourages the men to think more deeply about the working of the circuits than they would with apparatus already in working order.

Finally, the training is supplemented by the real jobs that come in periodically and also by the repair of the "accidents" that any amount of intensive training cannot completely eliminate.

THE WIRELESS INDUSTRY

FUSED joints between instrument wires have advantages over soldered joints in some applications, particularly where resistance alloys are concerned or where flux is undesirable. The "Fuzit" electrode wire jointing tool has been developed to facilitate this work and is described in an illustrated leaflet issued by Stanelco Products, Ferndown, Northwood Hills, Northwood, Middx.

Multicore Solders, Ltd., have moved to Commonwealth House, New Oxford Street, London, W.C.1. Telephone: Chancery 5171/2.

De La Rue Plastics, Ltd., have acquired the shares of Hammans Industries, Ltd., manufacturers of insulating materials.

We have received from Ardente Acoustic Laboratories, Ltd., Guildford, a copy of an illustrated catalogue describing their "Loud Hailer" power projector loudspeaker equipment and its applications.

The London office of Ferranti is now at 36, Kingsway, W.C.2. The old telephone number, Temple Bar 6666, is retained, but the telegraphic address is changed to Ferranti, Westcent, London.

Dr. A. H. Rosenthal, who was connected with Scophony, Ltd., of London, and contributed some of the more important Scophony inventions, has been appointed director of research and development of the Scophony Corporation of America.

CINEMA SOUND QUALITY

Analysis of Architectural Designs by Impulse Tests

By J. MOIR, A.M.I.E.E.

(Research Dept., The British Thomson-Houston Co., Ltd.)

(Concluded from page 323 of the last issue)

THE frequency characteristic as measured with normal equipment may not represent, even to an approximate degree, the quality of the sound which is heard. Measurements are usually made under steady conditions, whereas in practice the ear picks up sound which is rapidly changing and is more often composed of transients.

It appears probable that the ear estimates the direction of approach and frequency response by the characteristic of the sound arriving during the first few milliseconds. Existing measuring equipment will average over a much longer period, including in the sum the direct sound and the reflected sound reaching the microphone over a period corresponding to the operating time-constants of the instruments. The frequency characteristic of the reflected sound is entirely different from that of the direct sound, the proportion of the high frequency decreasing at every reflection. On this hypothesis measuring equipment having the directional characteristics and time-constants of the ear is required to obtain a true record of the effective response, and it is to be expected that such measuring equipment would show a better response in the high-frequency end than is obtained with the normal recording equipment.

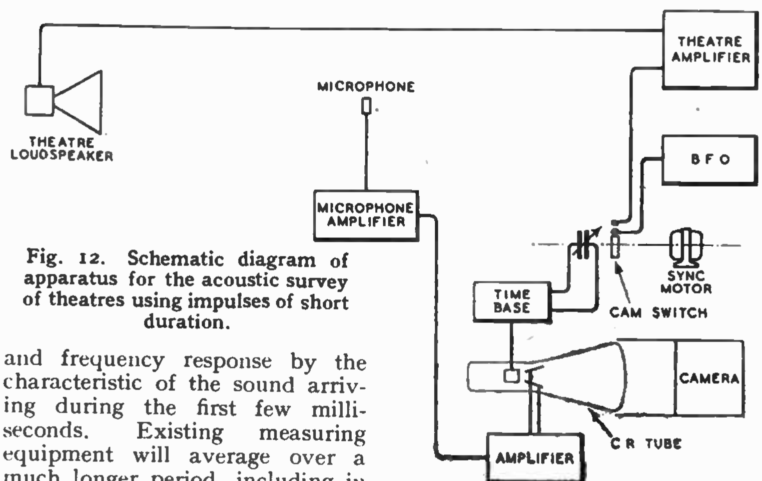


Fig. 12. Schematic diagram of apparatus for the acoustic survey of theatres using impulses of short duration.

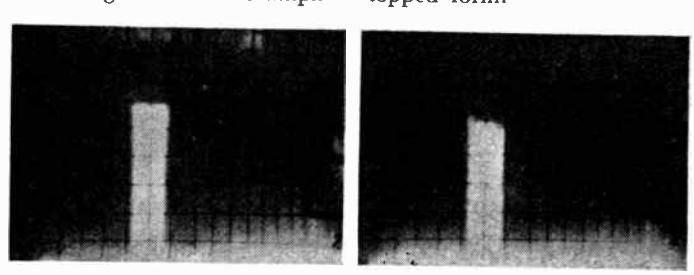
Investigation of Sound Measurement by Impulses

A new line of investigation was undertaken in which the paths taken by sounds of short duration in the auditorium are traced out by means of impulses applied to the loudspeakers. The technique is as follows.

The output from a beat-frequency oscillator is applied to the theatre amplifiers through a continuously working cam-operated switch. Adjustments are provided enabling the duration of contact to be controlled from 0 to 0.05 sec. The impulse therefore consists of a train of waves the frequency of which is determined by the oscillator setting, and the duration of which is controlled by the adjustment of the cam switch. The impulse is transmitted through the theatre amplifier to the loudspeakers in the auditorium, and a microphone is located in the auditorium to pick up sound. The output from the microphone is amplified and applied direct to the vertical deflector plates of a cathode-ray tube. The horizontal deflector plates are connected to a time base which is synchronised with the rotation of the cam which operates the impulse switch. A diagram of the complete set-up is shown in Fig. 12. Impulses are applied at intervals of about 1 sec., so that reflected sound decays to a negligible value before the next impulse. The horizontal time scale is arranged for a sweep time of 0.5 sec.

Except at very low frequencies, individual waves in the wave train comprising the impulse cannot be seen individually, but the complete impulse appears as a luminous vertical band on the screen of the cathode-ray tube.

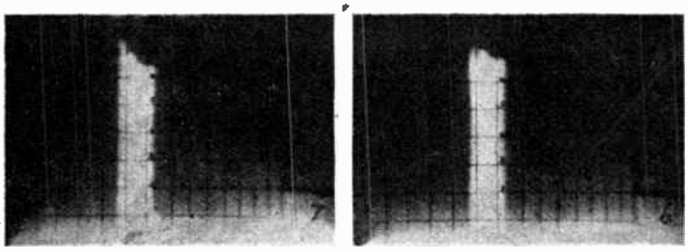
A typical impulse injected into the amplifier is shown in Fig. 13(a), while Fig. 13(b) shows the same impulse at the output stage of the amplifier. It will be noticed that the impulse is distorted a negligible amount in the amplifier. Fig. 14 shows the same impulse as picked up by a microphone in front of a high-frequency loud speaker fitted with a multi-channel horn, in an acoustically dead room. Fig. 14(a) is taken with the microphone located on the horn axis, and Fig. 14(b) with the microphone 30 deg. off the horn axis. It will be noticed that the impulse is still not unduly distorted and retains its square-topped form.



(a) (b)

Fig. 13. Oscillogram of typical impulse (a) at the input and (b) at the output of the theatre amplifier.

The impulses shown in Fig. 14 were taken with the microphone located 6ft. from the loudspeaker in an acoustically dead room. The length of impulse used was about twice that which had been used for investigations in auditoria. Images picked up by the microphone for typical conditions in a few types of auditoria will now be considered.



(a) (b)

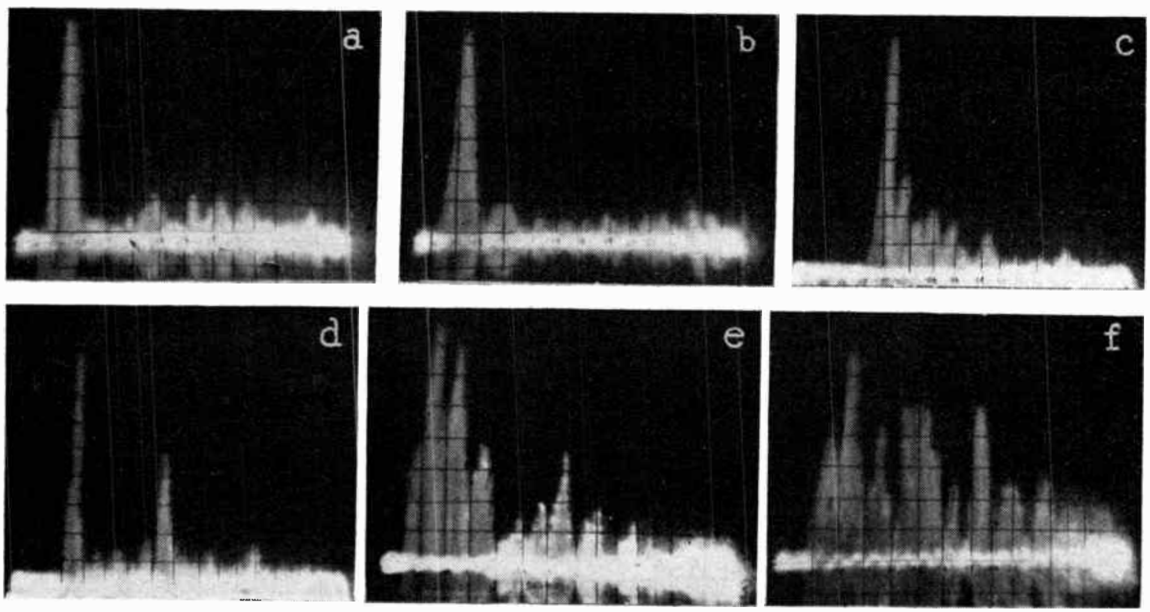
Fig. 14. Oscillogram of sound impulse picked up by a microphone in front of a multi-cellular HF horn loudspeaker in an acoustically dead room (a) on the axis and (b) 30 deg. off axis.

Impulse Measurements in Typical Auditoria

The oscillographic records for a reverberant room show the initial impulse received direct from the loudspeaker, followed by the reflected sound impulses from the walls and ceiling. A study of the time interval between these impulses enables the reflecting surfaces to be located and the sound paths to be determined.

Figs. 15 (a) and 15 (b) show two cathode-ray tube images obtained in a large theatre where sound quality was uniformly very good. Diagrams of this auditorium are given in Fig. 16. Sound-absorbent treatment is confined to the rear walls, the floors being heavily carpeted and the seats being of a luxurious type with high sound absorption. It can be seen from Fig. 16 that the shape of the auditorium is such that for a position A there is little change of anything but directly incident sound being picked up. Direct reflections from side walls or ceiling are not possible. This is illustrated in Fig. 15 (a); where the initial impulse is seen to have reflections of a negligible order. Position B (Fig. 16) at the front of the balcony indicates a possibility of some reflection from the ceiling, and this is shown in Fig. 15 (b). The reflection, however, is of a small amplitude and is separated from the fundamental by a very small time interval and does not cause any deterioration in sound quality. At the side of the theatre in position C the possibility of multiple reflections is high, but the differences in path length are low and the maximum difference between the subtended angles of incidence is small. For this reason the reflected sound has negligible detrimental effects on sound quality. This point is discussed in more detail later.

Fig. 17 shows an auditorium where sound quality was very



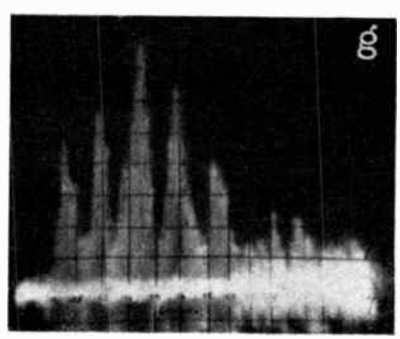


Fig. 15. Typical oscillograms for the theatres shown in Figs. 16, 17, 18 and 19, (a) Cinema No. 4, position A; (b) Cinema No. 4, position B; (c) Cinema No. 3, position A; (d) Cinema No. 3, position B; (e) Cinema No. 5; (f) Cinema No. 6, position 1; (g) Cinema No. 6, position 2.

Cinema Sound Quality—
good, except at a few isolated locations, one of which will be considered. The shape and acoustic treatment of the auditorium is such that the same arguments relating to absence of

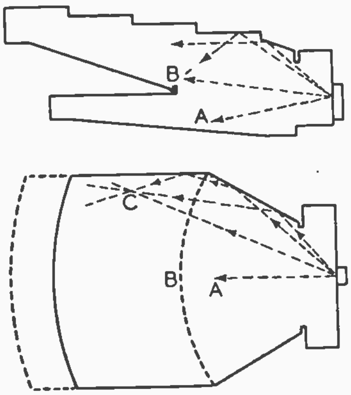


Fig. 16. Cinema No. 4, an example of good acoustic design.

reflections apply as in Fig. 16. Position A (Fig. 17) is typical of this condition, and the corresponding cathode-ray tube image is shown in Fig. 15 (c). One isolated bad spot in the theatre occurred under the front of the balcony, and the cathode-ray tube image for this position is shown in Fig. 15 (d). It shows reflections from the back wall at 80 millisec. delay. A further reflection at 220 millisec. delay, which appears to be due to reflection from the rear wall of the balcony on to the ceiling, and then from the curved proscenium arch and sides as indicated in Fig. 17 (position B), is also shown. Experience has indicated that the echo with less than 45 millisec. delay from the back wall can be tolerated, but that the echo with the time delay greater than 50 millisec. leads to a deterioration in sound quality due to lack of intelligibility. It is interesting to note that the frequency characteristics of the equipment taken at positions A and B are both similar and satisfactory, and do not in any way account for the difference in sound quality. These characteristics have been shown in Figs. 2 (a) and 2 (c).

Fig. 18 and Fig. 19 shows an auditorium where sound quality was of a medium order, the main complaint being lack of intimacy. The shape of the auditorium, as indicated in Figs. 18 and 19, shows a large expanse of flat roof and walls which are parallel for a considerable distance. Sound-absorbent treatment has been applied to the back wall only. For the microphone position shown in Figs. 18 and 19, the cathode-ray tube photograph shown in Fig. 15 (e) was obtained. The timing of the reflected impulses indicates that sound reaches the centre of the auditorium by reflection from the side wall, reflection from the ceiling, reflection from the angular space between side wall and ceiling, and a small amount of reflection from the back wall. Since the time delay of all reflections is relatively short, there is little interference with intelligibility, but the directions from which sound emanates is not well marked, and intimacy suffers accordingly. It will be noticed from the reflected paths shown in Figs. 18 and 19 that the solid angle subtended by the incident sound at the centre of the auditorium is far greater than the solid angle subtended in Fig. 16 (position C), which accounts for the much inferior intimacy in this theatre.

The auditorium shown in Fig. 20 and Fig. 21 is one where the quality of sound is very inferior, intelligibility and intimacy suffering considerably. At two typical positions in the auditorium, the impulse photographs shown in Figs. 15 (f) and 15 (g) were obtained. These indicate large reflections at both short and long time intervals, and the reason for the loss of intelligibility and intimacy is obvious. Both measured

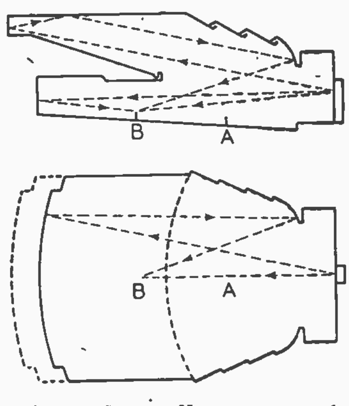


Fig. 17. Cinema No. 3, an example of a theatre showing local sound reflections.

frequency characteristic and reverberation time for this auditorium were quite satisfactory.

Impulse measurements have been made in many auditoria in addition to the above and the same general agreement was found to exist between the aural judgments and the results predicted from the impulse photographs.

General Remarks on Impulse Tests

Much still remains to be done in perfecting the technique, but it does appear that quantitative measurements are possible of factors that until now have only been treated qualitatively.

In all the theatres, observations have been made at three positions close together, and at five frequencies—250, 500, 1,000, 2,000

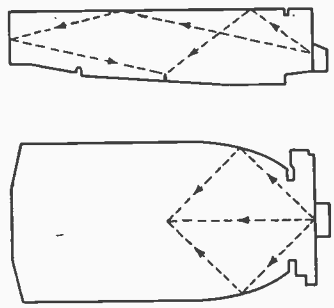


Fig. 18. Cinema No. 5 in which intimacy between sound and vision is poor.

and 3,000 c/s. The measured reflected impulses are then averaged before any conclusions are drawn. The impulse photographs in Fig. 15 are those which approximate most nearly to the average suggested from 15 to 20 observations at each location. There is some change in the type of reflection photograph with changes of frequency, and it is thought that this change with frequency is connected with the peculiar discriminating properties in the sound radiated from the loudspeaker in directions at large angles to the normal axis of the loudspeaker.

It is also noticed that the shape of the initial impulse from the loudspeaker as picked up in an auditorium is inferior to that as picked up under free-space conditions or in the acoustically dead room in the laboratory. This point can be seen by comparing Figs. 14 and 15, and remains to be explained.

Emphasis is placed on the value of the reflection photographs in calculating sound paths in an auditorium. In the majority of theatres it has been impossible to estimate the paths from two-dimensional drawings, and the problem has had to be considered largely as one of three dimensions.

Before the investigation was commenced, the significant features in the shape of an auditorium were not fully understood. From architects' plans, or even an examination of the theatre itself, it had been found impossible to deduce the paths taken by reflected sound. The reflection photographs have proved of great assistance in indicating the actual paths taken by reflected sound in typical auditoria. Accordingly, it is now possible to anticipate with fair accuracy the probable sound paths from the plans of a new auditorium and so to forecast the effects of the hall design on intimacy or intelligibility.

Requirements of Good Auditorium Design

From the data already collected it appears that further major improvements in sound-film reproduction will require closer co-operation between the equipment designer, the acoustical engineer and the architect in order that the maximum performance be secured from the equipment and the theatre considered as a unit. The author feels that equipment development is now at such a stage that the predominant factor in obtaining "good sound" is the control of sound reflections in the auditorium, although, of course, this does not imply disregard of the other factors.

It is realised that in many instances the shape and dimensions of a theatre are fixed by the available site, local regulations, the economic viewpoint, etc., but a short discussion of the ideal requirements may be of interest. There are four acoustic factors to which attention must be paid:—

(1) The reverberation time (theatre empty) should approximate to the optimum curve of Fig. 10.

(2) The shape of the reverberation-time/frequency curve should approximate to that of Fig. 7.

(3) The avoidance of reflection paths which exceed the direct path by more than 45ft. The author's tests have indicated that reflection paths exceeding this length lead to reduced intelligibility.

(4) The unavoidable reflected sound paths should subtend a small angle at any point in the audience. The test results have indicated that large subtended angles lead to poor intimacy.

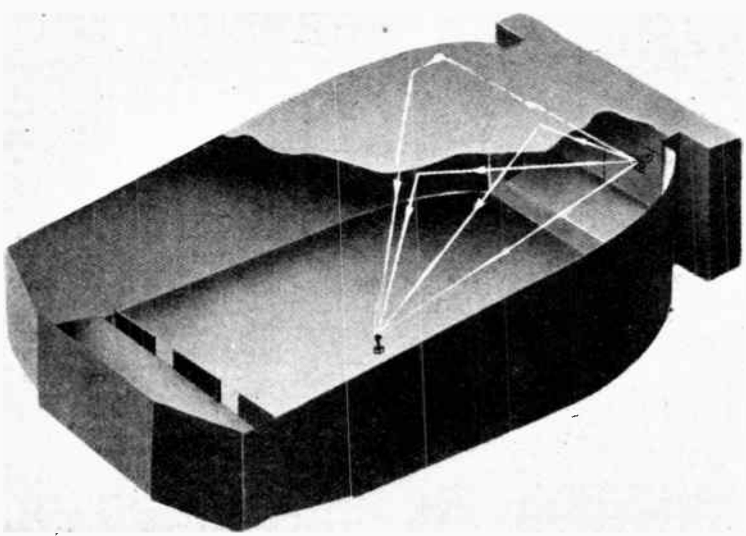


Fig. 19. Perspective drawing of Cinema No. 5, showing sound paths indicated by the oscillogram of Fig. 15 (e).

With present methods of construction and furnishing, (2) is probably satisfied automatically when requirement (1) is taken care of.

With the present standard of construction and furnishing it appears to be impossible to meet requirement (1) with the audience present, but the author is inclined to think that reproduction would be improved if this condition could be satisfied. The same remarks apply to requirement (2).

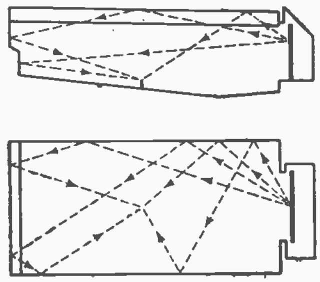


Fig. 20. Cinema No. 6 in which both intelligibility and intimacy were bad.

Condition (3) calls for the avoidance of reflection paths which exceed the direct sound path by more than 45ft., corresponding to a time difference of 40 milliseconds (maximum). This condition must be met in any theatre irrespective of size, and accordingly a standard scale design with a table of multiplying factors cannot be produced. The majority of theatres built during the last few years fall into the 1,000-1,500 seating capacity class, and to meet this range the design of Fig. 22 is suggested.

A balcony type of structure is adopted having the main ceiling stepped down towards the proscenium arch in order to minimise the hall volume and building costs. The reduction of ceiling height towards the proscenium opening has many advantages over the more normal type with the ceiling parallel to the floor. Reflections from the ceiling, back into the audience, follow a path which does not depart seriously from the path of the direct beam of sound from the speaker. In addition, sound incident upon the ceiling is to a large extent scattered by the reflection and diffraction by the ceiling steps which face the stage speaker equipment.

The reverberation times of the

Cinema Sound Quality—
three main spaces forming the theatre tend to be equalised by this construction, preventing sound-energy flow from a space having a high reverberation time into a space having a lower time.

The proscenium opening is splayed into the side walls with an included angle of approximately 80 deg. to maintain a sound-energy flow roughly parallel to the splays. As the hall is intended solely for use with a sound reproducer, the side splays are not intended to reinforce the sound source and indeed must not be used for such a purpose. Consequently, these splays should be broken up by pillars, panels or other reliefs. Non-parallel side walls are maintained up to the rear wall in order to minimise the time required to produce completely diffused sound within the enclosure.

The curved rear wall is eliminated and the rear walls are tilted forward in order to reflect incident sound into the rear seating, compensating for the normally lower-intensity level in the rear seats produced by attenuation from the front to the rear of the hall, and preventing the return of echoes of long delay time to the front of the theatre.

Exits and gangways are placed against the side walls in both balcony and ground floor to occupy space difficult to feed with direct sound.

The question of acoustic treatment is a point of considerable importance. It is the author's opinion that the theatre design should be such that acoustic treatment is not required, reflection of sound being taken care of by breaking up offending surfaces as part of the decorative scheme. From the data presented in the paper it follows that acoustic treatment is rarely required for the correction of reverberation time owing to the luxurious standard of seating and carpeting in the present-day theatre. Placement of a large proportion of absorbent in the seats is advantageous in minimising the change in acoustic condition produced by the audience.

When acoustic treatment is required it should be provided, in the form of strips, small panels, etc., of material having an absorption coefficient in the neighbourhood of 0.25-0.4. These strips should be spaced about the side walls. Concentrated areas of material having high absorption coefficient is wrong. Although leading to the same final reverberation time, the initial decay processes are dissimilar and it will be appreciated that the initial stages occupying the first 20-30 db. of the decay period are all-important. From many points of view it would be advantageous to manufacture floor covering with a lower absorption coefficient, the balance being supplied by side-wall treatment of material having a relatively low absorption coefficient (0.2-0.4). Ceiling treatment is very rarely required and is generally harmful. Sound energy flowing between floor and ceiling is heavily attenuated by the concentration of absorption in the form of seats and carpets, and, consequently, any further treatment should be confined to the walls.

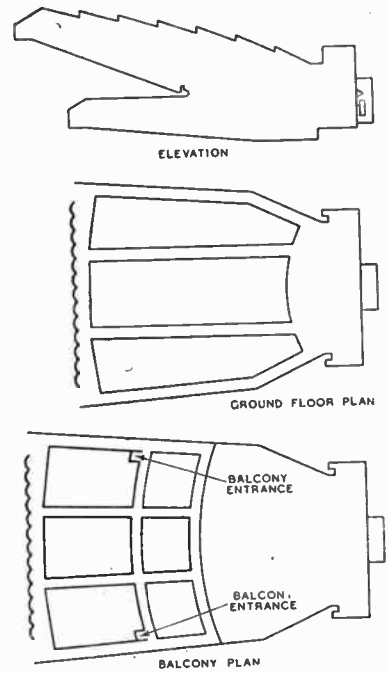


Fig. 22. Proposed optimum proportions and layout for a theatre with a seating capacity of 1,000 to 1,500.

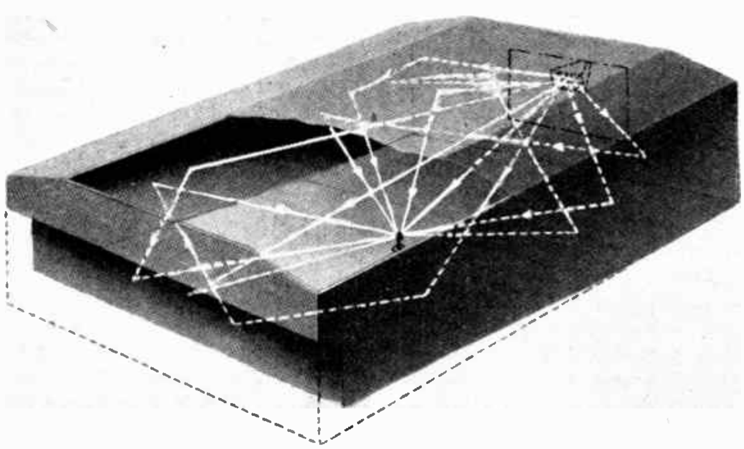


Fig. 21. Perspective drawing of Cinema No. 6 showing muliple reflections indicated by oscillograms of Fig. 15 (f) and (g).

Back-stage volume should be held to a minimum and the speaker placed as far forward and as heavily draped as possible in order to reduce the sound energy present in the back-stage space.

This combination of requirements has not been found in any one theatre, but the more closely they have been approached the more favourably has the sound been received by all concerned.

Acknowledgments

The writer would like to thank Mr. H. Warren, Director of Research of the British Thomson-Houston Co., for permission to publish the results of this investigation, and the I.E.E. for permission to make use of the author's paper published in the I.E.E. Journal.[4]

[4] C. A. Mason and J. Moir: "Acoustics of Cinema Auditoria." Journ., I.E.E. Vol. 88 Pt. III, Sept. 1941.

WORLD OF WIRELESS

"STANDARD SET" DECISION

ASKED in the House of Commons whether sets of simple standard designs were now being manufactured in Great Britain and when these would be available to the public, the President of the Board of Trade replied that "a design had been agreed upon and deliveries of raw materials and components had been planned." He added that, as stated in an earlier reply, no sets of this type would be available until next year.

Incidentally, C. O. Stanley (Pye, Ltd.) is reported as saying recently that "by next March a matter of 250,000 [standard] sets would become available and would be distributed through the usual channels at the rate of 5 per cent. per week."

In reply to a further question, Mr. Dalton announced that between June 1st and September 30th about 14,000 of the 90,000 sets in process of manufacture earlier this year had been completed and marketed. "This is disappointing," he said, "and I have taken steps to urge manufacturers to expedite the agreed civilian programme during the remainder of the year." He also stated that some 8,000 sets were recently imported from the United States, under the Lend-Lease agreement, and will shortly be released through normal trade channels.

TELEVISION DEVELOPMENTS

EVIDENCE of the interest in television was apparent when over 500 members and visitors attended the recent meeting of the British Institution of Radio Engineers, at which J. L. Baird described the developments in colour and stereoscopic transmission and reception. He outlined his scheme for linking by radio television transmitters throughout the country and pointed out that no alteration in receiving apparatus would be necessary and that only minor changes in the transmitters would be required if his three-colour stereoscopic system is adopted. He also expressed the opinion that when television restarted cinemas would show television "news-reels."

LARGE-SCREEN TELEVISION

A NEW system of large-screen television for theatres, homes, schools, etc., in black and white or natural colours, is foreshadowed by the recent issue to the Scophony Corporation of America of patents covering the Skiatron system of projection. It is stated that by this method a picture 20 feet wide, equal in brilliance to motion picture standards, can be projected.

The view was recently expressed by the president of the Corporation that television may develop as a subscriber service. Scophony has patented a system for scrambling transmissions, which will be unscrambled by subscribers' special sets.

SIR WILLIAM NOBLE

WE record with regret the death at the age of 82 of Sir William Noble, O.B.E., who was one of the pioneers of broadcasting in this country. He was Chairman of the first Broadcasting Committee, the work of which culminated in the formation of the British Broadcasting Company in 1922. Sir William was one of the nine original members of the Board of the B.B.C.

He entered the Post Office as a telegraphist in the Aberdeen office in 1877. On his retirement in 1922 he was Engineer-in-Chief, a post he had held for three years. On retiring from the Post Office he became a director of the General Electric Company.

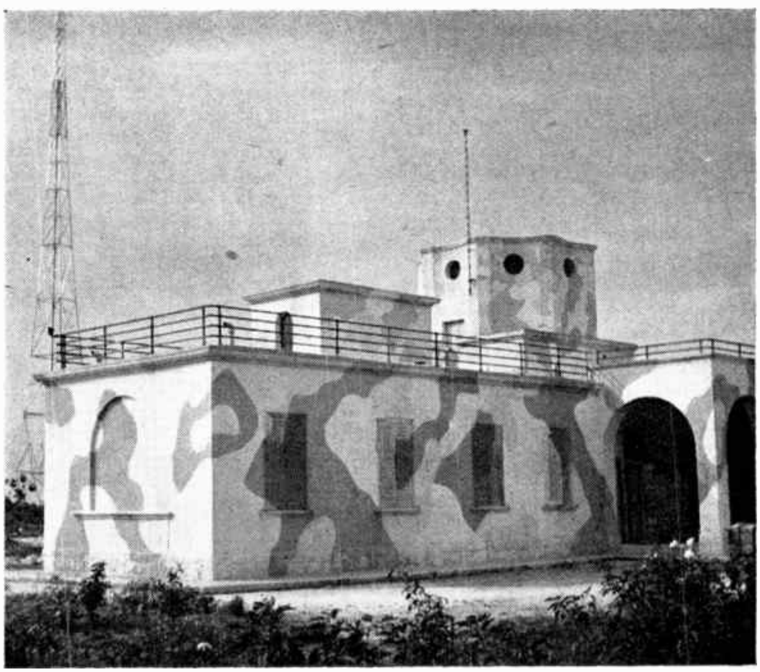
Sir William Noble, who was knighted in 1920, visited Australia in 1929 to study broadcasting, telegraph and telephone developments. He was a Member of the I.E.E. and had served on the Council of the Institution.

A.M.I.E.E. EXAMINATION

CHANGES in the examination for Associate Membership, which will become effective in October, 1945, are announced by the Institution of Electrical Engineers.

To replace the present Part I of the examination a Joint Section A will be held in conjunction with the Institution of Civil Engineers. Five papers of three hours each will be set in these subjects: English, Mathematics, Principles of Electricity, Applied Mechanics and Applied Heat. Evidence of laboratory work in the subject of Applied Heat and Principles of Electricity in the form of a certificate from the Principal or teacher, or the actual laboratory notebooks and reports may be called for.

Section B of the examination, which replaces the former Part II, consists of a three-hour paper on Electrical Engineering, and a three-hour paper on one of the following subjects: Electricity Supply, Electrical Measurements, Electrical Installations, Electrical Machinery, Radio Communications or Line Communications. The subject of Engineering Organisation and Management formerly included in Part II is under consideration. The Council's decision will be announced later.



BARI BROADCASTING STATION photographed after it had been captured intact by the 8th Army. It is the first station on the European mainland to fall into our hands. Erected in 1932, this 20-kW Marconi transmitter was employed as a relay station.

World of Wireless—

The revised examination regulations, which will be published shortly by the Institution, will contain full details of the syllabuses, copies of which may be obtained from the secretary.

CIVILIAN WIRELESS RESERVES

THE future of the Civilian Wireless Reserves, which at the beginning of the war were called upon to fill important posts in the Services, is discussed by John Clarricoats in the October issue of the *R.S.G.B. Bulletin.*

"It is," he writes, "fairly safe to assume that all three Services will take steps after the war to form reserves similar to the Royal Naval Volunteer (Wireless) Reserve and the Royal Air Force Civilian Wireless Reserve. . . These reservists will be trained in procedure and will operate to predetermined schedules on special frequency bands. But what equipment will they use?"

Pointing out that the success of the Reserves was largely due to the readiness of members to use their own equipment, the writer makes a plea for every qualified station to be provided with a standard Service transmitter and receiver complete with all accessories. The introduction of this suggestion would certainly absorb a considerable quantity of surplus Service apparatus and thereby avoid flooding the market with obsolete or obsolescent equipment.

The question of training is also dealt with in the article.

CAR RADIO

THE question of allowing some relaxation of the ban on carrying receiving sets in motor vehicles, imposed on May 31st, 1940, is being considered by the Government.

WHAT THEY SAY

THE question of censorship is something which is necessary during the war, but should be lifted within 24 hours of the cessation of hostilities. This is very important to the radio trade, because it is through the Press that the public voice their opinions and could indicate their various requirements.—*C. O. Stanley, at the Radio Industries Club of Scotland.*

Radio is to aviation what signals are to the railways.—*Sir Frederick Handley Page, at the Radio Industries Club.*

A friend whose wireless set has been out of action for some time tells me that during the resulting silent evenings he did more solid reading, and better work, than he had done at home for years. In the same period, incidentally, the children got far better marks than usual for their homework.—*A writer in "The Bulletin and Scots Pictorial."*

RESEARCH AND TRAINING

A REPORT just issued by the Parliamentary and Scientific Committee deals with scientific research in relation to the Universities in post-war Britain. It stresses the need for research and improved technical education in many branches of applied science. Mention is made of the proposal by the British Institution of Radio Engineers for organised radio research, and the establishment of Chairs of Radio Engineering at Colleges of Technology and in Universities is suggested.

NEWS ON SHORT WAVES

THE following schedule, which will be operative when this issue of *Wireless World* is current, gives the times (BST) and wavelengths on which news in English is transmitted by the B.B.C. on short waves.

0030, 0206	30.53, 31.32, 41.32, 49.10.
0345, 0415‡	30.53, 30.96, 31.32, 41.32, 41.96, 49.10.
0530	30.53, 30.96, 31.32, 41.32, 49.10.
0700	19.91, 25.53, 25.68, 30.53, 31.55, 42.13.
0900	19.44, 19.91, 25.53, 25.68, 30.53, 31.55, 42.13.
1000	24.80, 24.92, 25.29, 25.58, 25.64, 30.96, 31.41, 31.48, 31.61, 31.88, 41.38, 41.49, 41.96, 42.46, 48.43, 48.98, 49.10.
1600	16.84, 19.46, 19.91, 24.92, 25.68, 31.12.
1700	16.92, 19.66, 25.53.
1745	24.80, 25.38, 41.49, 49.10.
1900	19.66, 25.53, 25.64, 31.25.
2045	19.66, 25.53, 25.64, 31.25, 42.13.
2245	25.68,‡ 30.53,‡ 31.12, 31.32,‡ 41.32,‡ 41.38, 41.75, 48.66, 48.98, 49.42, 49.92.
2345	30.53, 31.32, 41.32, 49.10.

‡ Sundays excepted.

In addition to the news bulletins listed above there are transmissions of news in English in the General Overseas Service of the B.B.C. at the following times:—0030, 0300, 0500, 0600, 0700, 0800, 1200, 1400, 1600, 1900, 2145. The wavelengths on which these transmissions are radiated are not available from the B.C. It is stated "they are announced at the microphone."

IN BRIEF

FM "Walkie-Talkies."—It is announced by the U.S. War Department that frequency modulation is being employed in the latest model of the "Walkie-Talkie" pack transmitter-receiver.

Appointment. — A. W. Martin, who has been with E. K. Cole since 1928 and, as Assistant Chief Engineer, has been responsible for many important technical and design developments, has been appointed Chief Engineer of the company.

Training Radio Officers.—Recruitment and training being relevant factors in the matter of the post-war employment of Radio Officers, the Radio Officers' Union has taken part in discussions to formulate plans for the setting up of a Radio Officers' Training Board.

I.E.E.—At a meeting of the Wireless Section of the Institution of Electrical Engineers to be held at 5.30 p.m. on December 1st, two papers on hearing aids will be read. Dr. T. S. Littler's paper is entitled "Electrical Hearing Aids" and C. M. R. Balbi's "A Basis for the Prediction of Performance of Hearing Aids."

Radio Relay Subscribers.—The number of subscribers to radio relay exchanges is still increasing. Although there was one less exchange, the number of subscribers to the present 276 exchanges increased by 7,644 in the three months to June 30th, making a total of 455,588 subscribers at that date.

Brit.I.R.E.—A paper on "Stabilising Electronic Circuits" is to be read by M. M. Levy at a meeting of the British Institution of Radio Engineers to be held on November 25th. On December 15th a paper on "Selective Methods in Radio Reception" will be read by E. L. Gardiner (G6GR). Both these meetings will be held at 6.30 p.m. at the Institute of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1.

New Use for Television.—Television has been used in the United States in the search for missing persons. Recently a mother in New York City was televised appealing to her 15-year-old son to return home. It is estimated that about 5,000 sets received the transmission in New York, Philadelphia and Boston. The broadcast was arranged by New York City's Police Bureau of missing persons.

R.S.G.B.—E. L. Gardiner (G6GR), President-Elect of the Radio Society of Great Britain, will open a discussion on "Valve Voltmeters" at the next meeting of the London Section to be held at the Institution of Electrical Engineers at 2.30 p.m. on November 27th. The annual general meeting of the Society will also be held at the I.E.E. at 2 o'clock on December 18th, and will be followed by a paper by Dr. R. L. Smith-Rose, Honorary Member of the Society, on "Measurements in Radio Experimental Work."

Resignation.—E. J. Wyborn, M.I.E.E., who joined E. K. Cole, Ltd., fifteen years ago as chief engineer and has latterly been deputy managing director of the company, has resigned from the board and severed his connection with the company.

Callender's.—Sir Malcolm Fraser, Bt., G.B.E., has been elected Chairman of Callender's Cable and Construction Company and also of the Anchor Cable Company.

Frequency Checking Station.—A typographical error appeared in the note on the U.S. National Bureau of Standards station on page 337 of the November issue. The call sign is WWV and not WWY.

"WREN" RADIO MECHANICS

Maintaining Naval Air Arm Equipment

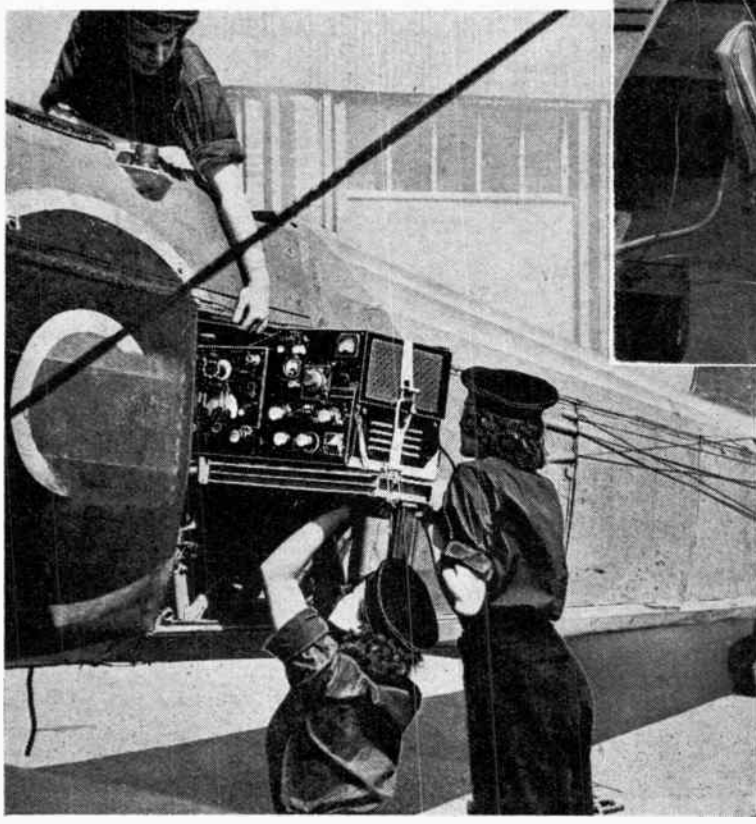
SOME months ago* we described the intensive course of training undertaken by members of the Women's Royal Naval Service to qualify as Radio Mechanics. It is now possible, as a result of a recent visit to a Royal Naval Air Station, to give some idea of the work undertaken by these girls when their training is completed.

The station chosen was H.M.S. *Kestrel*, where Wireless Telegraphist Air Gunners are trained for the Naval Air Arm. It is at such a station, where it is necessary to maintain a large staff of mechanics for the maintenance of the aircraft and associated wireless equipment used for training purposes, that Wren Air Mechanics (who look after the engines, airframes, ordnance and electrical equipment) and Radio Mechanics are playing a big part. The replacement of male naval ratings by Wrens has been going on at this station for some time, and there is now a dilution of 1 : 1. While in some categories the dilution is not so great, in that of Radio Mechanic 75 per cent. of the staff are Wrens.

Before passing out as Leading Wren Radio Mechanics, recruits, who must have had a secondary school or similar education and gained the school certificate with credit in mathematics or physics, take a four to six months' basic training course of the type already described, which is followed by a practical course at a Naval Air Station. After twelve months' service as Leading Wren they are eligible for recommendation for promotion to Petty Officer Wren.

* *Wireless World*, October 1942.

These photographs, taken at a Royal Naval Air Station, show Wren Radio Mechanics testing, repairing and installing radio equipment for the Naval Air Arm.



At H.M.S. *Kestrel* all radio apparatus installed in the training aircraft is tested after each thirty hours' flying. This means that there is a considerable amount of routine testing. When apparatus is found to be faulty it is removed by the Wrens and repaired in the workshops which, with the exception of a Chief Petty Officer, is entirely staffed by girls.

Another task undertaken is the testing of some of the apparatus in flight; those doing this work have, therefore, been nicknamed "Flying Wrens."

While there are, of course, circuit failures in the sets, quite a large proportion of the faults are

"Wren" Radio Mechanics—mechanical, brought about by vibration and other conditions of service.

Typical N.A.A. Sets

The number of different types of set handled by Wrens is fairly small, and they therefore quickly become conversant with faults likely to develop. One of the transmitter-receivers, which operates on 'phone and MCW, has remote press-button tuning for four spot frequencies, which are crystal controlled.

Another set handled by Wren Radio Mechanics was specially designed for the Naval Air Arm and is installed in multi-seater aircraft such as the Fulmar. An interesting point in the design of this transmitter-receiver, which works on CW only, is that the tuning coils are temperature compensated. They have a frequency stability of ± 0.1 per cent. at altitudes up to 40,000ft., and at temperature variations from $+30$ deg. to -30 deg. C.

The set derives its power from a motor generator driven by a 12- or 24-volt battery. The transmitter has an output of 10 watts.

The station visited is one of many such centres round the coast where Wren Radio Mechanics are doing a man's job.

OUR COVER ILLUSTRATION

THIS month's cover illustration shows a "worm's eye" view of the latest General Electric circular FM transmitting aerial installed at the top of the Wall Tower, New York, for the station W47NY operated by Muzak Radio Broadcasting Station, Inc., on a frequency of 44.7 Mc/s.

NEWS IN ENGLISH FROM ABROAD

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
Algeria			
Algiers	8.965	33.46	1600, 1700, 1800, 1900, 2100, 2200
	12.110	24.77	1700, 1800, 2100
America			
WRUW (Boston) ..	6.040	49.67	0800
WLWO (Cincinnati)..	6.080	49.34	0600, 0700, 0800, 0900
WCBX (Brentwood)..	6.170	48.62	0500
WGEO (Schenectady)	6.190	48.47	0515
WKTM	6.370	47.10	0200, 0300, 0400, 0500, 0600, 0700, 0800, 0900
WLWK (Cincinnati)..	7.575	39.60	0600, 0700
WCRC (Brentwood) ..	9.650	31.09	0600
WLWO (Cincinnati)..	11.710	25.60	1200, 1300, 2100, 2200
WCRC (Brentwood) ..	11.830	25.36	1100, 1200, 2200
WGEA (Schenectady)	11.847	25.33	1300, 1400, 1500, 1600, 1700, 2300
WBOS (Hull).. ..	11.870	25.27	1200
WKTM	11.893	25.22	0000, 2300
WKRD	12.967	23.14	0000, 1300, 1400, 1500
WBOS (Hull).. ..	15.210	19.72	2100
WLWK (Cincinnati)..	15.250	19.67	1400, 1500, 1600, 1700, 1800, 1900, 2000, 2100, 2200
WGEO (Schenectady)	15.330	19.57	1100, 1200, 2200
WRUL (Boston) ..	15.350	19.54	1500, 1600
WLWO (Cincinnati)..	17.800	16.85	1500, 1600, 1700, 1800, 1900, 2000
Australia			
VLI10 (Sydney) ..	9.580	31.32	1515
VLG3 (Melbourne) ..	11.710	25.62	0800
VLI2 (Sydney) ..	11.872	25.27	0800
VLG9 (Melbourne) ..	11.900	25.21	1515
VLI3 (Sydney) ..	15.320	19.58	1030
Brazil			
PRL8 (Rio de Janeiro)	11.715	25.61	2030‡
China			
XGOY (Chungking)..	9.635	31.14	1500, 1700, 2130
Ecuador			
HCJB (Quito) ..	12.455	24.09	0000, 2030
Egypt			
Cairo	7.510	39.94	1840, 2100
French Equatorial Africa			
FZI (Brazzaville) ..	11.970	25.06	1945, 2145
India			
VUD3 (Delhi) ..	7.290	41.15	0800, 1300, 1550

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
India (*continued*)			
VUD4	9.590	31.28	0800, 1300, 1550
VUD3	15.290	19.62	0800, 1300
Mozambique			
CR7BE (Lourenco Marques)	9.830	30.52	1155, 1712, 1915
Newfoundland			
VONH (St. John's) ..	5.970	50.25	2315
Palestine			
Jerusalem	11.750	25.53	1615
Portugal			
CSW6 (Lisbon) ..	11.040	27.17	2000
Spain			
EAQ (Aranjuez) ..	9.860	30.43	1915‡
Sweden			
SBU (Motala) ..	9.535	31.46	2220‡
SBP	11.705	25.63	1700
Switzerland			
HER3 (Schwarzenburg)	6.165	48.66	2150
HER4	9.535	31.46	2150
Syria			
Beirut	8.035	37.34	1820
Turkey			
TAP (Ankara) ..	9.465	31.70	1800
U.S.S.R.			
Moscow	5.890	50.93	2300
	6.980	42.98	1240, 1700, 2300
	7.300	41.10	1800, 2000, 2100, 2200, 2300
	7.560	39.68	2300
	10.445	28.72	1240
	11.830	25.36	1600
	12.190	24.61	1240
	15.230	19.70	0415, 1240
	15.750	19.05	1240
Vatican City			
HVJ	5.970	50.25	2015
	kc/s	**Metres**	
Algiers	1176	255	0100, 1400, 1800, 1900, 2000, 2200
Athlone	565	531	1340‡, 1845, 2210
Tunis	868	345.6	0000, 0100, 1900, 2000, 2100, 2200, 2300

It should be noted that the times are BST—**one hour** ahead of GMT. The timing of some of the bulletins may be changed to compensate for the reversion from Summer to Standard Time in some countries. ‡ Sundays excepted.

How to Apply "STANDARD VALUES"

NOTE: Tolerance range ± 20% must be used wherever possible

Tolerance range ± 10% may only be used where essential

For the range (in ohms)	10 – 11	11 – 13	14 – 16	17 – 19	20 – 24	25 – 30	30 – 36	36 – 42	43 – 51	52 – 61	62 – 74	74 – 90	± 10%
use — ohms	10	12	15	18	22	27	33	39	47	56	68	82	
For the range (in ohms)	10 — 12		12 — 18		18 — 26		27 — 39		38 — 56		55 — 81		± 20%
use — ohms	10		15		22		33		47		68		

For the range (in ohms)	90 – 110	108 – 132	135 – 165	162 – 198	198 – 242	243 – 297	297 – 363	351 – 429	423 – 517	504 – 616	612 – 748	738 – 902	± 10%
use — ohms	100	120	150	180	220	270	330	390	470	560	680	820	
For the range (in ohms)	80 — 120		120 — 180		178 — 264		264 — 396		376 — 564		544 — 820		± 20%
use — ohms	100		150		220		330		470		680		

For the range (in ohms)	900 – 1100	1080 – 1320	1350 – 1650	1620 – 1980	1980 – 2420	2430 – 2970	2970 – 3630	3510 – 4290	4230 – 5170	5040 – 6160	6120 – 7480	7380 – 9020	± 10%
use — ohms	1000	1200	1500	1800	2200	2700	3300	3900	4700	5600	6800	8200	
For the range (in ohms)	800 — 1200		1200 — 1800		1760 — 2640		2640 — 3960		3760 — 5640		5440 — 8160		± 20%
use — ohms	1000		1500		2200		3300		4700		6800		

For the range (in ohms)	9000 – 11000	10800 – 13200	13500 – 16500	16200 – 19800	19800 – 24200	24300 – 29700	29700 – 36300	35100 – 42900	42300 – 51700	50400 – 61600	61200 – 74800	73800 – 90200	± 10%
use — ohms	10000	12000	15000	18000	22000	27000	33000	39000	47000	56000	68000	82000	
For the range (in ohms)	8000 — 12000		12000 — 18000		17600 — 26400		26400 — 39600		37600 — 56400		54400 — 81600		± 20%
use — ohms	10000		15000		22000		33000		47000		68000		

For the range (in ohms)	90000 – 110000	108000 – 132000	135000 – 165000	162000 – 198000	198000 – 242000	243000 – 297000	297000 – 363000	351000 – 429000	423000 – 517000	504000 – 616000	612000 – 748000	738000 – 902000	± 10%
use — ohms	100000	120000	150000	180000	220000	270000	330000	390000	470000	560000	680000	820000	
For the range (in ohms)	80000 — 120000		120000 — 180000		176000 — 264000		264000 — 396000		376000 — 564000		544000 — 816000		± 20%
use — ohms	100000		150000		220000		330000		470000		680000		

For the range (in ohms)	.9 Meg – 1.1 Meg	1.08 Meg. – 1.32 Meg.	1.35 Meg – 1.65 Meg	1.62 Meg – 1.98 Meg	1.98 Meg. – 2.42 Meg.	2.43 Meg. – 2.97 Meg.	2.97 Meg. – 3.63 Meg.	3.51 Meg. – 4.29 Meg.	4.23 Meg. – 5.17 Meg.	5.04 Meg. – 6.16 Meg.	6.12 Meg. – 7.48 Meg.	7.38 Meg. – 9.02 Meg.		±10 %
use — ohms	1.0 Meg.	1.2 Meg.	1.5 Meg.	1.8 Meg.	2.2 Meg.	2.7 Meg.	3.3 Meg.	3.9 Meg.	4.7 Meg.	5.6 Meg.	6.8 Meg.	8.2 Meg.		
For the range (in ohms)	.8 Meg. – 1.2 Meg.		1.2 Meg. – 1.8 Meg		1.76 Meg. – 2.64 Meg		2.64 Meg. – 3.96 Meg.		3.76 Meg. – 5.64 Meg.		5.44 Meg. – 8.16 Meg.		8.0 Meg. – 10.0 Meg.	± 20%
use — ohms	1.0 Meg.		1.5 Meg		2.2 Meg.		3.3 Meg.		4.7 Meg.		6.8 Meg		10.0 Meg.	

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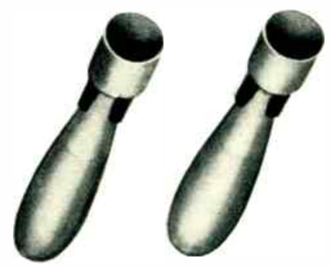

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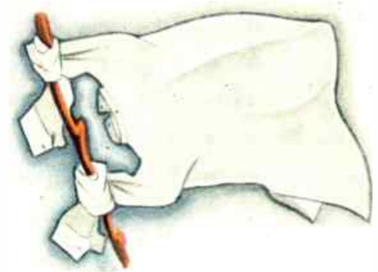

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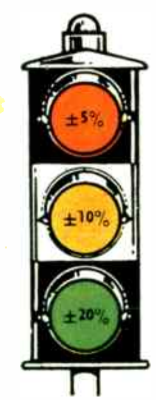
USE STANDARD VALUES

±5%			±10%			±20%		
10	1000	100000	10	1000	100000	10	1000	100000
11	1100	110000						
12	1200	120000	12	1200	120000			
13	1300	130000						
15	1500	150000	15	1500	150000	15	1500	150000
16	1600	160000						
18	1800	180000	18	1800	180000			
20	2000	200000						
22	2200	220000	22	2200	220000	22	2200	220000
24	2400	240000						
27	2700	270000	27	2700	270000			
30	3000	300000						
33	3300	330000	33	3300	330000	33	3300	330000
36	3600	360000						
39	3900	390000	39	3900	390000			
43	4300	430000						
47	4700	470000	47	4700	470000	47	4700	470000
51	5100	510000						
56	5600	560000	56	5600	560000			
62	6200	620000						
68	6800	680000	68	6800	680000	68	6800	680000
75	7500	750000						
82	8200	820000	82	8200	820000			
91	9100	910000						
100	10000	1.0 Meg	100	10000	1.0 Meg	100	10000	1.0 Meg.
110	11000	1.1 Meg						
120	12000	1.2 Meg	120	12000	1.2 Meg			
130	13000	1.3 Meg						
150	15000	1.5 Meg	150	15000	1.5 Meg	150	15000	1.5 Meg
160	16000	1.6 Meg						
180	18000	1.8 Meg	180	18000	1.8 Meg			
200	20000	2.0 Meg						
220	22000	2.2 Meg	220	22000	2.2 Meg	220	22000	2.2 Meg
240	24000	2.4 Meg						
270	27000	2.7 Meg	270	27000	2.7 Meg			
300	30000	3.0 Meg						
330	33000	3.3 Meg	330	33000	3.3 Meg	330	33000	3.3 Meg.
360	36000	3.6 Meg						
390	39000	3.9 Meg	390	39000	3.9 Meg			
430	43000	4.3 Meg						
470	47000	4.7 Meg	470	47000	4.7 Meg	470	47000	4.7 Meg.
510	51000	5.1 Meg						
560	56000	5.6 Meg	560	56000	5.6 Meg			
620	62000	6.2 Meg						
680	68000	6.8 Meg	680	68000	6.8 Meg	680	68000	6.8 Meg
750	75000	7.5 Meg						
820	82000	8.2 Meg	820	82000	8.2 Meg			
910	91000	9.1 Meg						
		10.0 Meg			10.0 Meg.			10.0 Meg.



STOP Not to be used except with prior authorisation from the appropriate Supply Department Design Authority.

CAUTION Proceed warily. Use only where essential.

GO ahead. Use freely and wherever possible.

USE ERIE RESISTORS

ELECTRONIC VOLTAGE REGULATORS

Practical Design Details : Derivation of Formulae

By F. LIVINGSTON HOGG

(Concluded from page 331 of the November issue)

TURNING now to practical points of design where experience is helpful, the following valves have been used very successfully :

For currents up to 35 mA, 6V6G (triode connected).

For currents up to 80 mA, DO24 or PX25.

For currents up to 120 mA, S.T.C. 4300A.

The control valve may be any type suitable for resistance-coupled amplification. Triodes have been shown above, but actually RF pentodes such as the 6J7G or Brimar 8D2 are very much better. The screen may be run from the output or input positive line through a dropping resistance or potentiometer ; usually a very low voltage is best. If the screen voltage is obtained from the input voltage, some degree of compensation can be got by careful adjustment of the screen voltage. This method is not recommended, as in practice it is susceptible to variation. The series valve is not affected by the actual HT voltage level, but if high voltages are used, the control valve must be watched. Actually some standard RF pentodes have been reported as being used to control supplies of some thousands of volts, but in these cases the valves must be chosen with great care.

In most radio applications it is advantageous for the stabiliser tube to operate at as low a voltage as possible. Here the S.T.C. 4313C is unique, as its volt drop is only 50–55 volts at 1 to 10 mA. The Mullard 7475 is excellent when the higher voltage of 90 can be tolerated. The Cossor S130 has been used with success with a current as low as 9 mA through it, but this is not in accordance with makers' ratings, as they recommend a very much higher tube current.

In constructing such a stabiliser it must be remembered that it is a high-gain amplifier, and must be made accordingly. For best results it is advisable to separate power pack and regulator, and not attempt to build them in one unit, because of the difficulty of eliminating hum pick-up on the amplifier. In no case when the amplifier has been properly designed and built has it been found desirable or necessary to use any extra devices to prevent instability. It is, however, always good to add a condenser C_1 (Fig. 2). This may be 0.5 to 1 microfarad. It transfers direct, instead of through a potential divider, to the grid of the control valve all AF variations across the output. This usually improves the residual mains hum by large amounts, 25 db or more, probably because the grid of the tube is tied down through a low impedance, and is therefore much less susceptible to pick-up.

As mentioned above, R_6 should be wirewound. It is best to insert in series with the variable the minimum calculated value so that the grid of V_4 cannot be run positive into a region of poor or no control.

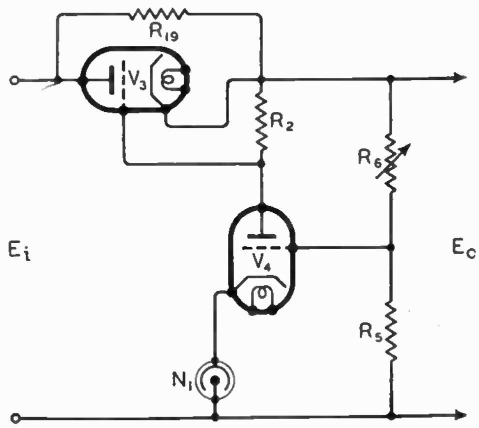


Fig. 7. By shunting V_3 with a resistance a greater current output may be taken at the expense of some range of control.

There are no doubt many other dodges which will suggest themselves, but for reasons of space only one more will be mentioned which was proposed by Bosquet in *Electronics*, July 1938. Supposing we wish to take a large current from the stabiliser, the size of valve required may be excessive. By sacrificing range of control, however, we can pass a very much greater current through a given regulator by shunting the series valve with a resistance, R_{19} (Fig. 7). For instance, a regulator using one DO24 can be made to supply enough current for the heaters of a number of AC/DC valves in series. This can give much better regulation than a barretter or flux regulated transformer.

The shunt resistance must be adjusted rather accurately to the calculated value. The method of design is to add new columns B′ and B″ to the table, for currents in resistance and valve respectively. Column D covers watts in valve and resistance. If the valve to be used is known, B″.8 gives the valve maximum wattage, so it can be filled in, whence B′8, and therefore R_{19}. The rest of the table then follows. Clearly the shunt resistance limits both voltage and current range seriously. When only a fixed output voltage and current are required, as for valve heaters, etc., the table can be reduced to three lines only. Care must also be taken that the rectifier output is adjusted to the design value, as the limits for good regulation are rather close.

Valves can, of course, be run in parallel, but great care must be taken as if one valve takes an undue share of the current it may fail prematurely. Another valve then follows suit, and the first sign of trouble on one unit I was once shown did not occur until the third valve failed. This tends to be expensive. It is advisable to use valves in parallel much more conservatively and to choose types likely to match well. Grid stopping resistances may also be required to prevent parasitic oscillation. A method which may be useful to

Electronic Voltage Regulators—
safeguard valves is to use a separate cathode resistance in each valve cathode lead, adjusting the values in such a way that any valve cannot take undue current. This involves the use of a separate winding on the heater transformer for each valve, unless indirectly heated valves are used.

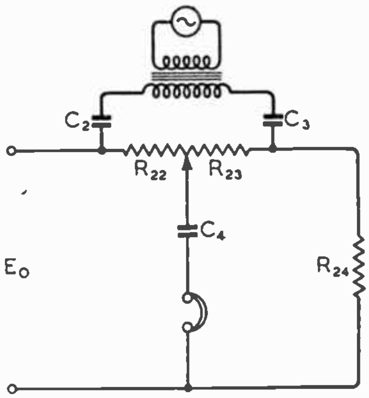


Fig. 8. Circuit for measuring the effective internal resistance of voltage regulators.

In any case, it is particularly recommended that one transformer supply all the heaters, and that a separate one be used for the HT. The HT can then be switched on and off in the primary circuit. This saves quite a bit on condensers and switching. If a wider range of voltage is required than is available in one range of control excess turns may be wound on the primary (with due regard to other considerations) to give reduced secondary voltage, or an auto transformer may be used. The number of ranges of control can thus be made as many as desired. It is better to control a wide range of voltage in steps, unless the current to be taken is very low. In the example, any greater voltage change would entail considerable reduction of the maximum current.

Heretofore the regulator has been considered only as a voltage stabilising device. It is, however, clear that it must have an internal resistance of low value. If stabilisation is perfect, the internal resistance (or more accurately impedance) must be zero. If there is overcompensation, the resistance is negative. This applies at all frequencies at which the control valve is an efficient amplifier.

This opens up a new field of use for the electronic regulator as an impedance which is sensibly zero to AC right down to the lowest frequencies, and yet has a DC potential across it. Regulators have been found invaluable, for example, in wide band amplifiers, for feeding screen circuits in such a way that compensation is not necessary at low frequencies. The device is also useful in coupling cathode ray tubes directly to amplifiers, as no auxiliary impedances are necessary. Moreover, regulators can be used to supply transmitter bias with advantage. The transmitter grid current would normally cause a considerable rise in grid voltage unless a heavy load is placed across the bias supply. If a regulator is used, it is only necessary that the load current be a little greater than the maximum grid current. Banerjee, in the paper mentioned in the last issue, proposes this idea in connection with the large Class B amplifiers, used in broadcast transmitters. It has also value in factory testing.

The use of regulators for such purposes does not yet seem to have had the attention it deserves; the applications mentioned are only indicative of the possibilities, being some I have found useful. In such applications, measurement of the actual internal resistance becomes interesting. The usual circuit is shown in Fig. 8. R_{22}, R_{23} and R_{24} are together the required load on the regulator. An audio oscillator is fed through a transformer and two condensers across R_{22} and R_{23}, while the junction of these two resistances goes to the negative line via a condenser and a pair of phones. If R_{22} and R_{23} are made from suitable variable and fixed resistances the slider is adjusted for minimum sound in the phones. The internal resistance is given by :

$$R_i = \frac{R_{22}.R_{24}}{R_{23}}$$

As an indication of the expected values, R_i for the sample regulator is of the order of 70 ohms maximum. Obviously this method can be adapted to use existing parts in a number of ways.

If a cathode ray oscillograph is available, there are other useful methods. If E_0 is applied to the CRO through a blocking condenser and amplifier, any residual mains hum will be seen. This can be used as a method of adjusting the voltage compensating resistance, provided the amplifier tube of the regulator does not pick up too much hum, which would mask the effect.

It is often necessary to know how the internal resistance (which is slightly inductively reactive) behaves when varying alternating voltages are applied across its output. This effect can easily be studied on the CRO in the following manner. The required load is made up of R_{25} and V_7, Fig. 9. R_{26} biases V_7 suitably as an amplifier. V_7 is chosen so that by varying its grid potential its anode current is varied over a suitable range. To start with, an effective load variation of 5 per cent. might be aimed at. As the compensation is varied, so the amplitude of the CRO trace will be modified. An accurate compensation can be made at any frequency, or a frequency characteristic can be taken. Actual measurement can only be made indirectly thus, but it is nevertheless probably the most convenient practical method, provided great care is taken to see that the CRO does not pick up directly and so give spurious results.

Tue tube V_7 could, of course, be placed across E_i, and thus voltage compensation adjustment made at a frequency other than that of the mains, if for some reason that is desirable.

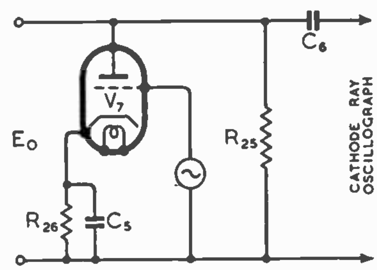


Fig. 9. Load circuit for use with CRO for visual adjustment of compensating circuits.

Limitations of space prevent the fuller discussion of the many points which arise. This article is therefore only intended to indicate simple and useful methods which have been tried out over a number of years. The principles laid down, while not at all deep, enable a designer to estimate the performance of a regulator with little trouble, and with every expectation of getting the required answer without much experiment. No apology is therefore made for the elementary and unacademic approach to the problem.

The work described above was carried out by the writer during his employment with Messrs. Standard Telephones and Cables, Ltd., New Southgate, to whom acknowledgements are therefore due. Mr. D. N. Corfield of the Sidcup Factory of that company, has also kindly helped by providing curves and figures for the 6Q7G valve.

APPENDIX

In Fig. 2, with voltage control as shown in (*b*), let V_3 have mutual conductance S and amplification factor μ. Let the overall amplification of V_4 circuit be n times, i.e.

$$\left|\frac{V_g}{E_g}\right| = n$$

Then the stabilisation ratio of the regulator is defined as:

$$a = \frac{\triangle E_0}{\triangle E_i}$$

and the internal resistance as:

$$R_i = -\frac{\triangle E_o}{\triangle i}$$

where the $\triangle$'s represent corresponding small changes in the variables.

From elementary valve circuit theory we can see that

$$\triangle i = S\triangle V_g + \frac{S}{\mu}(\triangle E_i - \triangle E_o) \quad \ldots \quad \ldots (1)$$

Now let k be the reduction factor of the potentiometer formed by R_5 and R_6

Then $k = \dfrac{R_6}{R_5 + R_6}$

and $\triangle V_g = -nk\triangle E_0$

whence

$$\triangle i = \frac{S}{\mu}\triangle E_i - S\triangle E_0\left(nk + \frac{1}{\mu}\right) \quad \ldots \quad \ldots (2)$$

If the load resistance is R

$$\triangle i = \frac{\triangle E_0}{R} \quad \ldots \quad \ldots (3)$$

Whence $a = \dfrac{\triangle E_0}{\triangle E_i} = \dfrac{1}{\dfrac{\mu}{SR} + \mu nk + 1} \quad \ldots \quad \ldots (4)$

Similarly, if the effective resistance of the power supply is R_r, we can see that

$$\triangle E_i = -R_r\triangle i \quad \ldots \quad \ldots (5)$$

and from (5) and (2) we can then derive

$$R_i = -\frac{\triangle E_0}{\triangle i} = \frac{\frac{\mu}{S} + R_r}{\mu nk + 1} \quad \ldots (6)$$

This shows that, as a rule, the power supply resistance has not much effect on the performance of a regulator, as far as its regulating properties go. It is, however, of great importance when a wide range of voltage control is desired, because the extra variations of E_i caused by the power supply resistance with varying load, all have to be dissipated in V_3. Unless the current is low, this is a serious limiting factor in wide range designs.

Voltage Compensation

In Fig. 5, let R_{10} be zero. As the resistance seen across the terminals of the regulator is very low, when we calculate the ratio $\frac{AC}{DC}$, R_5 and R_6 are effectively in parallel. Calling this factor q we get:—

$$q = \frac{\dfrac{R_5 R_6}{R_5+R_6}}{R_8 + \dfrac{R_5 R_6}{R_5+R_6}} = \frac{kR_6}{R_8+kR_6}$$

We can write the stabilisation ratio thus:

$$a = \frac{\triangle E_g}{k\triangle Ei} \quad \ldots \quad \ldots (8)$$

Now if compensation is to be perfect, E_0 is zero. There must therefore be a voltage change at point A equal and opposite to that implied by (8). If we obtain this change via R_8 from the changes in E_i, this voltage is obviously $q\triangle E_i$. Equating we get

$$q = \frac{k}{\dfrac{\mu}{SR} + \mu nk + 1} \quad \ldots (9)$$

from which we can at once evaluate R_8. Remembering that

$$q = \frac{kR_6}{R_8 + kR_6},$$

$$R_8 = R_6\left(\frac{\mu}{SR} + \mu nk + 1 - k\right)$$

Current Compensation

If Fig. 5 assume that R_8 is sufficiently high that it may be ignored when connected in parallel with R_5 and R_6. Let the potentiometer factor $\frac{AC}{FC}$ be t. Then

$$t = \frac{R_6}{R_5 + R_6}$$

As with (8) we may write

$$R_i = -\frac{\triangle E_g}{k\triangle i} \quad \ldots \quad \ldots (10)$$

The grid voltage change implied by this must be correspondingly balanced at point A.

Now $\triangle E_g = q\triangle E_i - tR_{10}\triangle i \quad \ldots \quad \ldots (11)$

Whence from (5)

$$\triangle E_g = -(qR_r + tR_{10})\triangle i \quad (12)$$

Therefore $R_{10} = \dfrac{kR_i - qR_r}{t} \quad \ldots (13)$

or expressed otherwise,

$$R_{10} = \frac{k}{t}\left(\frac{\frac{\mu}{S} + R_r}{\mu nk + 1}\right) - \frac{qR_r}{t} \quad \ldots (14)$$

If voltage compensation is not used at the same time, then R_8 is infinitely large, and

$$R_{10} = \frac{kR_i}{t} = \frac{k}{t}\left(\frac{\frac{\mu}{S} + R_r}{\mu nk + 1}\right)$$

These compensating resistance values are calculated for one set of controlling values only. Therefore any circuit or voltage output changes would require different values. The residual stabilisation ratio and internal resistance may be given thus:

$$a_{(c)} = \frac{1}{\dfrac{\mu}{SR} + \mu nk + 1} - \frac{q}{k} \quad \ldots (15)$$

and $R_{(c)} = \dfrac{\frac{\mu}{S} + R_r}{\mu nk + 1} - \dfrac{qR_r + tR_{10}}{k} \quad \ldots \quad \ldots (16)$

These resultants may obviously be positive or negative, corresponding to under- or over-compensation.

The method of computing the above results is based on that given by Lindenhovius and Rinia in the article mentioned in the last issue. The method is open to criticism when thus extended, on several grounds, and calculated compensation values should always be used as a guide only. The results are quite good approximations, and are much more convenient in practice than some others which have been published.

SEPARATING SALVAGE

According to the Waste Paper Recovery Association an average of 10 tons of foreign matter is being found in every 100 tons of waste paper received at the mills. As a result, thousands of tons of valuable salvage are being lost, principally rags, string, tins, rubber and paper. In addition, damage to machinery, with consequent hold-ups in production, results in many cases. Factories and business concerns are again asked to see that they keep their waste paper free from all other types of salvage.

UNBIASED

By FREE GRID

"Much against my will."

Speed of Electricity

THE amount of interest excited by my recent query as to the speed of electricity has been astonishing in its revelation of the broad appeal made by this journal, for I have had replies from all manner of folk, to whom it has been quite impossible to reply individually.

Nobody, however, seems to have hit upon the correct answer, and, although I have had many ingenious and carefully prepared mathematical expositions, none of them seems to agree with the others. As I expected, quite a large number of people confuse the matter with the speed of electro-magnetic waves and give me the figure of 186,000 miles per second, while others confuse the whole issue by dragging in such extraneous matters as lagging and leading currents, completely ignoring the fact that I endeavoured to exclude such irrelevant sidetracks by talking of a humble electron moving round a simple DC circuit without appreciable L and C, such as that of an electric torch. Nor did I want to drag in the question of vacuum tube phenomena.

I got such a welter of conflicting replies that I repaired to my library to consult the best authorities, only to find that they didn't seem to agree with each other very well, either. The most definite information with a minimum of shuffling was, I am glad to say, obtained from a well-known text-book on Wireless Engineering (Morecroft).

"Consulting the best authorities."

I need hardly say that the popular conception of electricity whizzing round the circuit at an incredible speed is entirely erroneous. Taking the case of the humble electron in the simple DC circuit which I have mentioned, it would appear that the speed is not much different from that of walking pace, though, as Professor Joad would remark, it all depends on what you mean by walking pace.

In the case of those who are on DC and live a few miles from the generating station it may take a few hours for an electron to reach them and get back home again. In the case of AC, of course, the electrons never even leave the generating station, for by the time they have started to stir their pins, a hundredth part of a second has elapsed and they have to turn back, and so on *ad infinitum*. This fact should, I think, do much to explain to the non-mathematically minded the nature of a condenser and why it does not form a break in an AC circuit. No doubt, Diallist and the licentious soldiery whom he instructs will find it useful.

Ersatz Run Riot

We are all expecting to find after the war that such enormous strides have been made in wireless matters, due to intensive research work, that it was rather a relief to me the other day to be shown an innovation which has nothing to do with the war but which is likely to exert a bigger influence on our post-war broadcast listening than any other single development.

Paradoxically enough, the thing has no direct connection with wireless, and I first made its acquaintance recently when I was introduced by Mrs. Free Grid, much against my will, into a very "arty" and high-brow musical circle to which she belongs, to listen to what she called a revolution in gramophone reproduction. In spite of my pointing out that gramophone reproduction was essentially a matter of revolutions she persisted in her purpose, and I eventually found myself amid a motley company which was listening enraptured to a loudspeaker churning out what to my untutored musical ear sounded like the blood-curdling screech which one usually associates with the dentist's chair. I was assured, however, that I was listening to a voice which made the efforts of the divine Tetrazzini sound no better than those of the top-note torturer at the average village concert.

At the conclusion of the performance, which I was truthfully able to agree with my hosts was unlike anything I had ever heard before, the mystery was explained to me. All the records, it appeared, had been made, not by recording any actual voices or musical instruments, but by the manual "hammer and chisel" method developed by Rudolf Pfenniger and described in *Wireless World* as long ago as February 3rd, 1933.

In the case of these records, however, Pfenniger had been out-pfennigered, since not only had the compass of the human voice been extended in both directions to frequencies it was quite incapable of reaching, but, in addition, instrumental music had been recorded in which were tones of a kind quite beyond the scope of any musical instrument yet invented, putting even such devices as "electronic organs" entirely in the shade, and, indeed, making their further development as useless and futile as would have been the further development of the long-bow and the cross-bow after the invention of firearms.

It seems quite obvious to me that when this thing gets really going after the war it will revolutionise the musical world, for not only will all records be produced this way, but the B.B.C. will be compelled to use records for all their programmes, since nobody will want to listen to an orchestra or a singer if something better can be produced by means of a hand-chiselled record. In fact, now I come to think of it, nobody will even want to visit the concert hall to listen to something inferior, and this will finally seal the doom of all vocalists, instrumentalists and other music manglers.

It looks to me as though it is going to enable the "bootleg" recording companies to short-circuit completely the virtual monopoly of first-class artistic talent which the big companies hold.

FURTHER NOTES ON THE CONTRAST EXPANSION UNIT

Simplifying the Control Circuit : Hints on Operation

By D. T. N. WILLIAMSON

THE correspondence which followed the publication, in the September issue, of the article describing a contrast expansion unit disclosed a number of problems relating to its design and operation which were considered to be of sufficient interest to justify second thoughts on the subject.

It should first be emphasised that the system described was not submitted as an ideal method of contrast control, but was designed to meet a need, felt to exist, for a circuit which would improve the contrast range of present-day broadcasts and recordings. In these the gain of the transmitting or recording channel is (or should be) reduced to the requisite level immediately prior to the occurrence of a sharp rise in signal level, but remains constant during this change. Thus the initial transient is given the same reduction as the rest of that particular passage.

Falling transients are, of course, similarly treated, since the control engineer waits for the cessation of a loud passage before readjusting the gain.

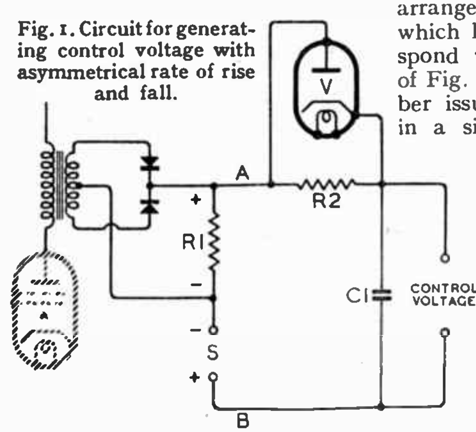
The expansion unit, therefore, is faced with the task of restoring the general level of the signal without altering the contrast of its transient content. In addition, since the transients must be reproduced at the higher level, the gain of the reproducing equipment should rise either immediately before, or simultaneously with, their commencement.

These conditions can be rigidly fulfilled only by a system in which the gain of the reproducing equipment is controlled by an auxiliary signal, transmitted on another channel if necessary, and determined by the gain of the transmitting or recording amplifiers.

In the absence of such a system the control for contrast expansion must be obtained from the signal itself, and a compromise has to be effected if a performance which is more acceptable than the compressed version is to be obtained. Unless a time-delay is introduced into the reproducing chain, so that the signal may be "inspected" before it is heard, it is obviously impossible to arrange that the gain is increased immediately *before* rising transients, and the best that can be achieved is that, by the use of a high rate of rise, the gain rises *during* such transients. This causes expansion of the original contrast, but it so happens that such expansion is not in any way objectionable—rather, in fact, does it improve an orchestral performance which is lacking in vigour.

It is relatively easy, by the use of a low rate of fall of gain, to ensure that the gain of the amplifier is maintained practically constant during falling transients, and for a short period after the cessation of a loud passage to avoid expanding the contrast between the reverberations and the parent sound, which would result in undesirable attenuation of the echo. The design described was based on these principles, having an extremely high rate of rise of gain so that negligible distortion of the "outline" of rising transients occurs, and a low rate of fall of gain to ensure, in addition to the above requirements, that the gain of the amplifier does not follow the alternations of the signal, which would give rise to non-linear distortion.

Fig. 1. Circuit for generating control voltage with asymmetrical rate of rise and fall.



In the original circuit the control voltage for the variable-gain amplifier was derived, by rectification, from the signal. The asymmetrical rates of rise and fall of gain were introduced by a circuit containing a diode and a condenser, as shown in Fig. 1. When the signal is increasing the diode V conducts and the potential of C1 rapidly follows the variation in voltage across AB; but on decrease of signal V is non-conductive, and as R2 is large compared with the conduction-resistance of V the voltage change occurs in C1 only after a time delay.

A simplified version of this control circuit has been suggested independently by two correspondents (Messrs. L. Gregory and E. L. Thomas). Their arrangement is shown in Fig. 2, which has been lettered to correspond with the original diagram of Fig. 7 (page 268 of the September issue). The circuit operates in a similar manner to a peak rectifier. Initially C8 is charged to the standing voltage taken from R17, corresponding to S in Fig. 1. When the signal is increasing, a voltage is developed across R15 and R16, in opposition to the standing voltage. This results in the rapid discharge of C8 through a path formed by the rectifier, the load resistors R20, R21, and the standing voltage supply, R17. If, now, the signal falls to a lower value, C8 can only acquire a further charge through R15 and R16, since the rectifier is non-conductive, and as this resistance is high considerable time delay occurs before the condenser follows the change. This arrange-

Contrast Expansion Unit—

ment thus gives a control voltage similar to that of the circuit previously described, and has the advantage of requiring only one valve.

The load resistance (R20+R21) should be kept as low as is practicable, since its value along with those of R17, C8, and the diode conduction-resistance determines the rate of rise of gain. The transformer, like that in the original circuit, should be a step-down output type with low-resistance windings to avoid appreciable power loss. Its ratio should be calculated to give the optimum load for the control amplifier, taking the secondary loading as (R20+R21). A centre tap although desirable is not essential, providing that the load resistors are of low value. Suitable component values are shown in Fig. 2.

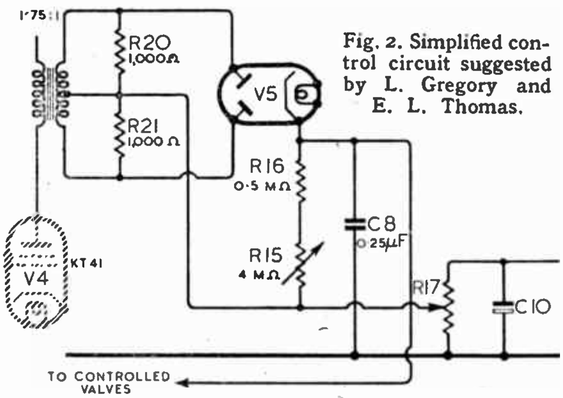


Fig. 2. Simplified control circuit suggested by L. Gregory and E. L. Thomas.

Alternative Valves

A table of alternative valves for the contrast expansion unit is given, since in wartime it is not always possible to obtain the first choice. An exact equivalent of the Mazda AC/SP1 is not obtainable, as this valve is specially designed for suppressor-grid control. Other short grid-base RF pentodes may be used, but are likely to require a higher control voltage. The change may necessitate alteration in screen and grid bias voltages, and to provide sufficient control R17 and the output from the control amplifier may have to be increased. An additional stage of amplification may be required if the output from the pickup is insufficient to provide the increase.

In a well-balanced orchestral performance frequencies lying in the band between 100 c/s and 500 c/s have considerably greater amplitude than the remainder of the frequency spectrum. Consequently the voltage change produced by the control equipment for a given change in intensity is much higher for signals within this band than for those of other frequencies. As a result, sounds such as timpani rolls, which occur mainly within this band, cause disproportionate fluctuations in the general level, which are unpleasant. To counteract this effect it is advisable to "weight" the frequency response of the control amplifier so that approximately equal voltages are produced by all frequencies at their normal intensities. This compensation may be achieved by the use of a resonant circuit tuned to about 350 c/s, and arranged to produce a trough of variable depth in the frequency characteristic, extending approximately from 100 c/s to 500 c/s. A more simple but quite effective remedy is the introduction of steady attenuation below about 500 c/s. This is easily arranged by suitable choice of the coupling condenser C6 in the original Fig. 7. Fig. 3 shows the response curves to be expected with various values of capacitance. Attenuation of the frequency response will reduce the overall sensitivity of the control amplifier and may necessitate the introduction of a further stage of amplification, which, incidentally, will give more scope for the design of suitable filters.

Modification of the frequency characteristic of the control amplifier does not, of course, affect the response of the variable-gain signal amplifier, but only the nature of the control voltage. If the contrast expansion unit should be preceded by a tone-control stage which is being used to accentuate (not merely to correct) some part of the audio-frequency spectrum, corresponding equalisation should be incorporated in the control amplifier.

The operation of a contrast expansion unit can have almost as much effect upon the performance as its design. To secure the optimum operating conditions it is desirable to have some form of indicator to show the state of gain of the variable-gain amplifier. This indicator in its simplest form may be a milliammeter in the common anode lead of the controlled valves, or perhaps more cheaply, a cathode-ray or neon tuning indicator operated from the voltage drop across a small, by-passed resistor inserted in the circuit. Such an indicator will enable the controls of the expansion unit to be set for correct operation, so that only the loudest pas-

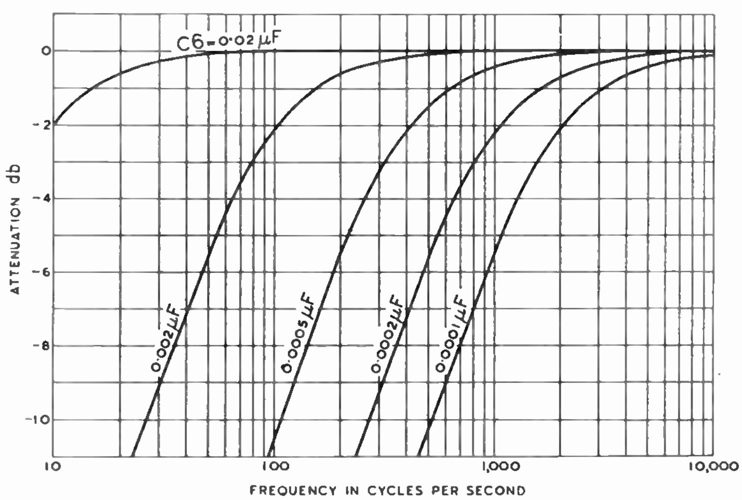


Fig. 3. Response curves showing attenuation given by various values of C6 in Fig. 7 of the previous article.

sages cause the anode current, and hence the gain, to be a maximum.

The use of contrast expansion on manually controlled broadcasts is open to criticism, as recent correspondence in this journal has shown, but in spite of this it can give greatly improved results where some skill in control has effected. If care has been taken in the design of the expansion system it should also be almost impossible to tell that contrast expansion is being employed, the performance being notable only for its lifelike volume range. To achieve the full effect of a large volume range it is essential that the reproducing equipment should

ALTERNATIVE VALVES

Position	Valve Used	Equivalent Valve 4.0 v. heater	Equivalent Valve 6.3 v. heater	Remarks
V1	Osram MH4	Mazda AC/HL Mullard 354V	6C5 6J7, Osram KTZ63	Strapped as triode.
V2, V3	Mazda AC/SP1	Osram MSP4 MSP41 Mullard SP4B	6J7	No exact equivalent. May entail alteration in screen, grid bias and control voltages.
V4	Osram KT41	Mullard Pen A4 Pen B4 Mazda AC5/Pen AC4/Pen AC2/Pen	Osram KT61 Mullard EL33	
V5, V6	Mullard AZ3	—	Mullard EZ2	Any low-impedance triode or pentode with electrodes strapped may be used for V6.

been exercised. There can be no doubt, however, of its value when used with orchestral recordings, in the vast majority of which only the limited volume range betrays the fact that compression has been be capable of creating really high sound intensities with extremely low distortion, as otherwise, if the peaks are obscured by distortion, the thrilling quality of the sound will be lost.

RECEPTION REPORTS

THE Control Centre of the International Broadcasting Union, which has recently returned to its headquarters in Brussels, has found it necessary to make use of a comprehensive code for determining the quality of a received signal. It is pointed out it is not sufficient to know the field strength; something must be known of local conditions and other determining factors.

A clear definition of the quality of a received signal is given by the following code which has been in use for some time in commercial telephony and has now been introduced for broadcasting.

It is pointed out in the *U.I.R. Bulletin* that it is also necessary to give details of date, time, geographical position, meteorological conditions and aerial used, to complete the picture of receiving conditions.

R = Signal Strength	5 very good; 4 good; 3 sufficient; 2 weak; 1 barely perceptible.
A = Amount of fading	1 very little; 2 small; 3 medium; 4 serious; 5 reception impossible.
F = Frequency of fading	1 very slow; 2 slow; 3 medium; 4 fast; 5 very fast; 6 audible frequency.
I = Interference from unwanted stations	0 none; 1 very slight; 2 slight; 3 medium; 4 strong; 5 very strong.
S = Atmospheric disturbance	0 none; 1 very weak; 2 weak; 3 medium; 4 strong; 5 very strong.
B = Noise level	0 none; 1 very low; 2 low; 3 medium; 4 high; 5 very high.
E = Transmitter background noise	0 none; 1 very low; 2 low; 3 medium; 4 high; 5 very high.
M = Modulation depth	6 too deep; 5 deep; 4 good; 3 low; 2 weak; 1 very weak; 0 none.
Q = Quality of Modulation	5 excellent; 4 good; 3 acceptable; 2 bad; 1 very bad.
O = General impression	5 excellent; 4 good; 3 acceptable; 2 bad; 1 very bad.

Is Disc Recording Obsolete ?

***QUESTION No. 16.** When the war ends we shall have an unrivalled opportunity of remedying the mistakes of the past and making a new start in more than one branch of wireless. That has already been pointed out in "Wireless World," but no one has mentioned the gramophone as a proper subject for a radical change.*

Is it agreed that the technique of the gramophone is due for supersession, and, if so, what system of sound recording for domestic reproduction should be adopted in its place?

JOHN HOPE

***STUART BLACK** criticises disc recording, especially in its present form, and suggests directions in which improvements should be made.*

AS one keenly interested in high-quality reproduction who has followed the progress of sound recording since the days of the early Edison phonograph, I am, perhaps, as well qualified to open this discussion as are others of greater technical attainments who may well be side-tracked from the ultimate object in view by irrelevant considerations.

Quite frankly, everything about our present methods of reproducing recorded music in the home appals me. There has been progress, of course, but it has been in spite of the basic methods employed, and not because of them. Fundamentally and mechanically, I maintain that the present methods are worse than those of the original Edison phonograph.

As a matter of interest let us compare the present-day gramophone with the Edison. We will ignore the electrical pick-up, which would obviously have been applied to the Edison if it had survived, and electric drive, which was, in fact, fitted to the more expensive Edisons. The Edison phonograph had a completely smooth record without any abrasive material, and in the later Blue Amberols an almost indestructible material composition was used; the stylus was a smooth sapphire or diamond; the traverse was mechanically driven so that the record had only to draw along the minute weight of the stylus-holding gear, and not the entire pick-up head and arm; the records were hill-and-dale cut so that the amplitude was, or could be, far greater if necessary; and, best of all, the lineal speed of the track under the stylus was constant. In the case of the present disc gramophone not one of the above advantages exists, for the record is deliberately made abrasive; the stylus is for all practical purposes always a steel needle, both of which factors make for scratch and all kinds of surface noise; the record groove has to drag the whole contraption along, and the contraption has to be massive enough to provide the necessary inertia for the relative movement of the pick-up system proper; the amplitude is strictly limited by the distance apart of the grooves, and the necessary thickness of their walls, which are often, alas! even then all too weak. Finally, the speed of the record relative to the stylus is constantly varying. How can one expect even tolerable reproduction under such conditions? Yet the miracle is that it has been attained, to a large extent by sheer misplaced ingenuity.

Now, for a moment, let us consider why, if it is agreed that there were such overwhelming advantages in the Edison, or cylinder, machines generally, they have completely died out. There can be but one main answer, and that is storage. The space taken up by even a dozen of the old phonograph records would accommodate possibly a hundred 12in. discs. Two subsidiary reasons for the eclipse were, I think, ease of manufacture, by pressing instead of moulding (though possibly modern methods of hydraulic pressing plus plastics might have overcome this), and length of playing, which was obviously more limited than on the disc.

What is the position now? Over and over again I have heard people say that the present position is due to vested interests and the amount of money locked up in the present system; that such-and-such firms could, if they would, turn over to sound-on-film, tape recording in one form or another, or what not. I have said it myself, and, while I think there is probably some truth in it, yet it is not the whole story. For one thing, there are too many disc machines in the world for them to be replaced at a touch; then imagine the state of a grand opera on reels of film in an average household, complete with children, after a few weeks. Then there is the matter of cost. We could doubtless have full symphonies or operas to-morrow on film at a price, but that price would be unquestionably prohibitive, and when one considers the difference in cost of processing a photographic record on many feet of film, plus the cost of the film itself and the enormous increase of time involved compared with the simple and speedy pressing of discs, it is easy to see where the advantage of the disc lies, and to some extent must probably always lie.

Alternative Systems

That being the position, what are the remedies or alternatives? It seems to me that the disc must retain its position as the chief source of recorded music in most households for a long time to come, but there is hardly one of the advantages which the old cylinder possessed that could not be incorporated in the disc without destroying its own inherent assets. It could be hill-and-dale cut, and is, in some cases; it could be played with a smooth stone or other similar stylus; it could have a mechanical traverse, thus relieving the record of more than half its work; it could still be pressed in the orthodox way but in some scratch-free plastic; and, finally, and most importantly, it could be made to play at constant linear speed. I harp on this question of constant linear speed for the principal reason that it seems to me essential, if one is to get the most perfect reproduction possible, it is nonsense to expect to get precisely the same result from a given sound when at one moment it occupies about 3in. of space and the next it is compressed into 1in.

There are endless other possibilities by other methods, the outcome of which is pure speculation. Sound on film may yet sweep the board, but even that may not be as we now know it. The sound track may be excited to fluorescence by a special exciter lamp, or it may be made by some new magnetic system if some way of easy duplication can be devised, or, again, it may be by some entirely new electronic method. All I hope is that we shall soon cease to get our music by scraping a steel point carrying some tons of weight per square inch over what is virtually a refined macadamised roadway.

Letters to the Editor

Restarting Television : Pitfalls of Negative Feedback : Synchronising Electric Clocks

Post-war Employment

AS one who has been connected for many years with the radio and allied trades, and is now serving in H.M. Forces, may I comment on "Diallist's" paragraph in the November issue.

From personal contact with wireless mechanic trainees, I can endorse his remarks that many men, particularly the youngsters, have developed a great interest in radio as a result of their training, and in so far as this develops into the pursuit of a fascinating hobby after the war, it seems to me to be an excellent thing.

But if these men contemplate, as "Diallist" correctly anticipates, entering the field commercially, I am afraid that disillusionment awaits them in the overcrowded (in peacetime) ranks of servicemen.

Admittedly the really efficient service man has hitherto been far too rare. But is this surprising when one considers that whether employed by large manufacturer or small retailer, he is usually expected to work longer hours for lower wages than the dustman or road sweeper. Or if he sets up business on his own he finds that the public does not expect to pay even moderately for his services.

Small wonder that in pre-war days the man with ability and enthusiasm turned elsewhere for his livelihood.

If there is to be an influx of labour after the war, conditions will become chaotic, and all schemes for promoting increased technical efficiency among servicemen will prove ineffective unless the public and the manufacturers are first brought to realise that servicing is a skilled trade and must be suitably rewarded.

R. S. S.

Restarting Television

DURING the 30 years I have been a reader of your paper I have had little complaint of your Editorial policy, but I must express my disapproval of the leading article in the November issue.

Television immediately prior to the war was carried on exclusively for the London area at the expense of the whole country. Hundreds of thousands of pounds of the public's money, much of which was subscribed by way of the so-called wireless licence, was poured out (one might say wasted) just to please a few hundreds of those fortunate enough to live under the shadow or within sight of Alexandra Park. No attempt whatever was made to cater for the millions who lived in the outer darkness of the North and Midlands.

Therefore I say that television must *not* begin where it left off. There must have been some progress during the war, in America if not here, and it is absurd to say that the present owners of sets must be catered for, and fresh people encouraged to purchase sets to work on the old lines, if progress demands that the old ideas should be scrapped and the new ones put into operation.

Television, when it starts again after the war, should have three main ideals: (1) Universal transmission in all populous parts of

Letters to the Editor—

the country; (2) a complete fresh start with methods bang up to date, with if necessary the scrapping of all existing sets if they cannot be modified to meet present requirements; (3) a special licence fee supplementary to the present wireless licence. Let those who want their fun pay for it, and not expect it to be a drain on the funds subscribed for wireless listening. It is bad enough that the foreign broadcasts are such a charge. LOUIS J. WOOD.

Halifax.

I FEEL I must express my disagreement with the leading article on restarting television.

No one could claim that the prewar transmissions were a great success so far as the number of "viewers" was concerned, and the principal reason for the lack of enthusiasm among potential purchasers of sets was undoubtedly the fear that the amount spent would soon be wasted as, due to improved transmissions, the set would become obsolete very quickly.

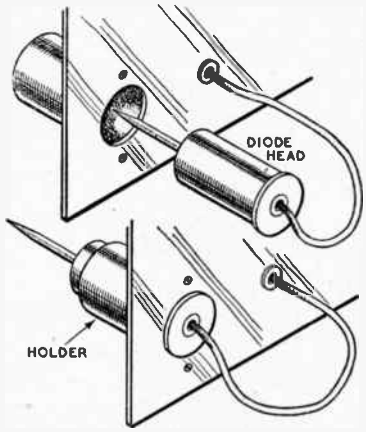
Your suggestion of two different transmission systems would greatly aggravate this position, both from the viewers' and the manufacturers' standpoints. The public must have reasonably priced sets, which will not date quickly, and to get these there must be: (1) A transmission system which is able to give results which will at least be considered moderately good after five years; (2) a universal scheme for the British Isles, which will allow manufacturers to work on mass-production lines.

FRED. F. MESSHAM.

Lytham St. Annes.

Valve Voltmeter Protection

MAY I make a suggestion regarding the "Multi-purpose Test Meter" described in your October issue? In instruments such as this, embodying a diode-head with a length of cable and plug for connection, there is always a risk that this unit, being loose and unprotected, will be damaged. I have therefore always adopted the expedient of providing a "garage" for the diode head on the panel of the instrument. The idea is shown in the accompanying sketch. A hole is cut and a length of paxolin tube lined with felt is fixed behind the panel to register with this hole. The far end of the cable is anchored inside the cabinet and the



cable runs freely in an ebonite grommet. When out of use, the diode head is "parked" and the cable fed back into the interior of the cabinet. This makes for easy portability and the diode head is always "there when it's wanted."

E. HAYTER SIMMONDS.

London, S.W.15.

"Negative Feedback"

I FIND myself in disagreement with Mr. J. T. Terry on a number of points in his article on "Negative Feedback" in your July issue. It is clear that Mr. Terry is not familiar with all the work that has been done on the subject; otherwise he would know that the conditions under which feedback can be applied, the methods of applying it, and the benefits to be expected from its application are all fairly completely understood.

A particularly misleading suggestion is that for feedback to be negative "the feedback voltage βV_0 should contain a component 180° out of phase with the applied voltage V_i." While it is true that in such a case the feedback is negative there are other circumstances in which feedback can be negative. i.e., in which gain is reduced and linearity, etc., generally improved. The true criterion of whether feedback is negative or positive is given in Black's original paper[1] and can be demonstrated as follows. Suppose that the magnitude of $m\beta$ is $|m\beta|$ and the angle of $m\beta$, i.e., the phase-shift which a signal undergoes while passing once through the m network and once through the β network, is ϕ. On a polar diagram describe a circle of radius 1.0, centre at the point $(1, \angle 0)$, passing through the origin, and from the origin draw a line of length $|m\beta|$ making an angle ϕ with the reference line. If the end of the line falls inside the circle the feedback will be positive; if the end of the line fails *anywhere* outside the circle the feedback will negative, i.e. gain will be reduced. This means that negative feedback can be obtained with ϕ less than 90°, and even with $\phi = 0$ if $|m\beta|$ is greater than 2.0. In practical amplifiers it is difficult to maintain stability with appreciable amounts of feedback at frequencies for which ϕ is small, but it can be done. Peterson, Kreer, and Ware[2], in experimental work designed to test Nyquist's Stability Criterion made a stable amplifier which at certain frequencies satisfied the $\phi = 0$ condition. More generally, it can be shown that in most amplifiers which have a fairly large amount of feedback round more than one stage, ϕ becomes considerably less than 90° at the ends of the working band, even though the feedback is still negative. An amplifier in which this is not so can be regarded as inefficient from the point of view of applying maximum feedback without oscillation.

Mr. Terry seems to have missed one of the important points regarding reduction of harmonic distortion in the output stage of an amplifier. Negative feedback, properly used, will give reduced distortion for the *same* output and the resultant reduction of gain can be made up by increasing the gain at an earlier stage in the amplifier where harmonics are not usually troublesome.

The example illustrated in Fig. 8 of this article is also misleading. No practical amplifier would give an output which is exactly zero during the negative half-cycle and if there is any signal there at all the application of negative feedback will increase it, relatively, so that the disparity be-

[1] "Stabilised Feedback Amplifiers," *Bell System Tech. Journ.* Jan 1934.

[2] "Regeneration Theory and Experiment," *Bell System Tech. Journ.* Oct. 1934.

tween the two half-cycles is reduced.

I must also disagree with the statement that ". . . it seems axiomatic that feedback can correct frequency distortion in voltage amplifiers if, and only if, the distortion is not due to series resonance." The fact is that the external gain, when feedback is applied, is *always* equal to $m/(1-m\beta)$. The reason why feedback sometimes fails to give the expected improvement is not because of anything wrong with the principle, but usually because m and β are not known with sufficient precision at all frequencies, including an octave or two above and below the limits of the working band, or else because disproportionate improvements are expected from small amounts of feedback. It is to be noted that at b in Fig. 2 of the article the amount of feedback is almost zero.

"ROOKIE."

[The author writes:—While I cannot claim to be familiar with all the work that has been done on negative feedback, I see no indication of a general analysis applying to amplifiers designed economically, i.e., with a small number of valves, as is often the case in radio. Indeed, in his paper, H. S. Black has stated quite clearly that his analysis, as far as it goes, applies to "good" amplifiers, i.e., "good" in the carrier-in-cable sense. While adding that "economy" amplifiers could also be improved by negative feedback, he pointed out that the analysis would go beyond the scope of his paper. It was the stated aim of my article to consider negative feedback with regard to amplifiers using a few valves only; I should be delighted to learn of an analysis of such circuits.

Black defined feedback as negative when the magnitude of $\frac{1}{1-m\beta}$ (= F, say) was less than unity. In connection with a chart of vector loci, he gave a geometric construction for determining whether F was larger or smaller than unity in magnitude. This is cited by the erudite "Rookie" to confound my statement that "the feedback voltage V_0 should contain a component 180° out of phase with the applied input voltage V_i". In fact, a little thought shows this to be identical with Black's criterion for negative feedback.

According to my statement, the ratio

$$\frac{\text{Voltage fed-back}}{\text{Applied volts}} = \frac{\beta V_0}{V_i} = \frac{m\beta}{1-m\beta}$$

should have a negative real part. But if $\frac{1}{1-m\beta} = F$, then $m\beta = 1 - \frac{1}{F}$; $\frac{m\beta}{1-m\beta} = F - 1$ and will have a negative real part if $|F|<1$, whatever phase angle of $m\beta$.

My Fig. 8 was deliberately exaggerated to bring home the point that negative feedback cannot deal effectively with discontinuities, and I did not think for one moment that "Rookie's" amplifiers would be designed accordingly.

My Fig. 2 was based on an example wherein $m = 30$, $\beta = \frac{1}{5}$; the sort of thing radio-engineers tend to do with a single stage of audio-amplification. Incidentally, Black has shown a curve wherein the feedback has roughly the same value and which also exhibits "bass resonance". My argument was not a criticism of the theory inasmuch as it exists, nor a criticism of the practice where it works; rather, it was to warn against certain pitfalls.—ED.]

Time Signals

IN view of the increasing popularity of electric clocks and time switching devices, I feel that a published time should be arranged, say once a week, when the master clock at the power station is as near as possible in synchronism with Greenwich time.

It is not difficult to see that, if the variation with an ordinary synchronous clock is plus or minus two minutes from Greenwich time, it is quite possible for a clock to be four minutes fast or slow, depending on the state of the power station clock at the moment that the electric clock was started, and even though set accurately by the wireless time signal.

Throughout Great Britain there must be many thousands of synchronous electric clocks in use, and if under war conditions it is impossible to maintain precisely correct frequency at all times, it would be an advantage to know that your clock was in step with the power station master clock, Letters to the Editor—

and therefore indicating the best average time.

Even under the worst conditions of load variations, it should be possible for the generators to be brought into step at, say, 9.00 p.m. every Sunday evening, thus giving a weekly "Setting Time" when all clocks could be synchronised.

EVAN W. DAVIES.
Cheadle Hulme, Manchester.

The First B.B.C. Broadcast

IS it not a pity that the B.B.C. are celebrating November 14th, 1922, the date when *daily* broadcasting began, as their birthday? Their first broadcast (with a truly memorable programme) took place on the 3rd of that month, two days after they were licenced to broadcast.

J. W. TURNER.
London, N.3.

Contrast Expansion

I WONDER if Mr. Moir's indignation (October issue) might be compressed a few db. by the reflection that this long and interesting correspondence has been conducted from two essentially different standpoints. It began, many months ago, with a plea from a correspondent for a system of controlled compression and expansion.

One group of letters has supported this plea and discussed—academically it may be—the principles which should underlie an ideal system and the extent to which they are at present practicable. On the other hand there are those, like Mr. Moir, who have been considering an expander circuit as an auxiliary to present systems of transmission and recording.

Surely it is evident that high-fidelity reproduction requires a controlled system in which the compression and the expansion are inverse. Such a system could work on the basis of inverse amplitude distortions, or inverse non-linear distortions, or a compromise between these two. A system based on amplitude distortions (i.e., a system with long "opening" and "closing" times) would ignore transients both at the compressor and the expander. Thus, provided none of the transients reached an amplitude sufficient to cause overloading at any part of the transmitting or receiving chain, all would be well. This, as I understood it, was the argument put forward by Mr. Bailey (October issue). It is a good case and seems to offer the most likely solution. The suggestion I have already dropped, namely, that the compressor and expander might introduce inverse non-linear distortions, would avoid the possibility of transient distortion but introduces formidable difficulties. I agree with Mr. Moir that these difficulties are very obvious: I dropped the suggestion in the hope that a reader might know of some practical attempt to overcome them.

J. R. HUGHES.
London, N.W.7.

RANDOM RADIATIONS

By "DIALLIST"

Lend-Lease Receivers

IT was recently announced that a quantity of radio sets had been imported from the U.S.A. under the Lend-Lease agreement. Hopes of getting a new set to replace a worn-out ancient must have risen in many a breast; but I fear that those who will be lucky in this way won't be a very numerous band, for some little time at any rate. The first consignment appears to consist of only 8,000 sets, and at the moment of writing even these few have not been released for sale. They are of several different types, and so grading, testing and pricing are necessary. Many, too, will have to be converted to suit our 230-volt supplies. I hear that other consignments of American sets are to follow—possibly the first 8,000 are more or less samples. This is good news, for in view of their war material commitments, our own makers can't cope with more than a fraction of the enormous public demand for new receivers. Valves—or rather the inability of makers to supply enough for civilian needs—are, I believe, one of the chief reasons for the scarcity of new sets on the market. Uncle Sam's valve industry is so gigantic that he may be able presently to give us real help in solving this pressing problem.

□ □ □

The I.E.E.

SOME of the most interesting of technical meetings are those held by the Institution of Electrical Engineers, either at the London headquarters or at its provincial centres. Hitherto admission has been confined to members, associate members, associates, graduates and students of the Institution. One of the Institution's greatest aims is to further the advance of electrical science, and it has long been felt that this could be helped on if people interested in the many branches of electricity, but not possessing the necessary qualifications for any form of membership, could be allowed to attend the technical meetings. It has now been decided that this shall be done. All that is necessary if you want to attend is to write to the Secretary of the Institution for a form of application and particulars of the scheme. A fee of 7s. 6d. will cover the meetings of one session. The Secretary will send a list of the meetings in London or at the appropriate provincial centre and an invitation card. Those so invited acquire, of course, no status in the Institution; nor have they the right to join in discussions unless permission is specially given. This new concession by the Institution is sure to be warmly welcomed by readers of the *Wireless World*, whether they are interested only in the meetings of the Wireless Section or in the wider aspects of electricity. I should think that the invitation card is one of the best seven-and-sixpenny-worths ever offered.

□ □ □

What of Interference?

IT'S a long time now since I've been able to do any long-distance work on my beloved short waves. Hence I know almost nothing about the interference position—I'm referring mainly to that of the man-made type—at the present time. I'd be glad to hear from any enthusiasts who are fortunate enough to be able to use their sets at all regularly how they are finding it. I imagine that in many places it is considerably less than it was in the days of peace. Flashing neon signs, for instance, are out of action; there are far fewer cars in the streets; the supply of refrigerators, hair dryers, vacuum cleaners, electric razors and other things that could be grave offenders has temporarily closed down and normal wear and tear must have reduced considerably the number of such appliances in use. On the other hand, there has been enormous expansion of many manufacturing industries, with the installation of vast quantities of electrically driven machinery. In some localities, then, interference may have become a good deal worse than it was. I wonder if we will take the splendid chance that will present itself when peace returns of introducing really effective anti-interference legislation. We may never have such an opportunity again. As I have said, a big proportion of the interference-producing domestic gadgets will either be quite worn out or on their last legs. Legislation prohibiting the making or marketing of offending apparatus should cause little hardship. And the same thing applies to cars. Thousands upon thousands of new ones will be turned out in the years after peace is signed; are we going to allow each of them to contain a miniature transmitter of unwanted radiation? New electrical factory machinery will be required everywhere; there is every reason why it should be of non-interfering type. One consoling thought is that electrical sausage machines, reputed to be amongst the worst offenders, should all be pretty well worn out by overtime working. Somehow I foresee a slump in sausages, and therefore in the interference caused by their production, when chops are chops and steaks are steaks once more.

□ □ □

Top Cutting

IN the last issue of *Wireless World*, P. B. Fellgett castigates me for having aired the suggestion that those who revel in dance music of the modern kind turn the tone control to a "woomphy" setting in order to make hearable some of the more horrible noises produced by the performers. It was but a suggestion, though it was the result of deep and earnest study of the problem in officers' messes throughout the war. Officers' messes to-day are peopled mainly by the young and many are "mixed"; that is to say, they contain both men and the alleged gentle sex. What has puzzled me is (a) that the first young thing to enter immediately switches on the wireless set and tunes in dance music if available, and (b) that he or she forthwith gives the tone control a hefty anti-clockwise twist (if it is not already up against its stop in that direction). I don't think that Mr. Fellgett's explanation that this is done to cut down valve hiss and so on is entirely satisfactory, for amongst the young inhabitants of almost any mess there are lovers of what, if he will allow me, I should call real music. They do not so misuse the tone control. If, then, dance music, with or without crooning, can be enjoyed only when its top is lacking, must this not be due to some special characteristic of such music? Few can deny that if the tone control is left in the position selected to make dance music bearable to the ear, the news bulletin when it comes on is almost incomprehensible. And, *vice-versa*, how many could stand dance music as reproduced by the ordinary domestic set if it followed the news and the tone control were left untouched?

TELEPHONE RELAYS

MANY new applications have been found for the electromagnetic relay normally used in telephone exchanges, and numerous modifications have been made to extend the range of operating speeds, contact loadings and switching arrangements.

To assist designers in finding the most suitable type for any given purpose the Panel "W" (Relays) of the Inter-Services Components Manufacturers' Council, 59, Russell Square, London, W.C.1, have published a booklet giving the characteristics of relays in the primary group recommended for new applications. Copies are obtainable from the above address, price 4d., postage paid.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

AC/DC SETS

THE figure shows a receiver of the universal type, in which a rectifier D and filter unit F deliver a smooth HT voltage when plugged in either to AC or DC mains. In such sets the usual mains coupling transformer is replaced by a wire connection L from the power supply to the chassis, which cannot therefore be directly earthed for fear of shorting the mains. At the same time it is necessary to by-pass any RF voltages that may be developed between the chassis and ground. The condenser C provided for this purpose must have a sufficiently low impedance to prevent undesirable back-coupling between the valves, and yet must not be large enough to accumulate a voltage likely to give a shock to the user of the set.

The inventors first meet the second consideration and then provide special means to offset any possible back-coupling.

They point out that the largest leakage currents will occur through stray capacities from the high potential ends of the primary and secondary windings of the last IF transformer T. One such path is shown in dotted lines at LC1; this completes a circuit from the primary winding to the chassis and back through the condensers C and C1 to the low potential end of the winding. The second leakage occurs at LC2, the circuit being completed through the condensers C and C2.

If these two leakage currents are made equal in amplitude and opposite in phase, the net current through the condenser C will be zero and no undesirable reaction can take place. According to the invention, the first of these requirements is met by placing a fixed condenser C3 of suitable value in parallel with the leakage path LC1; and the second by suitably adjusting the coupling and tuning of the two transformer windings.

Philco Radio and Television Corporation (assignees of E. C. Freeland). Convention date (U.S.A.) November 16th, 1940. No. 553028.

DOUBLE-BEAM CR TUBES

IN a known type of cathode ray tube, the electron stream from the gun is divided by an electrostatic screen into two distinct beams, which are then independently controlled by separate deflecting plates. It is found, however, that each beam is liable to be affected, to some extent, by the deflecting voltages applied to the other beam.

The inventors state that this undesirable inter-modulation effect, which is particularly in evidence when the deflecting plate circuits are of high impedance, is due to the collection by each of the plates of secondary electrons emitted by the electrostatic screen. The latter is inevitably subjected to a certain amount of bombardment by the original electron stream, especially at those parts nearest to the gun.

The source of the trouble is removed (a) by carbonising the surface of the dividing screen, so as to minimise secondary emission; and (b) by extending the upper end of the screen into close proximity with the anode of the tube, thereby reducing the penetration of each deflecting field into the region swept by the other beam.

A. C. Cossor, Ltd.; E. E. Shelton and H. Moss. Application date July 23rd, 1940. No. 553131.

IMPEDANCE CONTROL

IN an amplier which is negatively back-coupled through a cathode load resistance, the resulting feedback is known to vary with the gain of the valve. This is usually regarded as an undesirable feature, particularly when handling signal currents, since it introduces objectionable variations in the impedance of the input circuit. The effect can, however, be utilised to provide an independent control, within limits, of the working impedance of any selected circuit.

According to the invention the gain or mutual conductance of an amplifier with a feed-back resistance in its cathode circuit is varied at will, say, by adjusting the bias on the screen grid. This alters the effective impedance of any circuit connected across the input terminals of the valve. The circuit under control is, of course, in series with the amplifying channel or other working load, though the control valve is not.

The control unit can be used, say, to adjust the selectivity response of a wireless receiver over a comparatively wide range, or it will serve to adjust the coupling between the untuned elements of a filter network, thereby controlling the band-pass width.

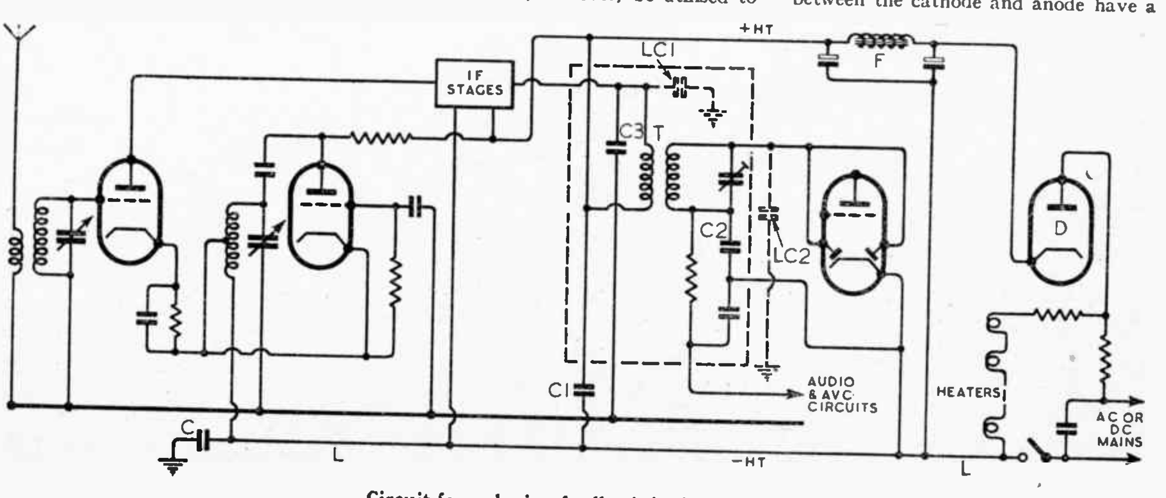
Marconi's Wireless Telegraph Co., Ltd. (Assignees of J. L. Hathaway). Convention date (U.S.A.) January 7th, 1941. No. 553884.

DIODE RECTIFIERS

AT very high frequencies, a diode rectifier is best operated on the upper bend of its characteristic curve. The positive anode bias then naturally gives a high electron speed and a correspondingly short transit time. For such work, it has been customary to use a small-sized tube with a very short filament, to maintain uniform temperature throughout.

By contrast, the inventors use a tube of normal size having an uncoated filament, preferably of pure or thoriated tungsten, of ordinary length. Owing to the dissipation of heat from the supply conductors, the temperature gradient along the cathode wire will then be represented by a bell-shaped curve, the hottest point being at the centre. The anode consists of a pointed wire or spade-shaped plate, which is carefully arranged opposite the centre of the filament, at the hottest point.

For very short waves, only the electrons passing across the shortest path between the cathode and anode have a

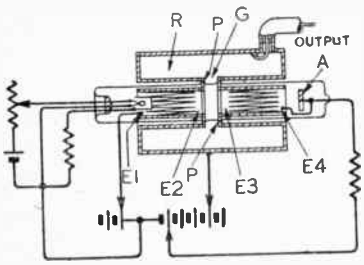


Circuit for reducing feedback in AC/DC sets transit-time which is short relatively to the cyclic time. Those reaching the anode from other points of the filament have such mutual phase-displacements that they effectively cancel out. A hairpin filament may be used, but a straight wire under tension is preferred.

Philips Lamps, Ltd. (communicated by N. V. Philips Gloeilampenfabrieken). Application date December 18th, 1941. No. 554977.

ELECTRON - BEAM MODULATORS

RELATES to discharge tubes of the kind in which an electron stream is first passed through a hollow resonator, where it is "bunched" by the action of the alternating fields inside the resonator. The stream can then deliver energy to a similar resonant system provided its passage through that system is suitably phased.



Electron oscillator

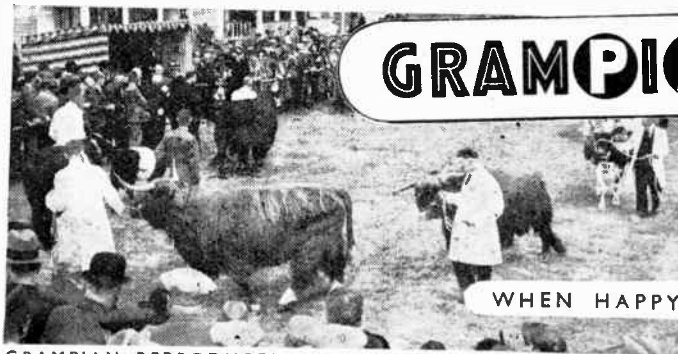
The efficiency with which such devices can be used to generate or amplify oscillations of ultra-high frequency is limited by the strength of the electron stream, and by the intensity of the alternating fields set up inside the resonating electrodes.

The figure shows an arrangement in which the electron stream is forced to oscillate to and fro across the gap G of the resonator R, somewhat in the manner of a Barkhausen-Kurz oscillator, instead of passing straight through as usual. This expedient is used to increase the overall efficiency.

The resonator R carries a higher positive potential than the anode A, which serves to collect only the more highly accelerated electrons. The "approach" electrodes E1, E2 and E3, E4 are made of two interleaved parts, as indicated by the zig-zag lines, which carry different positive potentials and are insulated from each other. The relative areas exposed to the stream are those required to create such a potential gradient along the length of the tube as will ensure that most of the electrons oscillate to and fro across the gap G until they have delivered up all their available energy, whereupon they are deposited on the periphery of the rings P, forming the edges of the gap.

Standard Telephones and Cables, Ltd. (Assignees of J. A. Morton). Convention date (U.S.A.) July 5th, 1940. No. 553866.

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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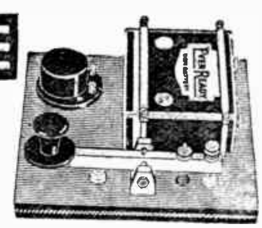

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QUALITY amplifier, speaker, gram. motor and components; s.a.e. details.—Read, 110, Mottingham Rd., S.E.9. [2184

PARMEKO disc recorder, with cutting head, as new, cost £70, accept £50; Andak cutting head, £4.—Harris, Strouds, Bradfield, Berks. [2207

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ONE Single spring Garrard motor, £1; 1 Western Electric cutting head, £5: Gambrell Novotone, £3/10; amplifier two-stage paraphase, 354vs P.X.4s, less output transformer, £10; attenuators, stud type, wire-wound, 3db 5,000 megohms, £2; Garrard R.C.10 record changer, slight adjustment needed, £12; Rothermel-Brush Studio crystal pick-up, £7/10; postage extra.—J. C. G., Gilbert, Pen Rhiw, Royal Ave., Worcester Park. [2219

Wanted

CASH paid for ac record players, gramotors, pickups, ac/dc meters, quality speakers, sound or faulty.—Box 2988. [2228

WANTED, diamond recording needles, must be undamaged; good price offered.—L. Gregory, 51, Higher Rd., Urmston, Manchester.

COMPONENTS—SECOND-HAND, SURPLUS

FINE radiogram cabinet, Philco 100 guinea model; £15.—Box 2974, c/o *W.W.* [2161

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AUSTERITY RADIO, Ltd. (formerly F. H. Wilson) 51 2 Chancery Lane, London, W.C.2

CONDENSERS, tubular, 0.0005mfd to 0.005, 6d. each, 0.02 to 0.01 9d. each; mica 0.01, 2,200v test, 1/6; silver mica, 0.00015, 0.0002, 0.0005, 0.00005mfd, 9d.

VARIABLE condensers, single 0.0005mfd, 2-speed drive with pointer, knob and dial, no escutcheon required, one-hole fixing for portables, crystal sets, &c., 6/-; tuning condensers, 30mmfd, 2/6.

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VALVE holders, 4-, 5-, 6-, 7-pin Paxolin, 6d.; International Octal, 9d.; Octal cable plug and socket, 2/-; 5-pin cable plug (to fit standard 5-pin English valve holder) with 5 coloured leads, 2/-.

PAXOLIN, polished, flat, strong, 18×2¾×3/32nds approx., 1/6; soldering tags, 3d. dozen; terminal strips, from 3d. to 9d.; eyelets, 1/2 to 1/6 gross; resistors, ½w, 6d.; 1w, 1/- each, most values available; Spiro clips, 2 a 1d.; flexible coupling joints, large, 1/-; dial lamp holders, 6d.; A1, A2, E panels, 6d.; Systoflex, coloured, plain and striped, 4d. per yd lgth; screen cable, single or twin, 1/6 yd.

See also our display advt. on p. 32.

AUSTERITY RADIO, Ltd., 51-2, Chancery Lane, W.C.2. 'Phone: Holborn 4691.

B.A. thread screws and nuts. Large stock. Enquiries invited. One gross assorted useful sizes, 2/6; ditto washers, 1/6 gross; fibre washers, 1/6 gross; assorted solder tags, 2/- gross; rubber-covered stranded copper wire, 1d. yard; heavier quality, 1½d.; very heavy, 2d. yard, ideal for aerials, earths, etc.; finest quality resin-cored solder, ½lb., 2/-; Wood's metal stick, 2½in.×¼in., 1/-; sensitive permanent crystal detector, Tellurium-zincite combination, complete on base, guaranteed efficient, 2/6; wireless crystal with silver cats-whisker, 6d.; new single earphone, 750 ohms, made originally for the Air Ministry, 5/6; reconditioned headphones, complete, 4,000 ohms, 12/6; all postage extra.—Post Radio Supplies, 67, Kingscourt Rd., London, S.W.16.

PRELIMINARY mike amplifier for moving coil mike, battery operated, £6; G.E.C. lapel mike, £4; G.E.C. moving coil mike, £6; Trix second stage amplifier type, 26, £12; electric gramophone with pick-up and tone arm £15.—Roberts, 9, Winsover Rd., Spalding.

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POWER TRANSFORMERS. Single phase 50 cycles 35 KVA. 35,000 watts, by Brit. Elec. Transf. Co. 220 volts to 110/110 volts, £30. 5 KVA 220 volts to 5,000 volts and 500 volts, £10. 2 KVA Foster 200 volts to 4,000 volts, £8 10s. 1½ KVA Zenith 100 volts to 6,000 volts, £8. 3KVA 400 volts SP 50 cycles to 600 volts, oil filled, by Metvick, £9. 2 KVA 230 volts SP 400 cycles to 11,500 volts. C.T., oil filled, Foster, £8 10s. 1 KVA 1,000 volts SP 50 to 20,000 volts, oil filled, by J. & P., £7. 1 KVA 240 volts to 17 volts 57 amps, 4 taps to 6 volts, air SP 50, by G.E.C., £7. ½ KVA 230 volts to 4 volts 100 amps., air SP 50, by A.M., £4 15s. All as new.

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T.C.C. condensers, 2mfd, 30v, d.c. working; 2/6.

2-GANG superhet variable condensers, .0005-mfd, with trimmers; 10/6.

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OAK switches, 2½in spindle, complete with knob, 4-way, 2-bank, with connecting block, 5/-; 4-way, 2-bank, 4/3.

SPEECH transformers, brand new, ex well known speaker maker, ratio 30 : 1, a fine job; 6/9 each.

RELAYS.—Brand new, surplus stock from Standard Telephones, electro-magnetic make and break units to operate on 1½ volts at 15mA; to clear stock, 5/9 each.

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T.C.C. tubular condensers.—.1mfd, 6,000 volt dc test, 8/9 each; also 2mfd tubulars, 30 volt working, 2/6 each.

T.C.C. condensers in metal cases, special offer, much reduced to clear, 4×4mfd, 70 volt working; 2/6 each.

SPEAKER transformers for Pentode output valves; 5/10 each.

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COUNTERS.—Ex. G.P.O., every one perfect, electro-magnetic, 500 ohm coil, counting to 9,999, operated from 25v-50v dc, many industrial and domestic applications; 6/-.

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DROPPING resistances.—To replace 2- and 3-way line cords, with diagram showing connections, .3amp, in strong metal case, 13/- each; without case, 10/- each.

ELEC. razor resistances, universal input, in strong metal case; 10/- each.

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(Continued on p. 32.)

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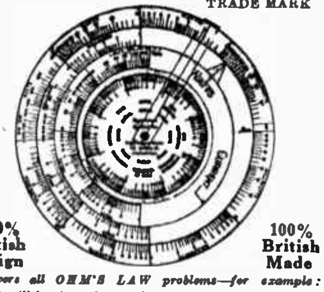

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What will be the voltage with watts value W and I current flowing ?

What is the current flowing where watts value is W and voltage is E ?

What current will flow though R resistance where voltage is E ?

What will be the resistance where current I flows at voltage E ?

What will be the resistance where watts W is at voltage E ?

What will be the resistance where watts W is at current I ?

What is the wattage at voltage E through resistance R ?

What is the wattage of current I through resistance R ?

What will be the wattage of I current at E voltage ?

The scales read from 1 millivolt to 1,000 volts. From 1 ohm to 1,000,000 ohms. From 1 milliamp to 10 amperes. From one-tenth of a milliwatt to 10,000 watts.

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(Continued from p. 31.)

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SEE also our display advt. on p. 34.

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WEBSTER M.C. microphone, desk stand, £6; Bruno Ribbon microphone and transformer, £4/10; Wright de Ooster 12in moving coil, 200v field, £4/10; Berco 200.000 megohms wirewound 3in potentiometers, £1; Plessey 3-gang 0.0005, 7/6; Jones 4-way plugs sockets, 5/-; Masteradio 12v G650 vibrator, 15/-; Dubilier 0.01 mica, 5/-; 0.1 mica, 8/6; Wearite IF transformers 465Kc, 5/6; Westinghouse rectifiers, H.T.8 10/-, H.50 7/6, H.10 5/-, Westectors 2/6; Lissen 4-way turret, 10/-; Meissner type coil unit, unit R.F. oscillator 465 Kc, F.C. air trimmers, 10-2.000 meters, £5/10; 1-watt resistors, 6d.; 2-watt, 1/-, all values; Celestion M.C. permanent magnet, universal transf., £2/5; Baker's triple cone permanent magnet, 15 megohms., £3; many British valves at ⅔ list price; 1852, 1853, 954, 955 at list price; Mazda Thryatron T.31 Marconi Stabilivolt, offers; postage extra.—J. C. G., Gilbert, Pen Rhiw, Royal Ave., Worcester Park. [2221

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14 assorted Screw Drivers and Box Spanners. Polished ebonite with metal plated parts. Complete with extension handles; in carrying wallet 30/-

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T.C.C. 0.1 non-inductive tubular condensers, in paxolin tubes, type 330, 350v wks., 6/6 dozen, 75/- gross.

SLOW motion (epicycle) drives, in well-finished brass, ratio 8-1, shaft 1½in long, ¼in dia., drilled to take pointer, 1/3 each.

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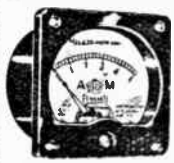

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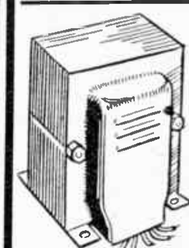

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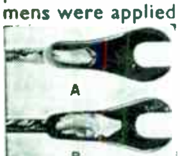

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Soft solders are made in various alloys of tin and lead, the tin content usually being specified first, i.e. 40/60 alloy means an alloy containining 40% tin and 60% lead. The need for conserving tin has led the Government to restrict the proportion of tin in solders of all kinds. Thus, the highest tin content permitted for Government contracts without a special licence is 45/55 alloy. The radio and electrical industry previously used large quantities of 60/40 alloy, and lowering of tin content has meant that the melting point of the solder has risen. The chart below gives approximate melting points and recommended bit temperatures.

ALLOY Tin Lead	Equivalent B.S. Grade	Solidus C.°	Liquidus C.°	Recommended bit Temperature C.°
45/55	M	183°	227°	267°
40/60	C	183°	238°	278°
30/70	D	183°	257°	297°
18.5/81.5	N	187°	277°	317°

VIRGIN METALS — ANTIMONY FREE

The wider use of zinc plated components in radio and electrical equipment has made it advantageous to use solder which is antimony free, and thus Multicore Solder is now made from virgin metals to B.S. Specification 219/1942 but without the antimony content.

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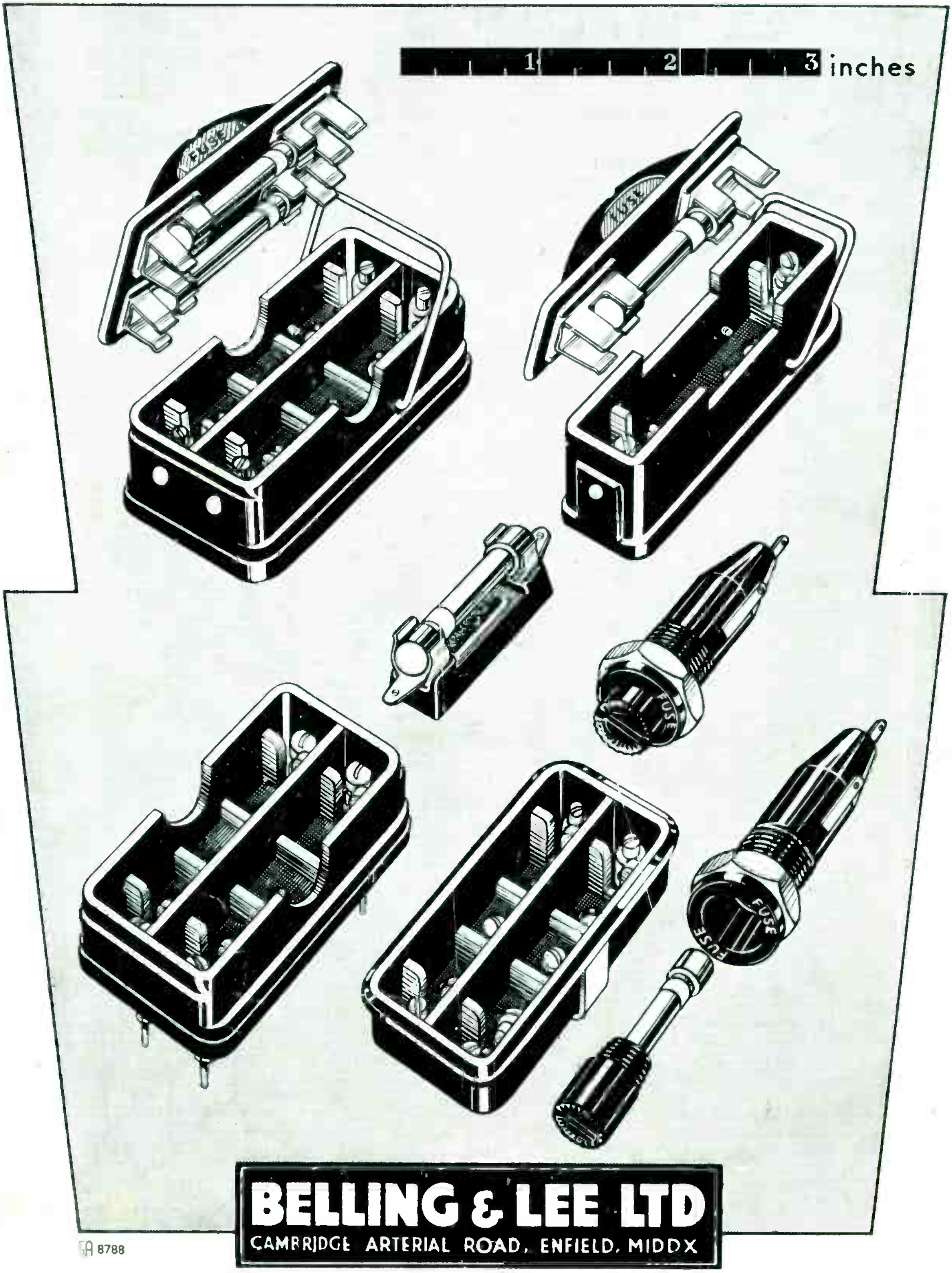
S.W.G.	10	13	14	16	18	22
Feet per lb.	23	44.5	58.9	92.1	163.5	481

CORRECT SOLDERING TECHNIQUE

Ersin Multicore Solder Wire should be applied simultaneously with the iron, to the component. By this means maximum efficiency will be obtained from the Ersin flux contained in the 3 cores of the Ersin Multicore Solder Wire. It should only be applied direct to the iron to tin it. The iron should not be used as a means of carrying the solder to the joints. When possible, the solder wire should be applied to the component and the bit placed on top, the solder should not be "pushed in" to the side of the bit.

ERSIN MULTICORE SOLDER WIRE is now restricted to firms on Government Contracts and other essential Home Civil requirements. Firms not yet using Multicore Solder are invited to write for fuller technical information and samples.

MULTICORE SOLDERS LTD., Commonwealth House, New Oxford St., W.C.1. CHAN 5171/2.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BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX