Wireless World

RADIO, TELEVISION AND ELECTRONICS

43rd YEAR OF PUBLICATION

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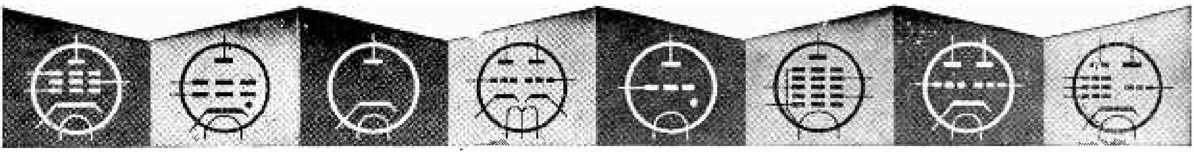
AUGUST 1953

In This Issue

PUBLISHED MONTHLY (last Tuesday of preceding month) by ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1. *Telephone:* Waterloo 3333 (60 lines). *Telegrams:* "Ethaworld, Sedist, London." *Annual Subscription:* Home and Overseas. £1 7s. 0d. U.S.A. $4.50. Canada $4.00. BRANCH OFFICES: *Birmingham:* King Edward House, New Street, 2. *Coventry:* 8-10 Corporation Street. *Glasgow:* 26B Renfield Street, C.2. *Manchester:* 260 Deansgate, 3.



VALVES, TUBES & CIRCUITS

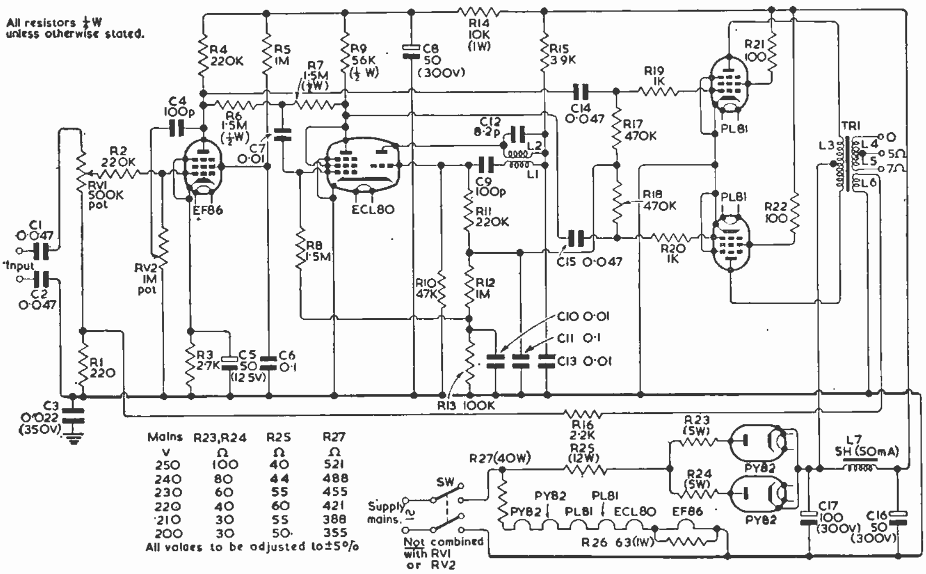
8. 15-WATT D.C./A.C. AUDIO AMPLIFIER

An amplifier suitable for use with D.C. or A.C. mains to give about 15 watts power output can be constructed with Mullard miniature noval-based valves. Two PL81 valves, used as a Class "B" push-pull output stage, are preceded by an ECL80 triode-pentode, the triode section of which operates as an R.F. oscillator at a frequency of about 2Mc/s. The direct voltage developed across its grid leak is used to bias the output valves and also the pentode section of the ECL80. The input signal is amplified by an EF86 and is fed direct to the control grid of one PL81. In addition, a portion of the signal voltage is applied to the pentode section of the ECL80 operating as a triode-connected phase inverter preceding the other PL81.

The power supply consists of two PY82's connected in parallel as a half-wave rectifier. The heaters of all the valves are connected in a 300 mA series chain, the 200 mA heater of the EF86 being shunted by a 63Ω resistor.

The potentiometer, RV2, acts as a treble tone control. An additional secondary winding L6 on the output transformer supplies a negative feedback voltage which is injected into the grid circuit of the EF86 via resistors R16 and R1. As the volume control RV1 is connected to R1, the feedback is minimum at maximum sensitivity of the amplifier and increases when the sensitivity is decreased. Care must be taken, as with all D.C./A.C. equipment, to avoid direct connection between the chassis and earth. In addition the chassis (H.T.—) line should be connected, where possible, to the neutral side of the mains.

An output of 16.2 W is measured at the primary side of the output transformer when the input at the grid of the EF86 is 220 mV. Without feedback the distortion is 6%, this being reduced to 1.8% by the application of feedback. The hum and noise level is 42 dB below at 16.2 W.



Mains V	R23,R24 Ω	R25 Ω	R27 Ω
250	100	40	521
240	80	44	488
230	60	55	455
220	40	60	421
210	30	55	388
200	30	50	355

All values to be adjusted to ±5%

BIAS OSCILLATOR COILS L1, L2.
Standard M.W. local oscillator coil (mains). With no input, current through R10 should be 0.7 mA at 220V mains. Current increased by adding turns to L1 and decreased by removing turns.

OUTPUT TRANSFORMER, TR1.
Shell type core 1¼ in. wide. "No waste" series laminations 0.02 in. thick. 1 in. stack without air-gap. Overall dimensions: 3¾ x 3⅛ in.

L3:	2 x 880 turns of 33	S.W.G.
L4:	88 turns of 18	S.W.G.
L5:	16 turns of 18	S.W.G.
L6:	120 turns of 29	S.W.G.

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Wireless World

AUGUST 1953 VOL. LIX No. 8

Orderly Development of Television

As an exercise in fact-finding, the Report recently issued by the Television Advisory Committee (with, no doubt, a great deal of assistance from its technical sub-committee) is an admirable piece of work. A summary of the Report, published elsewhere in this issue, shows that it deals in detail with the various frequency bands available for extension of our national television service, surveying their characteristics and the uses to which they might be put. But the Report is much more factual than advisory. It leaves many open questions, the most important of which can only be answered by the G.P.O. In a word, we are no nearer an alternative television service—and probably farther away from a competitive service—than we were when the question was, most regrettably, opened as an acutely political issue over a year ago.

The one dissentient member of the Committee, C. O. Stanley, does not exaggerate when he says, in his reservation to the Report, that the limited conclusion reached does not form "an adequate basis on which to plan alternative television services." Mr. Stanley's colleagues on the T.A.C. may be right in saying that his reservations are irrelevant to its terms of reference, but, nevertheless, he has done a useful public service in drawing attention to the unsatisfactory situation brought about by the way in which frequency channels in Band 3 (174-216 Mc/s) have been allocated during the past few years. Under the monopolistic powers conferred by the Wireless Telegraph Acts, the G.P.O. has long been the supreme arbiter in these matters, but there is an implication in the body of the Report that the Postmaster-General was wrong in allocating Band 3 channels to mobile radio services. Be that as it may, Mr. Stanley's protest will bring home to a wide circle that the Post Office is unduly secretive about matters of frequency allocation. It is not only in television that we have to plan ahead. Designers and potential users of radio equipment of every kind should know what is being done, and what it is proposed to do. Mr. Stanley's plea for the early establishment for a "B.C.C.", on the lines of the Federal Communications Commission of the U.S.A., will certainly have some support.

Even if the Report settles nothing, it at least provides the data for useful discussion, which is bound to centre on the uses to which Band 3 should be put. This band contains eight 5-Mc/s television channels, but is so largely occupied at present by business radio, navigational aids and other services that only two channels can be freed for television. What is to be done with this band? Potentially it is the most valuable for television in the existing state of the art.

Majority opinion in radio circles inclines to the opinion that Band 3 should be given exclusively to the B.B.C., if only in the interests of orderly development. This would allow the Corporation to complete its initial plan for virtually complete coverage of the country with a single programme by using the two channels immediately available. If the remaining six channels are freed, the B.B.C. could then carry through its published second-programme plan (*Wireless World*, June issue).

But is there any real hope that Band 3 will ever be freed for television in its entirety, as the T.A.C. has specifically recommended? Only the G.P.O. can give the proper answer to that question. *Wireless World*, without wishing to usurp the functions of the T.A.C., suggests it might be better to by-pass Band 3 entirely, and to plan straight away for use of the higher frequencies; we must come to them sooner or later anyway. It would complicate receiver design and commercial distribution if it became necessary to provide for the reception of a few Band 3 stations giving much less than full national coverage. We cannot accept the objection to this idea, made in the Report, to the effect that a home market in Band 3 receivers is desirable in the interests of export. That is not a valid reason for upsetting orderly development. So long as Britain adheres to the 405-line standard, there will be no export outlet for sets designed primarily for home use, but the industry has already proved it can make equipment for any foreign standards.

Reactivating the Dry Cell

Effects of a Reverse "Charging" Current

By R. W. HALLOWS, M.A. (Cantab), M.I.E.E.

THE main reaction during the discharge of a Leclanché cell described in the previous article* is, when one comes to think of it, simply electrolysis in reverse. In electrolysis, electrical energy is converted into chemical energy, while in the discharge of a primary cell there is a conversion of chemical into electrical energy. So long as discharge is in progress zinc is removed from the negative element and passes into the electrolyte to form zinc-chloride. Thus when the cell is in a partly discharged state conditions appear to be all in favour of the occurrence of electrolysis, should a reverse current be made to flow through it: the zinc is immersed in a solution of its own salts; the passage of the reverse current should lead to the removal of zinc ions from the solution and their deposition as metallic zinc on the negative electrode of the cell.

It is not, of course, quite so simple as that; for, as we have seen, the Leclanché cell is really a two-part device, whose overall e.m.f. is the sum of two e.m.fs in series. The electrolysis just mentioned involves only one part of the cell, that consisting of the zinc and the electrolyte. If the cell is to be reactivated, or restored to its original condition, the passage of the reverse current must also produce profound chemical changes in the part consisting of the manganese-dioxide element and the electrolyte. It must cause complete depolarization by removing hydrogen from the surface of the carbon and send it on its way through the cell in the form of positive ions. It must also dissociate the molecules of water, formed in the original process of partial depolarization, into positive hydrogen ions and negative oxygen ions, and cause each of the latter to combine with a molecule of Mn_2O_3 in such a way as to form two molecules of MnO_2, or manganese-dioxide.

Complex though it may appear, that is a very much simplified account of the reactions required, if a cell is to be restored by passing reverse current through it. Yet, given certain essential conditions, to which we shall come in a moment, a dry cell can be discharged and reactivated again and again. It can, in fact, be made to behave as a secondary cell. But no one has yet been able to give a completely satisfactory account of the reactions involved. No one, for that matter, has yet fully explained the discharge process. For instance, though no text-book reactions show any free chlorine, one has only to break open a partly-discharged (but, of course, unperforated) dry cell to detect its unmistakable smell. It has been my privilege to be able to discuss both discharge and reactivation with some of the most eminent authorities on the dry cell. Each of these has said modestly that, though the text-books might claim to have everything tidily wrapped up and labelled, he himself was, frankly, by no means certain of all the answers.

Perhaps, then, it is best to realize that we have as yet no more than a rather general picture of the way in which such an apparently simple device as the familiar dry cell works, whether it is discharging or undergoing the process of restoration by electrical recharging.

The essential conditions for the successful reactivation of a dry cell are these:

(1) It must be a "fresh" cell. Little or nothing can be done with an unused cell near the end of its shelf-life.

(2) A cell whose e.m.f. has declined as a result of long use cannot as a rule be reactivated.

(3) The best results are obtained from cells sub-

* "Improving the Dry Cell," June, 1953.

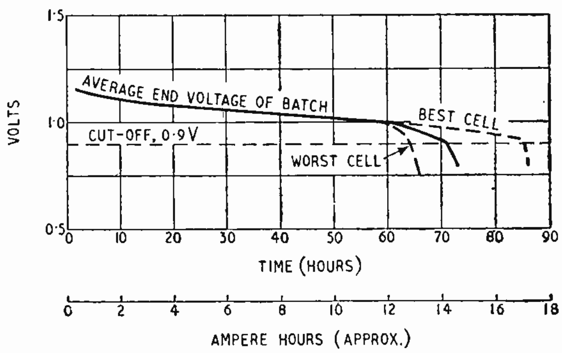


Fig. 1. Batch A. 6 cells of same make discharged 3 hours daily through 6 ohms and recharged at 0.1A for 8 hours. All cells came to an end through perforation of the cans.

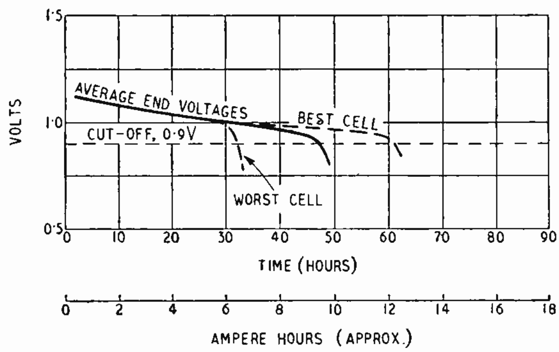


Fig. 2. Cells of another make discharged and reactivated under the same conditions. Worst cell perforated under discharge when e.m.f. was 1.05V.

jected to a heavy rate of discharge for comparatively short periods. Reactivation is not nearly so effective if reverse current is applied after a long period under a light load.

(4) The can must be unpunctured. It follows from this that cells liable to perforation of the can for reasons given in the previous article will not stand up satisfactorily to a series of discharges and recharges.

(5) Electrical recharging must take place as soon as possible after each discharge period.

(6) The applied reverse current must be carefully controlled.

The classic work on the reactivation of dry cells was done as long ago as 1936 by Kenneth A. Kobe and Robert P. Graham of the University of Washington.* They showed that dry cells $2\frac{7}{16}$in in diameter by 6in in height, whose cans contained an average of 120 grams of zinc could, by periodic reactivation, be made to deliver more than four-and-a-half times the amount of current theoretically obtainable from their entire metal content. From the discussion in the previous article of the electro-chemical equivalent of zinc it will be seen that the maximum amount of current theoretically obtainable in the ordinary way from such cells is 120/1.2, or 100 Ah, and that the useful current, with the e.m.f. not below 0.9 V, to be expected from cells of the highest quality is rather less than 40 per cent of this, say 36–38 ampere-hours.

Kobe and Graham continued their experiments until the batch of cells, discharged at 1.25 A and reactivated by what had been found to be the optimum charging e.m.f. and current, had achieved an average of 466 Ah —the equivalent of 4.66 times the zinc in their cans. With the cells still nearly as good as new by every test, the experiments were discontinued. There was no point in going on with them, for they had given conclusive answers to the question: Can dry cells be reactivated? The reverse charging current clearly brought about a redeposition of the zinc, for the original amount of metal was still there, even though sufficient current had been delivered by the cells to account for the removal from the cans of more than four-and-a-half times its weight. It is worth noting that there was no pitting of the inner surface of the cans.

Unfortunately, the experiments of Kobe and Graham were not very realistic. They contrived a rotary switch which put the cells on discharge for so many seconds then immediately on charge for so many more. Their best results were obtained by discharging cells at 1.25 A for a few seconds and then charging them at 0.2 A for seven times as many. A high-grade dry cell used for ringing an electric bell might thus be kept in good condition for an indefinite period. All that is required is a device which switches in a charger and keeps it in action for, say, 30-40 seconds whenever the bell-push has been pressed. It would, however, be simpler and far cheaper to operate the bell through a mains transformer. Proof that dry-cell reactivation is a practical proposition and that it can pay was given a year or two before the war by the Commonwealth Edison Electric Company of Chicago. This company employs a considerable number of meter-readers, each of whom is provided with a flashlamp. When he returns to headquarters after the day's work each reader hands in the battery of his flashlamp, which is placed in a large charging rack. Next morning he is given a recharged battery. The fact that the system is still in regular use is proof positive of its efficacy.

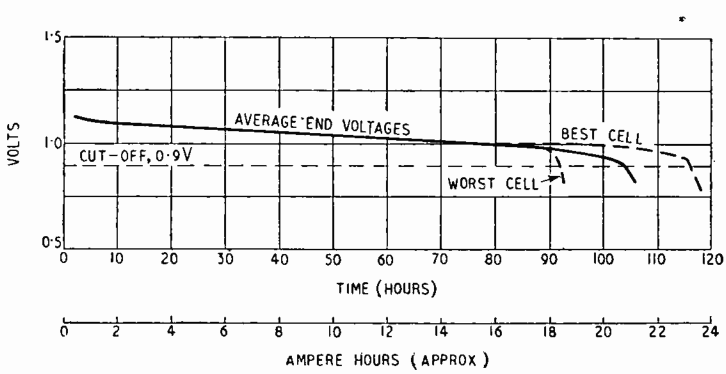
Simple Experiments

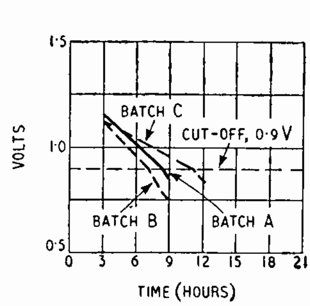
Any reader who is attracted by the problem will find experiments in reactivation most interesting to carry out. The only equipment needed is a 2-volt charger, an ammeter with a 0–1 A range, a high-resistance voltmeter and a rheostat for controlling the charging rate. For my own experiments I used batches of six cells of the " U2 " size, each batch being of a different make. The average weight of zinc in the cans was 19 grams, theoretically capable or producing 15.8 Ah of current.

The cells were discharged for 3 hours a day through 6-ohm loads. The average current over the day's run was found to be so close to 0.2 A that a figure of 0.6 Ah was assumed as the average for each 3-hour discharge period. Charging began as soon as the day's run was finished and lasted for 8 hours, the rate being kept as near as possible to 0.1 A. The cells were rested overnight and put on discharge again the next morning.

Readers who make experiments should be careful not to let the charging rate for cells of this size rise much above 0.1 A; more rapid charging at higher rates causes the cells to become too hot—and may even lead to their blowing up, with rather devastating effects! I have a feeling that better results than those

* " The Effect of Applying a Counter E.M.F. to a Leclanché Cell." Paper read before the Electro-chemical Society, U.S.A., 30th April 1938.





Left: Fig. 3. Batch C. Even the worst performer in this group produced current corresponding to a much greater weight of zinc than was originally contained in the entire can. Right: Fig. 4. Cells discharged under the conditions of Figs. 1, 2 and 3, but not reactivated. Voltages at the end of each 3-hours run are shown.

shown in the accompanying graphs might have been obtained, had it been possible to charge at 0.05 A for 15–16 hours.

The graphs of Figs. 1, 2 and 3 are the lumped end voltages under load for three batches of different make. The individual batch figures are:

Batch A

Average service	70½ hours
Best performance	86 hours
Worst performance	64 hours
Average output	14.1 Ah.
Equivalent weight of zinc ..	16.92 grams

Batch B

Average service	47 hours
Best performance	61 hours
Worst performance	34 hours
Average output	9.4 Ah
Zinc equivalent	11.28 grams

Batch C

Average service	104 hours
Best performance	116 hours
Worst performance	92 hours
Average output	20.8 Ah
Zinc equivalent	24.96 grams

Every test of the series was brought to an end by the same cause, perforation of the zinc cans. Unlike those used by Kobe and Graham, the cells available could not, therefore, be made to behave exactly as secondary cells. Kobe and Graham make no mention of creeping and the absence of pitting recorded by them is evidence that most, if not all, of the zinc was redeposited on charge in the places from which it had been removed during discharge.

External Zinc Erosion

Every one of the perforated cells which I broke open showed signs of creeping: erosion of the zinc had taken place through local action in places outside the electrolyte, where redeposition could not be brought about by the passage of the reverse current. Given cells free from creeping, I have no doubt that reactivation could be made to extend service lives to scores, if not hundreds of ampere-hours for " U2 " sized cells intermittently discharged at the very heavy average rate of 0.2 ampere.

Even with the cells now generally available reactivation pays handsomely, as will be seen by comparing the discharge curves of Fig. 4 with those of Figs. 1, 2 and 3. Three cells of the same makes as those of the batches whose respective performances are illustrated by Figs. 1, 2 and 3 were put through the same tests, except that they received no reactivation. They were discharged each day for 3 hours through 6 ohms and rested for 21 hours.

Some very interesting points were noted in the course of the charge-discharge tests. One of these is that the e.m.f. of a cell at the end of a charging period may be as high as 2.3 volts, or even a little more. If the cell is left on open circuit for an hour or two the e.m.f. usually falls to the neighbourhood of 1.8–1.9 V. With some makes of cell the decline is rather more marked; but even after 5 or 6 hours the e.m.f. may be well above the normal Leclanché 1.5 volts.

The high e.m.f. that may be found immediately after reactivation leads one to wonder how the filaments of miniature and subminiature valves would fare if they were heated by cells which were reactivated

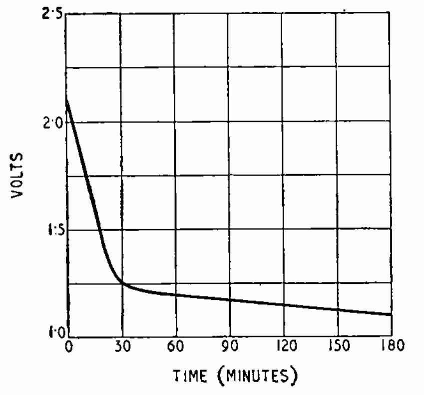


Fig. 5. E.m.fs of a typical reactivated cell during a 3-hours discharge through 6 ohms.

daily. One knows that they can stand up for short periods to e.m.fs of the order of 1.48 V when new l.t. batteries are fitted; but what would be the effects of a daily dose of filament voltage starting at 2.15 V and taking 10 good minutes or more to fall to 1.5 V? As Fig. 5 indicates this is what happened when cells of one type were switched straight from " charge " to " discharge." When these cells were given two hours rest after reactivation, the closed-circuit e.m.f. was 1.64 V and this fell to 1.5 V in less than 10 minutes.

To be on the safe side, then, it would seem wisest to rest cells used for filament heating for at least an hour after reactivation is finished.

The service-life graphs of Figs. 1, 2 and 3 leave no doubt that one effect of reactivation is to reverse in Part I of the cell (zinc and electrolyte) the discharge reactions:

$$Zn + 2NH_4Cl = ZnCl_2 + 2NH_3 + 2H.$$

Redeposition of metallic zinc must occur. The best performer of Batch A had a current output which corresponds to the removal of 20.64 grams of zinc from the can, or more than it contained to begin with. For Batch C the average zinc equivalent was 24.96 grams and that of the star performer 27.84 grams.

What happens in Part II of the cell, consisting of the carbon, the depolarizer and the electrolyte, is much more difficult to follow. There must be significant chemical changes, for (a) complete depolarization takes place, (b) the e.m.f. rises far above its original value and (c) the internal resistance becomes lower than in a new cell.

Temperature Effects

One cannot help feeling that thermal effects play an important part in producing these results, for during the reactivation process cells become warm to the touch—they must not be allowed to get *hot*. Temperature has a marked influence on the rapidity and effectiveness of depolarization. Some years ago I conducted an extensive series of tests for an American battery company, some of their own products being included as a check on my results. To our mutual mystification my tests, though conducted strictly according to instructions at living-room temperature, showed service lives for their cells about 10 per cent shorter than those obtained in their own laboratories. My thermostats had been set at 63°F; when they were reset at the 70°F of American living rooms there were no more discrepancies. Old hands will recall, too, that it was discovered in the early days of wireless that expiring h.t. batteries could be given a short new lease of life by a spell in the airing cupboard, or even the oven!

The lowering of internal resistance that occurs is quite remarkable. The cell whose performance is shown in Fig. 5 showed when new an open-circuit e.m.f. of 1.51 V, which fell instantly to 1.48 V when the 6-ohm load was switched in. After reactivation the open-circuit e.m.f. was 2.18 V and that on closed circuit 2.15 V. From these readings the internal resistance when new and that after reactivation are readily obtained. It is, by the way, very important that the voltmeter should be a high-resistance instrument; otherwise the readings will be misleading. That used throughout these tests has a resistance of 2,000 ohms per volt.

Calling the open-circuit voltage E and the closed-circuit voltage V, we have for the internal current of the cell

$$I_{int} = \frac{E - V}{R_{int}}$$

where R_{int} is the internal resistance.

$$\therefore R_{int} = \frac{E - V}{I_{int}}$$

But $I_{int} = I = \frac{V}{R_L}$

where I is the current through the load resistance R_L.

$$\therefore R_{int} = \frac{(E - V) \times R_L}{V}$$

In the case under discussion the internal resistance of the new cell was

$$\frac{(1.51 - 1.48) \times 6}{1.48} \simeq 0.12\,\Omega$$

and that after reactivation

$$\frac{(2.18 - 2.15) \times 6}{2.15} \simeq 0.08\,\Omega$$

It was suggested in the previous article that the redesigning of the dry Leclanché cell with a view to making its discharge less wasteful of valuable materials might be a profitable field for research and development. There seems, too, to be another promising opportunity: the production of a dry Leclanché cell specially designed to stand up to a long series of discharges and reactivations. That this could be done I have no doubt at all.

GERMAN RADIO JUBILEE

Telefunken's Fiftieth Birthday

AT the opening of the present century, two groups were striving in Germany to develop wireless telegraphy: Braun-Siemens and Slaby-Arco-A.E.G. After some disputes about patent rights and other questions, the two groups amalgamated in May, 1903, to become the Telefunken Company.

Telefunken's first great achievement was in 1906 when the quenched spark transmitter was introduced. Up to the time of the first World War—indeed, until the valve became commonplace—this proved a highly successful system, and was installed at stations all over the world. To historians of the early days of radio, the name of Telefunken will always be associated with the quenched spark method. Its operation depended on the rapid extinction of oscillations in the closed primary circuit and the production of oscillation trains of relatively low damping in the open aerial circuit. But real continuous waves were still to come; to quote the Jubilee issue (May, 1953) of *Telefunken-Zeitung*, this was "the era when men not only looked yearningly into the promised land of undamped oscillations, but set about entering it in diverse ways."

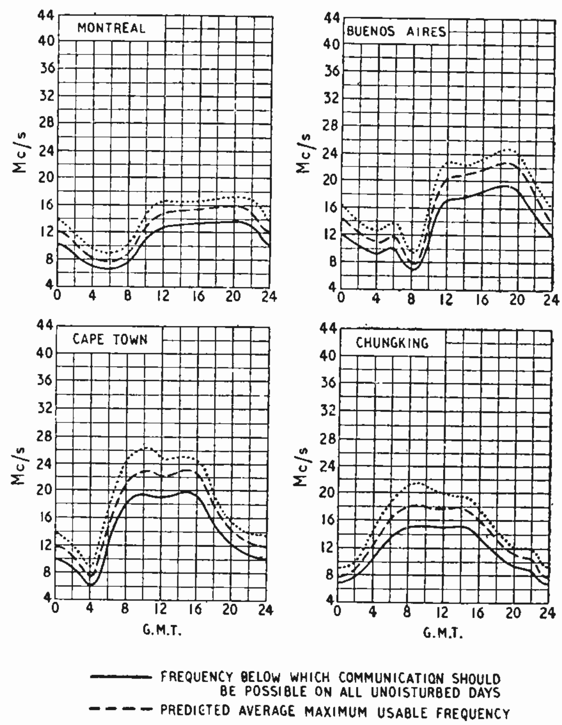
One of the ways explored by Telefunken in the early days for producing undamped oscillations was by means of the radio-frequency alternator, which provided a neat engineering solution of the problem, but one that proved in the end to be of limited application. Nevertheless, the Nauen "machine sender," near Berlin, achieved direct communication with the United States in 1914—no mean feat at that time. But, although several r.f. alternator stations were later installed, the centre of interest soon shifted to the higher frequencies, with which the machine generator could not cope. The day of the valve had arrived, and Telefunken has played a distinguished part in developing this and other devices of the present radio age. These developments are surveyed in detail in the Jubilee issue of *Telefunken-Zeitung.*

Short-wave Conditions

Predictions for August

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during August.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.



A.C./D.C. Communications Receiver

Eddystone Model 840 Seven-valve Superheterodyne Covering 30 Mc/s to 484 kc/s with Flywheel Tuning and Station Logging Scale

THE introduction by Stratton of an a.c./d.c. communications receiver should go some way to dispel any notion that an a.c. supply is really necessary for the satisfactory operation of sets of this type. Communications sets are used in many parts of the world for one purpose or another and flexibility in the mains supply required is an undoubted advantage.

TABLE 1

Circuit Position	Valve Type	Heater Volts	Function
V_1	UAF42	12.6	Tuned r.f. amplifier.
V_2	UCH42	14	Combined mixer and oscillator (frequency changer).
V_3	UAF42	12.6	I.F. amplifier at 450 kc/s.
V_4	UAF42	12.6	Combined detector and 1st a.f. amp.
V_5	UL41	45	Power output pentode.
V_6	UAF42	12.6	Beat frequency oscillator (B.F.O.).
V_7	UY41	31	Half-wave mains rectifier.

TABLE 2

Range	Coverage	Amateur Bands	Broadcast Bands
1	30.6 to 10.5 Mc/s	28, 21 and 14 Mc/s	11, 13, 16, 19 and 25 metres.
2	10.6 to 3.7 Mc/s	7 Mc/s	31, 41, 50, 60 and 76 metres
3	3.8 to 1.4 Mc/s	3.5 and 1.7 Mc/s	90, 125 metres and lower part of medium wave broadcast.
4	205 to 620 metres (14,600 to 484 kc/s)	None	Major portion of medium wave broadcast

(*Note.* The broadcast bands in the last column are given only in metres as the majority of short-wave listeners are better able to identify them in this form.)

Known as the Eddystone Model 840, the set is intended for general-purpose reception and is suitable for both amateur and professional purposes. It employs seven miniature valves in a reasonably orthodox superheterodyne circuit, the function of each valve, its type and position in the circuit, being given in Table 1.

The adoption of the a.c./d.c. technique has enabled a worthwhile saving in weight to be effected as there is no need for a mains transformer, and this is generally one of the heaviest items in a mains receiver.

Four switched tuning ranges are provided and together they cover 30.6 Mc/s to 484 kc/s. Individual coverages are given in Table 2, which also includes details of the specially marked sections of each range. These take the form of coloured bars embracing small bands of frequency and show at a glance where the broadcast and amateur bands lie. Blue is used for amateur and red for broadcast.

It has been said that the circuit is reasonably orthodox, by which is implied that the main circuitry —r.f., mixer, i.f., a.f. and BFO stages do not depart much from orthodox practice, but there are a number of features which are exclusive to the Eddystone 840. For example, it is usual a.c./d.c. practice to connect all valve heaters in series, using valves of the same current consumption throughout. In this set a combination of series and parallel connections is adopted and details of the arrangement are given in Fig. 1.

Of course, there is a very good reason for this choice. If all valve heaters were joined in series their combined voltages would add up to 140 V and it would then be impossible to operate the set on 100/110 V. Against each valve in Table 1 is marked its voltage requirements, and this will enable the rather unusual arrangement of valves V_2, V_5 and V_7 to be appreciated. The heater voltages of V_2 and V_7 add up to that of V_5, so that these two are connected in series and the pair joined in parallel with the third (V_5). Incidentally, all valve heaters take 0.1 A, but by this method of connection the filament consumption is 0.2 A and the total set consumption amounts to 0.275 A at any voltage.

The component marked T in Fig. 1 is an anti-surge thermistor to keep the current to a safe value at the moment of switching on, while L represents the dial light. The other components are readily identifiable.

One of the requirements of a communications receiver is the facility to monitor the transmitter when one is used at the same station. As in some cases the

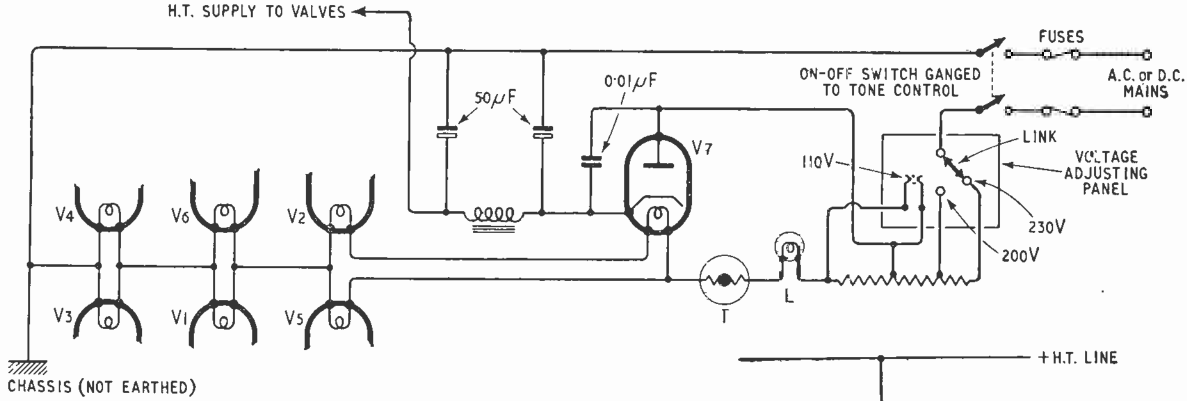


Fig. 1. Series-parallel arrangement of the valve heaters in the Eddystone Model 840 communications receiver.

receiver will be tuned somewhere near the transmitting frequency, it will either have to be switched out entirely, or adequately de-sensitized when transmitting. It is generally more convenient to de-sensitize the receiver and use it as a monitor.

All Eddystone communications receivers include this "stand-by" feature, and in the Model 840 de-sensitizing is effected by applying a rather large negative bias to the r.f. and i.f. stages (V_1 and V_3) by making the cathodes of these two valves more positive than normal. A simple on-off switch suffices and the arrangement employed is shown in Fig. 2. With S_2 closed valves V_2 and V_3 have the normal fixed bias derived from their respective cathode resistors and the r.f. gain control, which is augmented when receiving a signal by the a.g.c. negative voltage provided by a diode in V_3 (the UAF42 r.f. pentodes all contain a single diode). With S_2 open an additional 47-kΩ resistor is inserted in this circuit and as some current is "bled" through the network R_{33}, R_{32}, R_{34} from the h.t. positive line the point of connection of the cathode resistors becomes some 18 V positive and the grids of these valves take up about

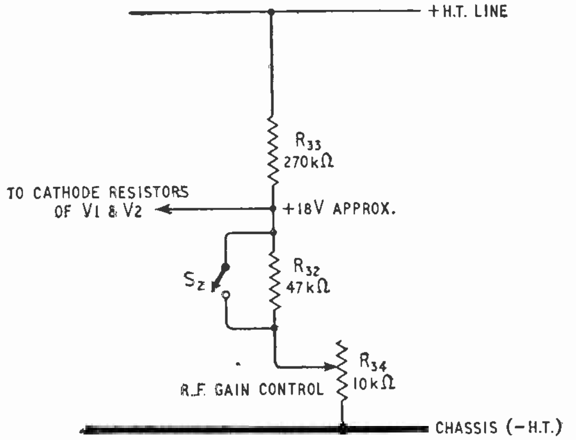
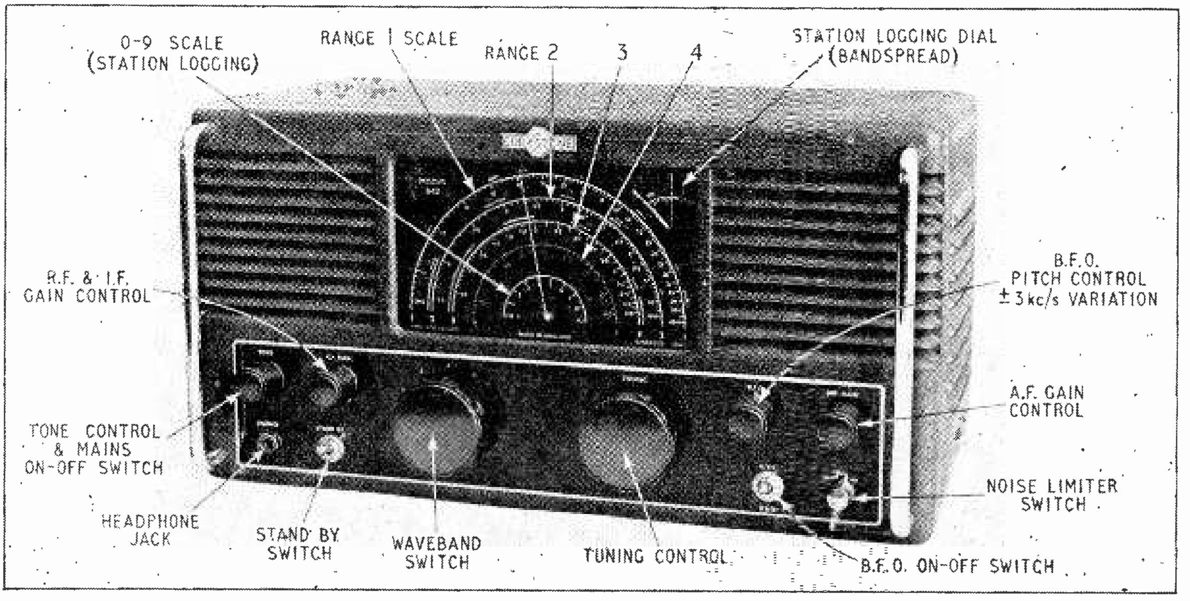


Fig. 2. The stand-by switch raises the cathode of the r.f. and i.f. valves about 18 V positive, the resulting negative grid potentials de-sensitize the set sufficiently for monitoring a local transmitter.

Front view of the Eddystone Model 840 a.c./d.c. communications receiver with the controls annotated.



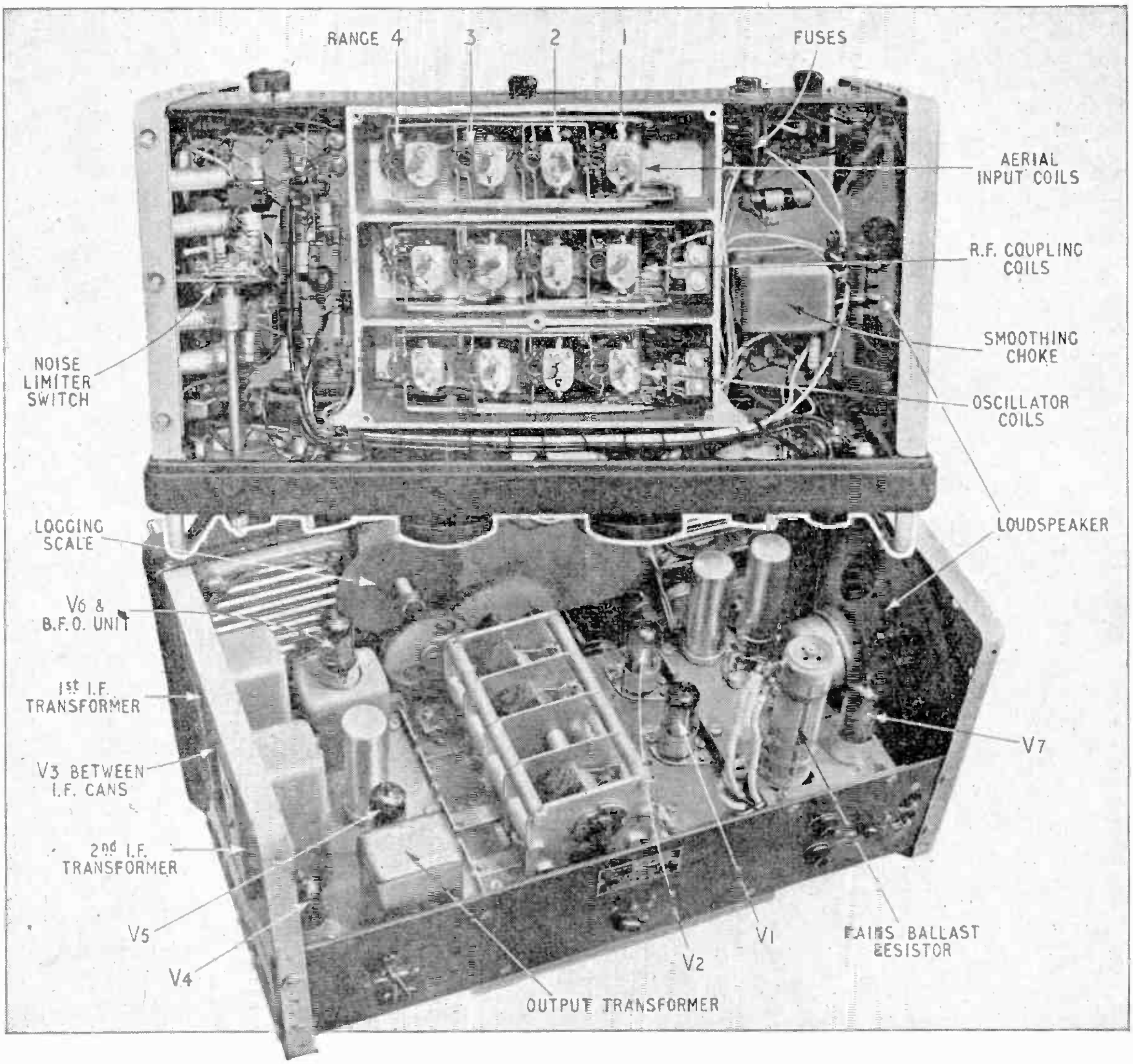
the same negative potential. This de-sensitizes the set sufficiently (or if it does not the a.f. gain control can be backed off) to enable the local transmitter to be monitored either for modulation or, with the BFO on, for c.w. telegraphy operation.

The BFO is a normal electron-coupled oscillator, the only interesting feature from the circuit angle being that its "on-off" switch is ganged with another which in its "on" position short-circuits the a.g.c. line to earth (chassis of the set, not the real earth). A.g.c. can be a nuisance when receiving c.w. telegraphy unless a particularly long time-constant is used and then this may become a nuisance for telephony reception as it will not respond to fast fading. So unless suitable time-constants can be selected for each type of service it is better to dispense altogether with a.g.c. for telegraphy work.

One other circuit feature of interest is that a crystal diode is employed for the noise limiter. This is switched in when required and is of the series type, being rendered non-conductive by a strong impulse of noise such as arises from motor car ignition systems. It is included in the circuit between the signal detector diode load and the grid of the audio amplifier (between valves V_3 and V_4). It limits the interference to a tolerable amount but we have handled better examples of the series type. However, the makers say it is intended to have only a limited range of control over the interference and as such can be accepted. In any case this type of interference, which is only really troublesome above about 10 Mc/s, will become less and less as more motor cars are fitted with suppressors.

The 840 is designed to provide communications receiver facilities without the high cost usually associated with this class of set and it is not possible therefore to have all the refinements of a high-priced set in one costing only £45 (U.K. price). The user must be satisfied with a little less effective noise limiter, no variable selectivity and no crystal i.f. filter. However,

The underside of the chassis showing the massive die-cast three-section coil box with cover plate removed. The neat layout of the top section is shown in the lower photograph.



these do not make or mar a set; they only enhance the pleasure of operating it. Just as a good performance can be obtained from relatively inexpensive sports cars, so an equally high performance is possible with an inexpensive communications receiver. If any doubt exists on this point half an hour with the Model 840 will quickly dispel it.

Its performance is unquestionably praiseworthy; sometimes there is a little more interference from adjacent channels and image signals than would be accepted with a more expensive receiver, but here again the price limitation applies. Taken by and large, the 840 will satisfy a large number of people requiring a receiver above the average. Its tuning mechanism is a joy to handle and is entirely devoid of backlash and exact precision in tuning is possible.

The four tuning scales are calibrated either in megacycles or metres and checks of the calibration against a quartz-crystal controlled frequency meter show the calibration to be substantially accurate throughout. In addition there is a small logging scale —some may call it a bandspread feature as it lengthens the readable scale considerably—which enables stations to be logged accurately and, what is most important in a set of this class, to return unerringly to that station, or tune the set to that station if it may not be working at the time with the assurance that when it does come up the set will be tuned to it. This logging dial is in the top right-hand corner of the scale and is used in conjunction with a 0-9 calibrated scale which is the innermost of the five on the face of the main dial.

Good C.W. Reception

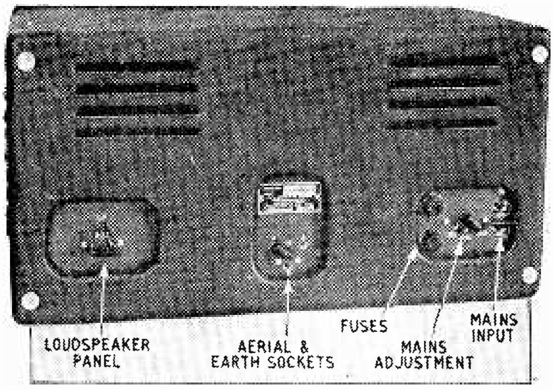
The BFO and the mixer oscillator were found to possess very good frequency stability and when listening to c.w. transmissions only very occasional re-adjustment of the BFO tuning control was required. Even this may not indicate drift in the receiver, the distant transmitter may quite well suffer a little frequency instability.

With both r.f. and a.f. gain controls turned up fully the background noise of the set is surprisingly low. it compares most favourably with other sets we have tested having comparable sensitivity and may even surpass them, but this could be verified only by a side-by-side comparison.

The model 840 is entirely self-contained, even to the inclusion of a loudspeaker. Provision is made for using headphones, the insertion of the 'phone jack automatically disconnects the speaker. The connections from the internal loudspeaker are brought out to a plug and socket panel on the back of the set and if desired an external speaker (3 ohms impedance) can be substituted.

Either a single-wire random length aerial or a dipole with balanced or unbalanced feeders may be used; with either kind the aerial is isolated from the chassis by capacitors. The cabinet is isolated from the chassis also by means of a capacitor and the actual earth connection is made to the cabinet not to the chassis. Good insulation is therefore necessary between chassis and all chassis fittings and the cabinet, and this fact must be borne in mind whenever the set is taken down for servicing.

The set is very robustly built, light alloy die-castings being employed wherever practicable. The cabinet is of rustproofed steel and well ventilated, and tropically tested components are used throughout. The tuning mechanism gives a reduction ratio of approximately 140 to 1 and works on the loaded flywheel principle, one or two spins of the knob sufficing to carry the pointer from one end of the scale to the other.



At the rear of the set are the voltage control panel, aerial-earth connections and loudspeaker panel. These are marked for identification.

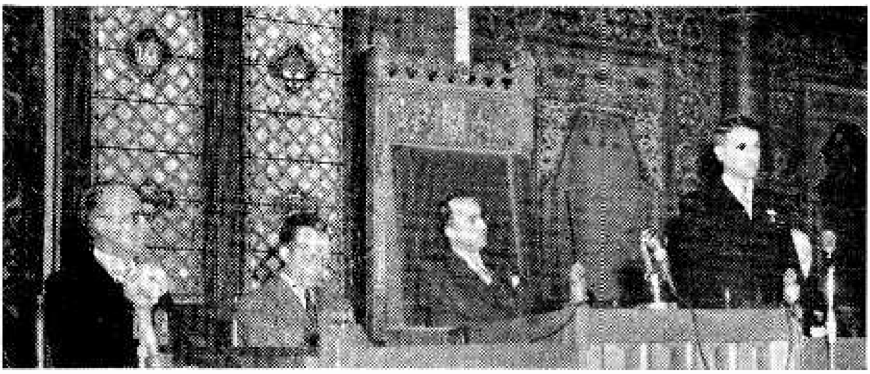
In conclusion, the performance of a receiver is no better than its aerial, a point very often ignored and the Eddystone 840 gives of its best when used with a really good aerial. This does not mean that a long, high aerial is essential for receiving as we picked up signals from all parts with only a short indoor wire, but the signal-to-noise ratio was inevitably poor. Changing over to the outdoor aerial, only 50ft of wire in this case but well in the clear, the improvement in signals had to be heard to be believed. This is not an exclusive characteristic of the "840" but applies to any receiver. Too many sets are criticized adversely solely because they are expected to accomplish the impossible and give good reception but denied the means whereby those results can be achieved.

The makers are Stratton and Co., Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31.

LICENCE DISTRIBUTION

THE regional distribution of sound and vision licences at the end of May, when the respective totals were 10,629,228 and 2,316,600, are given in the following table. The bracketed figures give the percentage of the total number of licences in each region. When giving these figures in reply to a question in the House, the Assistant P.M.G. pointed out that they refer to Post Office Regions and not the B.B.C. Regions.

	Sound only	TV and Sound
London	1,728,457 (70%)	751,452 (30%)
Home Counties ..	1,461,820 (85%)	262,336 (15%)
Midlands	1,319,044 (73%)	489,325 (27%)
North Eastern ..	1,734,433 (86%)	269,308 (14%)
North Western ..	1,348,767 (82%)	301,306 (18%)
South Western ..	1,034,778 (93%)	76,089 (7%)
Wales	671,332 (88%)	88,550 (12%)
Scotland	1,115,353 (94%)	75,854 (6%)
Northern Ireland ..	215,244 (99%)	2,380 (1%)
	10,629,228 (82%)	2,316,600 (18%)



At the opening session in the Ridderzaal, The Hague. (Left to right) R. Vermeulen (Netherlands, Vice-chairman of the Organizing Committee), Prof. R. H. Bolt (U.S.A.), J. M. L. Th. Cals (Netherlands Minister of Education, Arts and Sciences) and Prof. C. W. Kosten (President of the Congress).

Trends in Electro-Acoustics

Pointers from the Recent International Congress in the Netherlands

DURING the past two or three decades the science of acoustics has been dominated by the influence of electrical and electronic methods, not only in the recording and reproduction of sound, but in all the fundamental physical measurements necessary for its proper application in communications, industry, medicine and numerous other spheres of human activity. This emphasis on physical measurement, resulting from the elegance and precision of modern electronic equipment, has tended in recent years to obscure the fact that acoustics, by definition, deals with those manifestations of vibration *which can be heard*. The boundaries of the field of physical measurement are in sight or have already been reached at many points, and there are already signs in many quarters of a shift of interest to the characteristics of man himself, and his reactions to his acoustical environment.

Structure of Acoustics

In his opening address to the International Electro-acoustics Congress, held in the Netherlands from 16th to 24th June, Prof. R. H. Bolt (Chairman of the International Commission of Acoustics) took for his theme the structure and organization of the "new acoustics" and showed how the techniques of electro-acoustics could assist in integrating its diverse parts. In the days of Pythagoras it was possible for one man to have all the available knowledge of the subject, and customary to view problems as a whole, in their subjective as well as their objective aspects. Nowadays, with the vast increase in extent of knowledge and the need for specialization, a recognition of the organizational character of the subject was essential for the better co-ordination of effort, and to facilitate communication between teams working in allied fields. The nucleus of acoustics was formed by two equally important parts —physical acoustics (the study of vibration, "mass systematized by force"), and bio-acoustics (man's interaction with his acoustical environment). The interplay of these main elements through the medium of electro-acoustics had resulted in four main branches of activity:

(1) *Communication.* Telephony, broadcasting, speech reinforcement and innumerable special applications in intercommunication.

(2) *Health, safety and comfort.* Noise abatement, protection from high ambient noise levels, medical diagnosis and therapy, hearing aids.

(3) *The musical arts.* The science of musical sounds, acoustical environment for the hearing of music, psychology of æsthetic reactions.

(4) *Tools for science and industry.* Techniques for studying the properties of materials, analysis and routine testing, treatment of materials during production.

These four branches of acoustics had themselves been enriched and their scope broadened by contact with other fields of science and technology such as physics, electrical engineering, architecture, building, chemistry, metallurgy, psychology, medicine and public health.

With so many affiliations, and the prospect of more to come, it would be premature, in Prof. Bolt's opinion, to attempt a rigid classification at the present juncture. After all, it had taken centuries to reach the present state of the art, and some years might reasonably be allowed to elapse, after the initial impact of electronics, before considering what form the organization might finally take. He was content that it should remain for the time being in close relationship with physics.

Topics Discussed

The scope of the Congress was commensurate with the breadth of Prof. Bolt's theme. It was divided into seven main sections presided over by acknowledged authorities, who opened the proceedings by general reviews of the chosen subjects, as follows: I, Sound Recording (R. Vermeulen, Netherlands); II, Public

Address Systems (E. Meyer, Germany); III, Acoustic Measurements (L. L. Beranek, U.S.A.); IV, Hearing Aids and Audiometers (P. Chavasse, France); V, Electro-acoustics in Ultrasonics (G. Bradfield, Gt. Britain); VI, Electro-acoustics Applied to Musical Instruments (E. G. Richardson, Gt. Britain); VII, Sound Insulation of Lightweight Structures (C. W. Kosten, Netherlands). Over eighty lectures and discussions were scheduled for the five working days, and in order to get through the programme it became necessary to run four sections concurrently. Even so, only specialists could hear all that was said (in three languages) on any particular subject, and those with wide general interests had to do much heart searching in making a choice from so much promising material. Not until the late autumn, when the full proceedings are to be published, will a complete assessment of the Congress be possible, but it may be useful at this stage to give some indication of current thought and work in the acoustical world.

Subjective Judgments

In the sphere of high-quality recording and reproduction of sound, the recalcitrant residual distortions of wide-frequency-range, single-channel systems, and the demand of the three-dimensional cinema for comparable phenomena in the accompanying sound have revived interest in, and called for a clarification of ideas on the aims and objects of "stereophonic" "binaural," "pseudo-stereophonic" or "spatially distorted" sound. There are those who are satisfied that their work is done when two or more loudspeakers, spaced to correspond with microphones are fed through amplifiers which are free from frequency, amplitude and phase distortion; others who claim that the only true stereophony is by headphones coupled to microphones in an artificial head; and a third and growing group who contend that neither of these systems can deceive the human hearing faculty, as exercised naturally under binaural conditions in a free field of sound. Stereophony is based on the properties of the mind, as much as on the physical effects at present capable of measurement by electro-acoustic methods; and until more is known it must be left to the artist to produce the best subjective effect with any means at his disposal.

Another topic much discussed at the present time is information theory. Here again it was felt that present analytical treatment, although of value in increasing the efficiency of transmission of intelligence by speech, was of little value for the better reproduction of music. As Vermeulen put it, a reproducing system for music is not just a "book for the blind" for those who lack the knowledge and skill to read a musical score. It must reproduce the tonal and temporal "redundancies" which distinguish an interpretation of genius from a mere recital of the basic information conveyed by the score.

Subjective assessment of the quality of reproduction must take precedence until correlation with objective measurements can be placed on a surer footing. The choice of monitoring equipment, and particularly of a suitable loudspeaker, is of prime importance to a broadcasting organization, and T. Somerville gave some experiences of the B.B.C. in this connection. On the choice of acoustic environment for the monitoring, he was in favour of a room with a reverberation time of about 0.5sec, furnished like an average living room, rather than, as some people had argued, a "dead" room with little or no reverberation. In choosing a suitable monitoring loudspeaker the decision could be influenced by the nature of the programme material used in the eliminating tests. More consistent results could be obtained by surreptitiously changing the loudspeaker unit in the monitoring cabinet and then observing the reactions of those responsible for "balance and control" in the matter of microphone placings. An unsatisfactory loudspeaker invariably stimulated activity in this department at rehearsals, with much moving of microphone positions. A word of warning was given about attempts to identify individual qualities in the loudspeaker, such as intermodulation distortion; bad intonation by players at rehearsal bore a strong resemblance to the roughness characteristic of intermodulation. One of the most searching tests for a loudspeaker was to listen to a person, known to the listener, speaking in non-reverberant surroundings over a direct line. To an experienced listener any resonances could be detected with as much certainty as those revealed by the method of successive "dubbing" for checking recording systems.

Investigations into basic physical principles are at present very much to the fore in the minds of those occupied with the problems of magnetic tape recording, and the progress so far reported indicates that we may soon be in a position to segregate the many interdependent variables involved in what is an eminently successful, though incompletely understood, process. On the practical side, the use of ferrite cores for recording heads holds promise not only of reduced losses at high frequencies, but also of negligible wear from tape abrasion.

In the sphere of disc recording increasing support was given to the idea of a standardized characteristic for reproducing equipment as an alternative to trying to standardize a recording characteristic—or even to define what it is. This would firmly place the onus of making a pleasant sound on the record manufacturer, and would reduce the cost of high-grade record reproducers, which at present included anything up to half a dozen different equalizing circuits. Prof. F. V. Hunt read an important paper in which his earlier work, in conjunction with J. A. Pierce, on the analysis of tracing distortion in lateral-cut discs has been extended, in conjunction with F. G. Miller, to take into account the deformation of the groove wall—an important factor in modern plastic pressings. In practice intermodulation distortion products arising from this factor are limited at high frequencies by the scanning loss function, which has been evaluated and found to give results in agreement with measurement.

Sound Reinforcement

With the exception of the "Ionophone" (already described in the Jan., 1952, issue of *Wireless World*) and an electrostatic loudspeaker for high frequencies (described by W. Kuhl), in which a foil diaphragm is supported on the projecting irregularities of a fixed dielectric, discussion of loudspeakers was confined principally to the detail design of conventional moving-coil cone units, and to intermodulation methods of assessing non-linearity distortion.

Prof. Erwin Meyer in his co-ordinating paper on public address systems gave an account of the development of line-source loudspeaker arrays and their important influence, together with the discovery of the effect of time delays of echoes on the subjective directional properties of the ear, on the design of modern p.a. systems. In high-level sound reinforcement systems out-of-doors, echoes from surrounding buildings and other objects often cause trouble, and P. Arni described how at the 1952 Olympic Games at Helsinki an echo from the scoreboard was eliminated by perforating it with holes, 5 mm in diameter, spaced 2 cm apart; a building echo was deflected to the ground before reaching the audience by the simple expedient of altering the height of the directional column-type loudspeakers.

Much work has been done in architectural acoustics, and in particular on the qualities of studios and concert halls. The acoustical environment is determined by many factors other than the reverberation time. The dispersion and diffusion of sounds reflected from the boundaries of the auditorium is important, and controversy continues on the merits of different geometrical forms for the reflecting surfaces. Measurement of this quantity in terms of the ratio of the mean difference between maximum and minimum peaks to the frequency range covered has been proposed by Roop and Bolt and is termed the "frequency irregularity" of the space. The calculation of this factor is laborious, but it can be obtained automatically in two types of apparatus described by P. V. Brüel, one involving the use of two special level recorders, and the other a level recorder employing a 100-element contact strip operated by a single level recorder, which measures in conjunction with an electronic scaler, the total "length" of the response curve in db. By reading the scaler at intervals of, say, 10 c/s, the "frequency irregularity" in db per c/s can be easily plotted. According to W. Furrer, even closer agreement with subjective assessment is obtained if, in addition to the total length of the curve, the number of peaks is taken into account; the correlation holds over a range of volumes from 30 to 20,000 cubic metres.

Musical Instruments

The application of electro-acoustic techniques to the study of traditional musical instruments and the evolution of new sources of musical sound is a fruitful field of study. J. M. A. Lenihan and S. McNeill described experiments to determine the nature of the scale used in the Highland bagpipes and found (not surprisingly) that it varies from one instrument to another and, more markedly, from one player to another. The use of electronic equipment has introduced a scientific element into the "voicing" of organ pipes, and D. M. A. Mercer showed how the measurements could be correlated with the observed sounds, and gave some support for early "air reed" theories for the excitation of the pipe and the generation of edge tones. G. Pasqualini reported similar studies on bowed instruments, and R. W. Young on the vibration of pianoforte strings. Discussion of electronic organs centred more on their relation to traditional instruments in the matter of tone quality rather than on the details of construction. The facility with which tuning can be varied over a small but accurately calibrated range has been exploited in a special instrument described by W. Kok in which the qualities of equal temperament can be compared with other systems of tuning. A visit was also made to hear the 31-note Fokker's organ in the Teylers Museum at Haarlem which incorporates Huygens' principle of equal temperament.

In the section dealing with electro-acoustic measurements the principal topics were the standardization of laboratory microphones, and the measurement of acoustic impedance. It was pointed out by L. L. Beranek that many of the problems would be solved if a microphone could be evolved which measured pressure and velocity at the same place and time. Problems of noise in jet engines and high-speed aircraft are assuming high priority and two papers dealt with the measurement of acoustic pressures in moving air streams by means of streamlined microphones and by optical methods. O. K. Mawardi described an acoustic pulse method of measuring wind velocity.

Hearing Aids

The section on hearing aids dealt with problems of audiometry, performance criteria and measurements on hearing aids and standardization. A notable paper by H. Mol emphasized the difficulties of applying a hearing aid in cases of deafness arising from deficiencies in the cochlea. He explained how the axis of rotation of the stapes bone is under muscular control in a manner which modifies the mechanical coupling between the eardrum and the oval window, and that control is effected by a feedback loop from the brain to keep the excitation of the basilar membrane within its dynamic range of 30 db above threshold. The control has a long time constant and operates on average rather than peak values. With deterioration of the basilar membrane the hearing aid cannot be expected to confer the benefits obtained in cases of conductive deafness, since it is outside the feedback loop which affords protection for the cochlea.

The introduction of barium titanate and the ferrites has brought about a revolution in the field of ultrasonics. Transducers in an infinite variety of shapes for different purposes can now be moulded from these stable substances, which are made from cheap and plentiful raw materials. With ferrites mechanical Q factors of the order of 1,000 have been achieved, though for some purposes the ultimate strength of the material places it at a disadvantage compared with nickel-iron alloys.

In the symposium on lightweight structures, as used in aircraft, railway carriages, etc., it was shown how the law of proportionality between mass per unit area and sound absorption can be circumvented by the use of double walls. The problems of design are bound up with the production of flexural waves which are induced by sound impinging at other than normal incidence. Interference with waves reflected from the boundaries of the wall can give the effect of resonance and the transmission is suddenly increased when the motion of the two partitions is in resonant opposition with the compliance of the enclosed air. An interesting consequence of the theories which have been developed is that with white noise at random incidence the transmitted sound will be directionally "coloured," high frequencies emerging normal to the panel and lower frequencies fanning out at progressively smaller angles to the surface.

The Congress was attended by 303 members from 19 countries, and visits were organized to the Philips factory at Eindhoven, the research laboratories of the Netherlands Radio Union at Hilversum, and the Philips gramophone record factory at Baarn. The organization throughout was faultless, for which chief credit must go to Prof. C. W. Kosten and Mr. P. A. de Lange of Delft Technical University and their colleagues from other participating bodies in the Netherlands.

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BUSH	MARCONIPHONE
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ENGLISH ELECTRIC	McMICHAEL
ETRONIC	PHILCO
G.E.C.	PILOT
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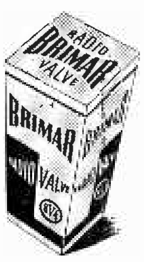

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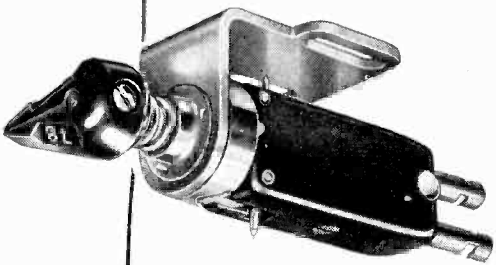

Here it is—the HGP 33, capable of tracking the highest modulation levels that can be engraved on either standard or long playing records.

Nominal output is one volt on standard records and ¼ volt on long playing records. Response is smooth and completely without resonances. Equalisation can be easily carried out if required.

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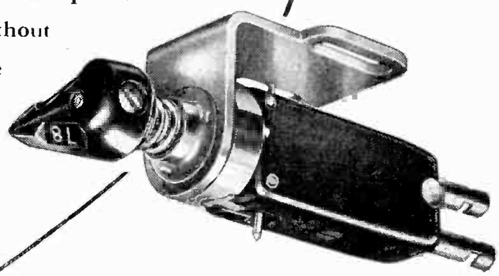

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Anarchy into Order

50th Anniversary of the First International Radio Conference

FIFTY years ago, such little wireless communication as existed was ruled by the law of the jungle. Indeed, anarchy did not finally give way to international regulation until 1912, when the United States (the last of the Great Powers to do so) ratified the Convention of 1906. In the early days, everyone used the wavelength that seemed good to him, or rather, the wavelength at which his aerial would radiate most effectively. Not only did the various competing "systems" refuse to exchange telegrams but deliberate jamming of competitors' signals was a common practice. There were no rules to enforce secrecy, and the story goes that cable companies, anxious to discredit their new rival, issued advertisements disclosing the texts of private radio-telegrams they had intercepted, thus seeking to show there was no secrecy in wireless communication. Similarly, the cable interests, making use of information obtained by interception, drew attention to long delays that occurred when the transatlantic wireless service first started.

G.P.O. Monopoly

Inside the United Kingdom, the Postmaster-General had, almost from the start, swept wireless telegraphy into his monopoly net, ruling, as a matter of expediency, that the new method of communication was covered by the existing Telegraph Acts. But he specifically disclaimed responsibility for control outside territorial waters. The P.M.G.'s position was regularized by the Wireless Telegraphy Act of 1904.

The story of international control starts with Kaiser Wilhelm II of Germany, who was perturbed because a wireless telegram from his nephew, Prince Henry of Prussia, travelling in a German ship, was refused by a British coast station. The Kaiser, with support from the President of the United States, accordingly convened a preliminary international conference to be held in Berlin in August, 1905.

The agenda of this first conference was simple enough. The main objective was to make obligatory the exchange of telegrams between coast stations and ships, irrespective of the system used. Problems concerned with wavelength were to be discussed, as were telegraphic charges, which should be "reasonable," and equally allocated between coast and ship stations. It was also hoped to formulate "service regulations" governing the interchange of traffic.

Most of the nine countries represented chose as their delegates officials of the post and telegraph services, together with army and navy officers. The subject was clearly regarded by most as of insufficient importance to warrant the sending of "top brass." The Spanish delegation, for instance, was headed by a mere Major in the Squadron of Military Aerostation (what was the supposed connection between ballooning and wireless?). The Russian group, led by a naval captain, included Professor Popov. Great Britain had a rather more imposing delegation headed by J. C. Lamb, Second Secretary of the Post Office, supported by the Engineer-in-Chief of the G.P.O. and naval and military officers. Herr Kraetke, Secretary of State for the postal department of the German Empire, was chairman. His opening address, in which he surveyed the development of the art, is of some incidental interest in throwing light on one of the vexed question of priority of invention. According to the Minutes of the Conference (which had been approved by all the delegations) he said it was to Popov that "we owe the first radiograph (*sic*) apparatus" but Marconi "first employed an antenna."

Most of the proceedings, as recorded in the Minutes, make dull and tedious reading. Everyone was floundering for lack of real knowledge and more than one delegate had an axe to grind. Some were clearly in genuine doubt as to whether all the "systems" would in fact work together, and others took advantage of this uncertainty to fog the issue. The general tone of the conference was one of difficulty in reconciling jealousies between the supporters of the different systems. The conference was further handicapped by difficulties in obtaining technical details of all the methods employed.

Clearly, the better-informed delegates saw little hope, in the existing state of the art, of obtaining relief from interference by "syntonization," and saw more possibilities in time-sharing. Attempts to agree on international wavelengths did not get much farther than the proposal that they should be standardized in round hundreds of metres. It was agreed that stipulations to minimize interference should be adopted as a matter of principle. The idea was accepted that countries could exercise their national sovereignty in choosing wavelengths for all except international traffic.

Limited Agreement

The main conclusion of the conference, included in the final protocol, was that most of the delegation undertook to recommend their governments to agree to the interchange of telegrams between coast and ship stations irrespective of the systems used. The British and Italian delegations, while agreeing to pass on the recommendations, accepted the protocol with reservations. Thus the stage was set for the conference of 1906, which succeeded in producing a useful and workable set of regulations for the exchange of international traffic.

One of the delegates present, the Marchese Solari, who represented Italy, recently gave *Wireless World* some personal recollections of the conference. A German delegate had proposed that range of ship-to-shore communication should be limited to 100 miles. Marchese Solari, who had been closely associated with Marconi, objected emphatically to this, and after lively exchanges undertook to produce documentary evidence of communication at much greater distances.

In some respects the advertisements appearing in the book in which the Minutes of the 1903 conference were printed are, to the modern reader, more interesting than the text. The Marconi Company gave a list of its coast stations in the British Isles, Italy, Canada, Labrador, U.S.A. and Germany—in that order. There was also a list of 47 ship stations of various nationalities. Telegrams could be accepted only at the Company's offices or stations.

The National Electric Signal Company of Washington, U.S.A., exploiting the Fessenden system, offered standardized transmitters "off the peg" for working up to 150 miles over land or to 350 miles over sea; equipment for longer ranges could be supplied "at short notice." It was claimed "no expert knowledge needed, as any telegraph operator can handle after a week's practice."

How was wireless communication carried out during the chaotic period that existed before stereotyped procedures for dealing with traffic had been evolved? What kind of gear did they use? The author of the article printed below gives a picture of the conditions ruling in those days.

Wireless Fifty Years Ago

Reminiscences of the Pre-control Radio Era: Apparatus of the Period

By MAURICE CHILD*

SHORTLY after Marconi had publicly demonstrated the practicability of sending and receiving telegraphic messages in the morse code by the hertzian wave method, a considerable number of scientific people claimed inventions of "systems" based on the fundamental discoveries of Hertz and Sir Oliver Lodge. Thus in the year 1903 a study of early literature shows that something like twenty of these "systems" were in what might be termed the embryonic stage. Most of them never developed commercially. In Europe, most of the principal countries adopted the "system" of one or more of its nationals. Of the various systems little need be said, since they only differed from one another in respect of some of the instruments used either for transmitting or receiving or both. All of them generated the waves by discharging high-voltage capacitors through spark gaps and employed aerials at both sending and receiving ends. The basic principles of tuning—or syntony, a prettier term—were published in detail and first demonstrated in the Lecture Hall of the Royal Institution in 1894 by Sir Oliver Lodge. But it is not the purpose of this article to deal with the early researches and achievements of those who contributed to the science of the production and detection of hertzian waves. It is rather to recount a few personal episodes in my early associations with commercial wireless communication from 1903 onwards.

Earliest Experiences

In the summer of 1903 I joined the Marconi International Marine Communication Company. This company had recently erected a station on the sands at Seaforth, Liverpool, on the estuary of the Mersey. A part of the building was set apart as a school for the purpose of teaching telegraphist probationers the art of adjusting, working and maintaining the apparatus as installed in ships.

My first commission was to install a set of equipment in the s.s. *Empress Queen* (call sign EQ). This ship was said to be the largest paddle-steamer afloat and made the round trip to Douglas, Isle of Man, from Liverpool daily. Temporary accommodation for the wireless gear was provided aft by enclosing a space between a part of the top deck overhanging the main deck. A small sliding ground-glass window was fitted for ventilation. The work of installing had to be carried out during two round trips but was much delayed owing to rough weather and the usual human discomfiture associated with it.

The aerial, a twin vertical, was suspended from the end of a 24ft bamboo sprit supported from the truck of the main mast by a halyard attached at a point one-third of the sprits' length and kept in an upright position by a "tail" rope. All ships at that period had sprits for increasing the height of the aerial, and these gave them a distinctive appearance.

On Saturday, August 22, 1903, an assistant and myself were instructed to accept telegrams from passengers travelling from Liverpool to Douglas. The minimum charge was 2s per telegram of 12 words (address free), of which half was intended for the company and the balance for the G.P.O.

By the time the Bar Lightship was reached we had collected some 30 telegrams and I decided not to accept any more. A preliminary test on the previous day had proved that once the ship rounded the headland near Douglas we would be screened by the land from Seaforth and communication in consequence was interrupted both ways. Unless, therefore, the accepted messages were sent before reaching the headland, those remaining would be much delayed and would have to be held over until the return trip.

The normal maximum speed of working was about six words per minute under favourable conditions, and

*The London Telegraph Training College.

Seaforth was pressed very severely to receive the 30 messages in the 3½ hours available. Acknowledgement of the last message came through as signals began to fail.

With the early Marconi coherer receivers, signals were normally recorded on a morse printer and subsequently deciphered from the paper slip. For "calling-up," a bell could be switched on as an alternative to the printer, and those trained to read by sound could use the bell method of reception. This last method was often preferred as extra "dots" due to atmospherics, etc., could usually be "read out." If the dots were recorded the slip was very difficult to read and could lead to errors. The bell, together with the noisy blue 1-cm sparks of the transmitter, provided good public entertainment but from the point of view of secrecy there were serious objections.

The story now reverts to Seaforth (LV) and was unfolded to me the next day by the staff on duty. In 1903 there were no facilities for forwarding telegrams by telephone, and there was no land line linking LV with the G.P.O. telegraph system. The disposal of paid public telegrams received by wireless was a problem which had not arisen and, if an occasional odd one arrived, it was taken by hand to the post office.

The nearest post office to LV was at the village of Waterloo, about ¾ mile distant, and formed a small part of the premises of a grocery business kept by an elderly lady who was, I believe, single-handed. The telegraphic instrument, an A.B.C. machine, already very much out of date, was incapable of handling traffic expeditiously.

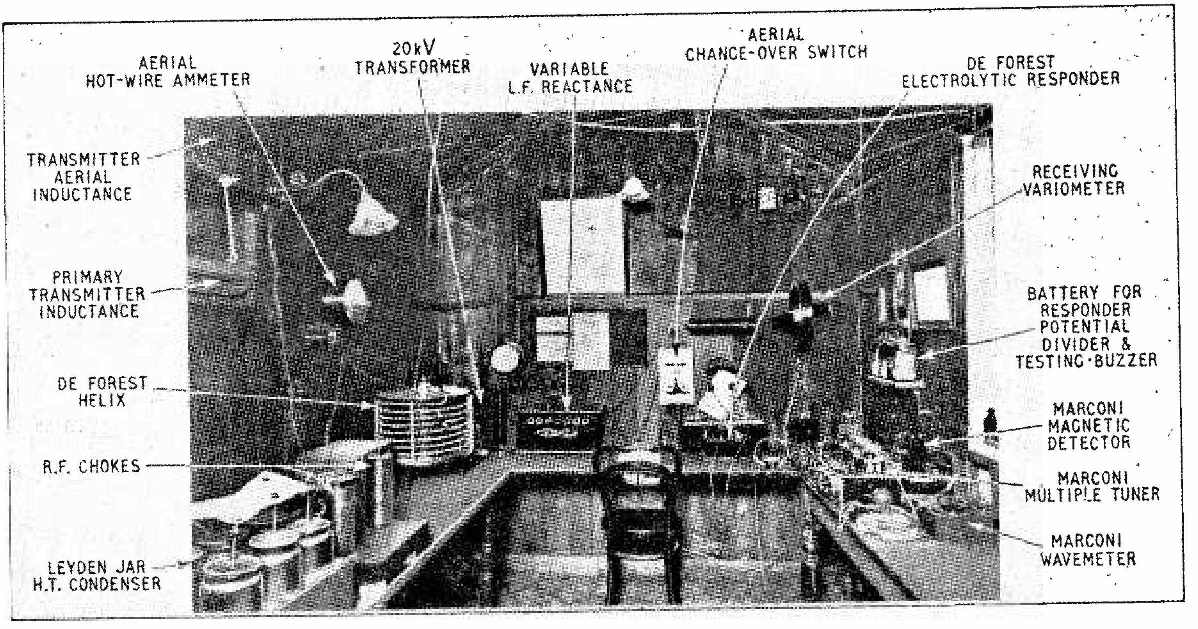
As the telegrams from EQ were received a probationer from the school went out, with at first batches of three and later five at a time. With the first consignment the lady at the shop expressed surprise; between one or two a day was her average. Before she had time to count the words, take the money and attend waiting customers another batch arrived and long before these had been accepted another and yet another and so on throughout the morning. I was told, in effect, that our efforts to swell the revenue of the Post Office were not appreciated. Tears gave way to rage and hysteria, culminating in an SOS or its P.O. equivalent being sent to the Head Office at Liverpool. From there representations were made to London, where it seems the solution to the problem was referred to the Legal Department. Apparently, the provisions of the Telegraph Acts were considered to have been infringed by the sending of telegrams from EQ and penalties were threatened. This accounted for the "Urgent Service" message I received on board on the return trip: "Cease accepting any more public messages." Exactly what happened in London was never disclosed, and it is unlikely any record now exists, but the fact remains that no more EQ telegrams were taken and the ship installation was dismantled shortly afterwards.

Operating Early Transmitters

From my early experience with the Marconi Company and later as chief technician and instructor to the staff of Lloyds, who took over from the Marconi Company most of their coast W/T Stations, it became clear that, as the marine services developed, a new type of telegraphist would be needed. Apart from proficiency in telegraphy, he would need special training in the actual operation of various types of transmitting and receiving equipment.

Until about 1908 practically all ships and a number of coast stations in this country were fitted with large induction coils worked from batteries or ship's mains. These coils were the essential part of the transmitter and were fitted with very slow-acting contact breakers giving from 10 to 16 sparks per second. Their primary circuit took from 8 to 12 amperes, depending on adjustment, and this current had to be carried by heavy ¼in diameter platinum contacts on the key. The keys were essentially of heavy construction and

Early apparatus at the Earls Court station of the London Telegraph Training College. Though units of various sytems were used, the station is typical of the period when wireless first came into practical use.



needed what was called a "heavy" style of manipulation.

The contacts used frequently to stick or partially weld together and the telegraphist needed to be ready at any instant to "lift" the key. This required considerable practice. When a.c. 50μ or 100-c/s rotary converters and h.t. transformers replaced the induction coil, the heavy type of key had still to be used on account of the large currents in the primary circuits.

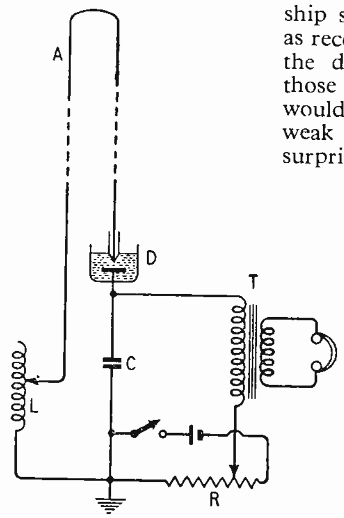
About 1910 the Telefunken Company in Germany and Siemens in England began installing ships with 500-c/s motor generators. The sending difficulty was therby almost solved but the keys, whilst much lighter and improved, were still not well adapted for high-speed manual operation. Apart from the apparatus, which of course varied much in design and type, there were important items such as emergency batteries which needed periodical testing, charging, etc.

Specialized Training

The radio officer was a law unto himself. If any fault or damage occurred in his equipment it was he who would have to locate and repair it. A highly specialized training was therefore indicated and in 1905 I was instrumental in starting a telegraph school at Earls Court and organizing wireless technical and telegraphic training. Commercial wireless equipment was difficult to obtain and in any case far too costly. A workshop was opened and students were shown the construction and use of different types of detectors, capacitors, inductors, etc. They also had lectures on fundamental electrical principles.

Between 1905 and 1912, in addition to the stations operated by the G.P.O. employing chiefly Marconi apparatus, experimental stations were operated by the United Wireless Company of U.S.A. (De Forest and Fessenden systems), Amalgamated Wireless Telegraph Co. (Poulsen arc system), British Radio Telegraph and Telephone Company (Balsillie system) and the Lodge Muirhead Syndicate. With the exception of the last-named, which specialized in the military sphere, all the above-mentioned Companies employed staff who had been trained at the London Telegraph Training College (call sign ECX).

One of the most important features of the training was to accustom students to read signals transmitted from commercial land and ship stations. The signals as received in London with the detectors available in those days were what would be now called dead weak (R_1 to R_2) but it was surprising how with practice the hearing improved and with what exactitude they could be deciphered.



Electrolytic detector circuit. A, twin aerial looped at top end; L, tuning inductance; C, 0.001 μF; R, potential divider, 1000Ω; T, telephone transformer (ignition coil reversed); D, electrolytic detector.

Of the detectors used for these practices, I found the best which combined the qualities of sensitiveness and reliability to be the perikon (zincite-bornite); Schlomilch electrolytic (used by De Forest); carborundum (United Wireless Company), in the order given. The first two needed very careful protection from the strong r.f. voltages which could be applied from the spark transmitters when these were used and open-circuiting *both* leads to the detector was necessary, the leads being no more than 1 inch long.

A favourite circuit for the electrolytic detector is shown in the Figure. It was used by the De Forest Company of U.S.A. The detector itself consisted of a platinum wire 0.0001in diameter just touching the surface of a sulphuric acid solution contained in a lead cup. A positive polarizing voltage, to balance out the voltage generated by the detector acting as a primary cell, was applied through a potential divider to the platinum point.

Composite System

The photograph on the previous page shows the ECX wireless cabin as it was in the early days. Two types of aerial coupling to the closed oscillatory circuits could be used alternately if desired. In one case the Marconi method of inductive coupling on the extreme left was employed and what was called the direct or galvanic coupling by a single helix could be equally well used. Provided both were correctly adjusted as regards the percentage of coupling used, there was nothing much to choose in the results obtained.

The power employed was usually about 200 watts and the working frequency could be varied between 660 kc/s and 1,000 kc/s. The College also had another station (MHX) at Acton to which senior students were sent for telegraphic practice to ECX.

With the advent of the first World War, the stations were compelled to cease transmissions and, after the war, with the enormous increase in the number of stations and technical developments of the thermionic valve, it was decided by the G.P.O. that such practice transmissions as had been authorized previously were no longer essential, a dictum with which I personally felt I must reluctantly agree.

In concluding this account of some of the early experiences of wireless communication I have tried, in recounting them, to present a picture of the conditions appertaining to the commercial development of this science. Consequently, I have omitted the more fascinating experimental work with which I, from time to time, was associated.

Transistor Coupling Transformer

WHAT must be one of the smallest transformers ever made has just become available in the form of an inter-stage coupling for transistor circuits. It has a Mumetal core and measures only $\frac{3}{8}$in × $\frac{3}{8}$in × $\frac{1}{4}$in. The step-down ratio is 4.5 : 1, with a d.c. resistance of 870 ohms for the primary and 170 ohms for the secondary. The inductance of the primary over the a.f. band is 4H with a direct current of 0.4 mA through the winding.

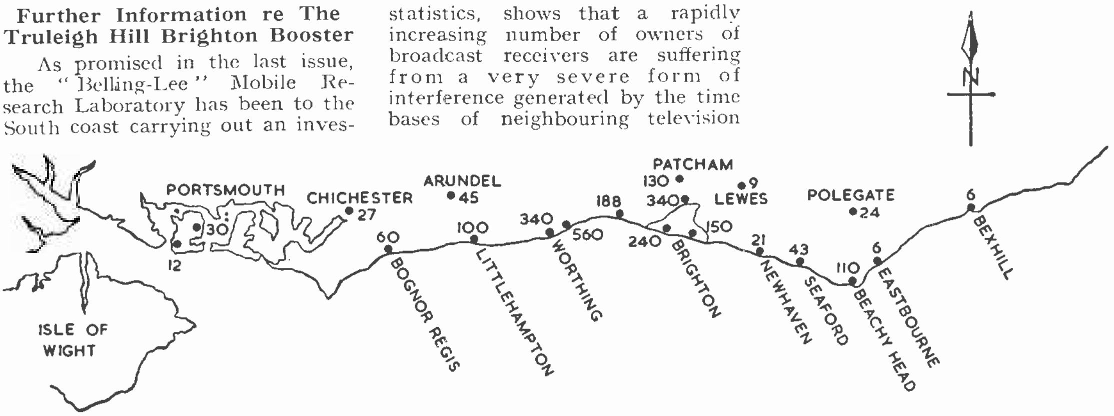
Another midget transformer produced by the same firm (John Bell & Croyden) is designed for matching a high-gain pentode to a transistor. This has a step-down ratio of 30 : 1, with a primary resistance of 6,000 ohms and a secondary resistance of 80 ohms. The primary inductance is 125H with 50μA d.c. through the winding.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference.

Further Information re The Truleigh Hill Brighton Booster

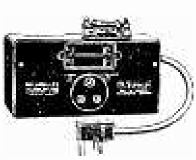
As promised in the last issue, the "Belling-Lee" Mobile Research Laboratory has been to the South coast carrying out an investigation into what can reasonably be expected from the Brighton booster in various locations on a front extending from Southsea in the west, to Bexhill in the east;



All readings were taken on a "Belling-Lee" "Junior Multirod" 3-element array L816 with the crossarm 30ft from the ground. A study of the map section shows variable results, and the report is that generally a satisfactory signal is only possible over a semi-optical path. This of course is to be expected where such low power is available.

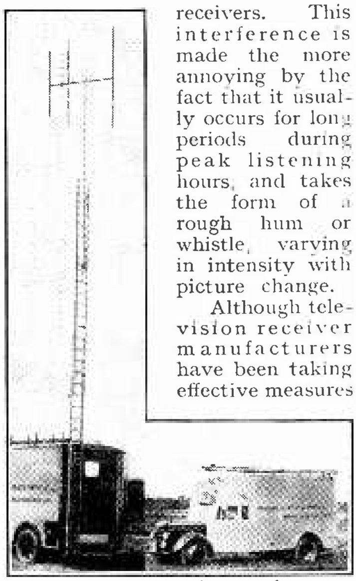
In the last issue we mentioned some remarkable results that were obtained in the Isle of Wight. While we have not sent the Mobile Laboratory over to the Island, we have had telephone conversations which confirm consistently good reception. Our information is that whereas the picture would not compare with one in London under Alexandra Palace, Truleigh Hill gives viewers on the Island a very much better picture than they ever received from London direct, and it is considered of real entertainment value. These results are not confined to the eastern end of the Island; reception in Ryde is said to be good.

Interference from Television Receivers



"Belling-Lee" Set Lead Suppressor L.300/3

Scrutiny of the correspondence columns of newspapers and technical press, together with collected statistics, shows that a rapidly increasing number of owners of broadcast receivers are suffering from a very severe form of interference generated by the time bases of neighbouring television receivers. This interference is made the more annoying by the fact that it usually occurs for long periods during peak listening hours, and takes the form of a rough hum or whistle, varying in intensity with picture change.



Although television receiver manufacturers have been taking effective measures to combat this interference for some time, there still remains a large number of existing receivers which are capable of interfering with broadcast receivers over a wide area.

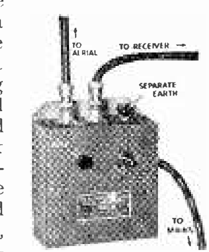
The interference reaches the broadcast receiver by direct radiation on to the aerial, and by conduction along the mains wiring. If the two receivers are very close together (e.g., back to back across a party wall) the first attempt at a cure should consist of moving one or both receivers, in order to increase their separation and decrease coupling.

If interference is still experienced when the receivers are widely separated, then mains propagation may be the trouble, and our mains lead suppressor, L.300/3 price £2/19/6, fitted to either the television or broadcast receiver may form an effective cure.

Our Mast Head Pre-Amplifier

While on holiday, we had occasion to visit an old friend who was we think, fortunate in being able to live right away in the country, but was some seventy odd miles from a television transmitter.

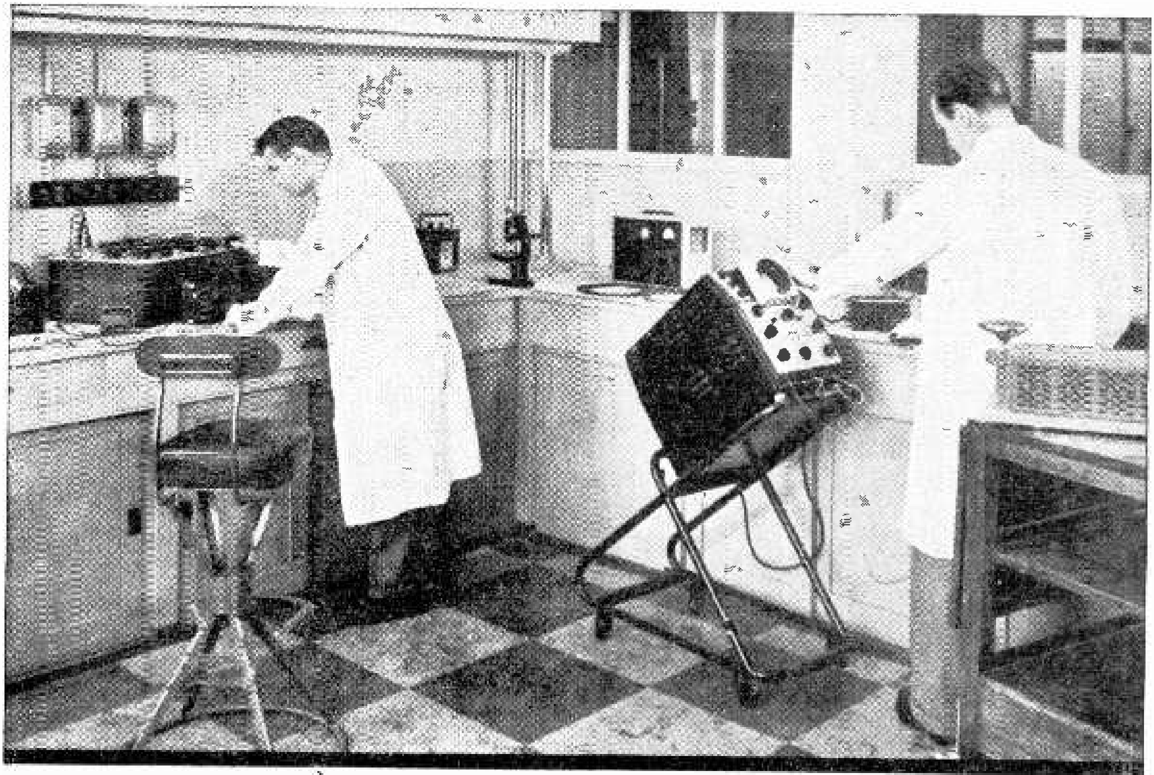
Now we know of many cases, probably many hundreds, where a satisfactory picture is available at this distance. In this particular case, the aerial was a "Belling-Lee" 3-element "Junior Multirod" but the original picture was shocking, and although the old chap had seen good television, he thought his was worth having, and the best he could hope for. This was a case where money was not the over-ruling factor, and when told about the mast head pre-amplifier, one was ordered immediately, and fortunately one was found.



The change in that household needs to be seen to be appreciated. It seems to be ridiculous, but we have never caught up with orders; there is a long waiting list, and there must be very few amplifiers in dealers' shops.

Written 27th June, 1953.

BELLING & LEE LTD
CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDX., ENGLAND



TRANSISTORS

By THOMAS RODDAM

7.—*The Principle of Duality*

IN an earlier article of this series, I touched briefly on the use of duality in converting the familiar valve circuits into the corresponding transistor circuits. This process is of great value in determining the form taken by the transistor circuit, and in this article and the next I propose to consider in some detail the idea of duality and its application to circuits using point transistors and combinations of point transistors and valves or junction transistors.

The basic idea of dual circuits is discussed only sketchily, if at all, in most textbooks. The life of the student is made even more complicated by a terminological confusion, because Bode, and some other writers who approach duality from the purely analytical point of view have used the term *inverse* instead of *dual*. I propose to adopt a verb, to dualize, seldom used in this work, in order to avoid the linguistic trap of saying that " on inversion, we obtain the dual."

Conversion of an electrical system to its dual is carried out by replacing all currents by voltages, and all voltages by currents in the network equations. To effect this change, a scale resistance must be used, so that the dimensions are kept under control. Let us look at the equation usually called the general form of Ohm's Law, $V = ZI$. With a scale resistance R we can express V as $I'R$ and I as V'/R where I', V' are the duals of V and I respectively. Then $V = ZI$ becomes $I'R = ZV'/R$ or $V' = (R^2/Z)\ I'$. The impedance R^2/Z is the dual of Z.

When Z is a pure resistance r, we have as the dual another pure resistance $r' = R^2/r$.

When Z is a capacitance, $1/j\omega C$, we have as the dual an inductance, $Z' = j\omega CR^2 = j\omega L'$, with $L' = CR^2$.

When Z is an inductance, $j\omega L$, we have as the dual a capacitance, $Z' = R^2/j\omega L = 1/j\omega C'$, with $C' = L/R^2$.

More complicated impedances can be calculated by the student, using the basic equation $ZZ' = R^2$. Fortunately this is not the way in which we set about dealing with more complicated systems, however. Let us look at the dual of a pair of impedances connected in series. Take $Z = Z_1 + Z_2$. Then $Z' = R^2/(Z_1 + Z_2)$. The dual admittance is, obviously, $\frac{1}{Z'} = (Z_1 + Z_2)/R^2 = Z_1/R^2 + Z_2/R^2$. The admittances of the duals of the individual impedances are Z_1/R^2 and Z_2/R^2, so that the admittance of the dual of two impedances in series is equal to the admittance of the separate duals in parallel. In fact we have the conversion shown in Fig. 1.

This is the first step towards developing a way of drawing the dual of any ladder network. Let us take, for example, the T-network shown in Fig 2(a). The first arm, looking in from the left, is in series with an impedance, the rest of the network, which can be boxed off by itself, as shown in Fig 2(b). Dualizing,

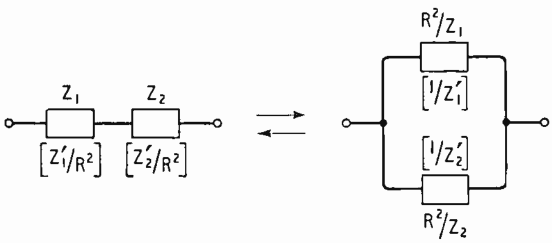


Fig. 1. The dual relationship between series impedances and shunt admittances is a symmetrical one.

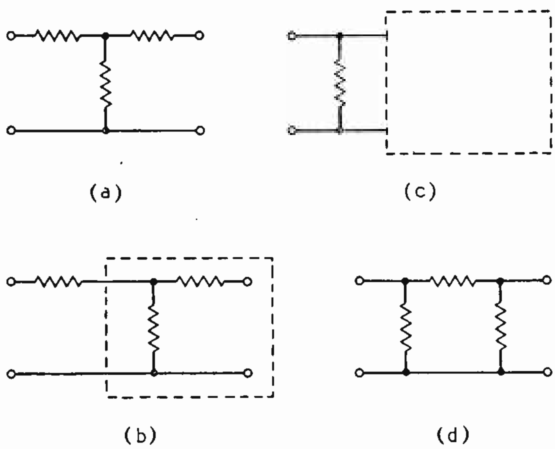


Fig. 2. In developing one dual of a ladder network (a) we take the first arm and the " rest of the network " (b), dualize the first arm (c), and then proceed to operate in the same way on each succeeding element (d).

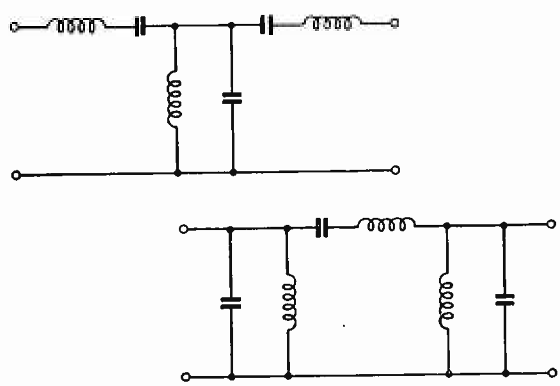


Fig. 3. These two bandpass filters are duals.

this series arm is converted to the shunt arm shown in parallel with the dual of the boxed impedance in Fig 2(c). Repeating the process with the first element, a shunt arm, inside the box we obtain a series element. Step-by-step we go from T-network to π-network. Each arm may be complex, but the same process of converting two elements in series to their duals in parallel is allowed. As long as the network is of this straightforward ladder type we have no difficulties. As an example, the two bandpass filters in Fig 3 are duals. This inter-conversion of T-sections to π-sections is well known for filters, and we usually take the characteristic impedance of the filter as the scale resistance without thinking about it at all.

There is a rather interesting connection between the idea of dual networks and the idea of analogue networks. Suppose we write down the familiar law of motion:

$$\text{Force} = \text{mass} \times \text{acceleration}$$

This can be written symbolically as $F = m\frac{dv}{dt}$, or preferably, for our purposes, $F = \frac{d}{dt}(mv)$. For a sinusoidal movement we have the equation $x = a\epsilon^{j\omega}$ and we thus have

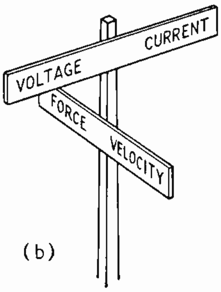
$$\frac{dx}{dt} = j\omega \,.\, a\epsilon^{j\omega t} \quad \text{or} \quad \frac{d}{dt}\,.\,x = j\omega\,.\,x.$$

This means that we can write $F = j\omega mv$ or $v = F/j\omega m$. There are two schools of thought about what to do next. One school writes $F = j\omega mv$ and $V = j\omega L\,.\,I$, the other school writes $v = F/j\omega m$ and $V = I/j\omega C$. As a result, one school decides that Force and Voltage can be taken as analogous, while the other school associates Force and Current. It seems to me perfectly clear that, as we can always do a duality conversion, the simplest thing to do is to draw, not the simple diagram of Fig 4(a), but the signpost diagram of Fig 4(b), and let the analogue user twist round clockwise or anti-clockwise as he likes. But it is interesting to notice that an ideal electromagnetic loudspeaker driving an ideal crystal pickup will give an output voltage proportional to input current, and thus acts as a duality converter. This, by the way, is often called a gyrator, because in mechanical systems a gyroscope will perform this dualization operation.

A table of basic duals is given on pages 388 and 389 of the *Bell System Technical Journal*, Vol. 30, April 1951, in a paper by R. L. Wallace, Jr., and G. Raisbeck. This table, with suitable extensions, is extremely useful in transistor circuit design.

VOLTAGE	CURRENT
FORCE	VELOCITY

(a)



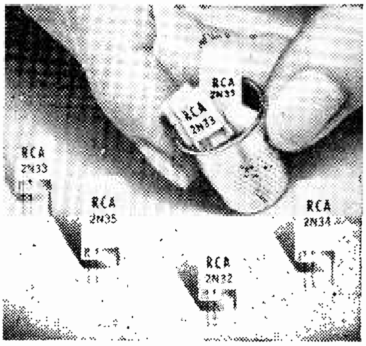
(b)

Fig. 4. The usual analogue diagram (a) is more circumscribing than the diagram (b) which gives a choice of two analogues.

New Transistors

THE latest transistors to appear on the market are from RCA and details of them are now available from RCA Photophone of 36, Woodstock Grove, London, W.12. The 2N32 is a point transistor intended for use in pulse or switching circuits. It operates with a collector voltage of −25 V and an emitter current of 0.5 mA, and has a current amplification factor of 2.2 and a power gain of 21db. The other point type, the 2N33, is designed for use as an oscillator at frequencies in the region of 50 Mc/s. In a typical circuit it operates with −8 V on the collector and 0.3 mA emitter current and gives a power output of about 1 mW.

Types 2N34, and 2N35, on the other hand, are junction transistors (the first being *p-n-p* and the second *n-p-n*) and are intended for use as a.f. amplifiers. They both operate at the very low supply voltage of 6 V (although with opposite polarities), and in a suitable circuit will give a power gain of 40db. All four types are mounted in small plastic cases and have projecting base pins, for which sockets are available.



A group of the new RCA transistors showing their size relative to a thimble.

V.H.F. Amateur Band Planning

AT a meeting convened by the Radio Society of Great Britain and attended by representatives of the principal amateur organizations interested in v.h.f. work, plans were drawn up and approved for general usage within the 2-metre and 70-cm amateur wavebands.

A zoning scheme has been in operation on the 2-metre band for a few years now and as it works so well and is so widely used it was agreed to adopt it *in toto* and the R.S.G.B. has undertaken to circularize all European amateur organizations with the view to getting it adopted throughout the Continent.

Briefly the scheme consists of allotting bands of frequencies to different zones (so far only in the British Isles) and arranged so that adjacent zones use widely separated bands. This plan has led to a big reduction in local interference among amateur stations on this band and its extension to other v.h.f. bands before they become overcrowded is definitely worth while.

The advent of amateur television in the 70-cm band makes band planning all the more desirable here and it was agreed to recommend the following allocations:—

420 to 425 Mc/s—SEO (self-excited oscillator) communications.
425 to 432 Mc/s—Amateur television.
432 to 438 Mc/s—Frequency-stabilized communications in zones harmonically related to those in the 2-metre band.
438 to 445 Mc/s—amateur television.
445 to 455 Mc/s—future amateur development.
455 to 460 Mc/s—SEO communications.

Re-defining "Electronics"

Extending the Meaning: A New Word Wanted

By B. E. NOLTINGK, Ph.D., F.Inst.P.

In last month's issue *Wireless World* drew attention to the increasing confusion caused by the different connotations of *electronics*. The author of the following article has already protested against suggestions to broaden unduly the present academic definition of the word, though he admits it might be widened to embrace all those devices in which electrons travel, not only through gases or a vacuum, but through anything except normal conductors.

IN any attempt to build up a comprehensive philosophical system, the importance of attaching a precise meaning to each phrase used can scarcely be exaggerated; but it is true also in other fields that words must be carefully defined if confusion is to be avoided. How much time, for instance, has been wasted at international conferences because *democratic* carries at least a different shade of meaning according as the speaker comes from across one frontier or another?

The whole history of science and technology is based on increasing precision and carefulness, and there is no excuse for engineers and scientists to be inexact in their use of words any more than in their use of meters or mathematics. Unfortunately, they are sometimes guilty of such inexcusable lapses. Discussions have recently been going on (we might almost say "waged"!) about the meaning of the word *electronics*, in which enthusiasm has sometimes been more apparent than calm consideration. It is open to anyone to coin new words, which may achieve general acceptance if they are found to fill a need, but when defining—making more definite—a word that is already in circulation, it is legitimate only to clarify boundaries that have already a vague existence. It is not permissible to mark out a new frontier which involves the annexation to that word of territory which was formerly quite independent. This tendency to broaden and cheapen words is all too common in schoolboys—e.g., *wizard* and *super* (was "superlative" contracted to "super" to be re-expanded to "supersonic"?)—but maturity of expression should guard jealously against it. It is the more regrettable that two recent definitions of *electronics* should transgress so flagrantly in this way. One[1] has already been argued against.[2] The other[3] seems to err even more widely; for in saying that "electronics is the science . . . of the transfer of information . . . by . . . electro-magnetic radiation . . ." it includes within the definition at least the whole field of optics.

If we examine current usage of the word *electronics* we find that it is actually employed in two senses. These merge into one another, but can generally be distinguished. The first, and more correct, concerns phenomena occurring when electricity is conducted by free electrons moving through gas or in a vacuum. The "electronic" device, in this sense, which has played by far the largest part in technological development, is, of course, the thermionic valve, and the second sense of the word *electronics* has been stretched to include any techniques and instruments in which such valves are used. Since it is convenient to group together techniques dealing with valves, with transistors, transductors and other non-linear circuit elements, and even with some other, simpler components (such as inductance-type strain gauges, which may well be used without valve oscillators or amplifiers), *electronics* is already occasionally used to embrace this wider field.

It would therefore be possible to make out quite a strong case for a re-definition of the word to cover such usage, or at least some of it. We would have to be careful that *electronics* did not become synonymous with *electricity*. An alternative, however, which appears to have considerable attractions, is to restrict the word to its original subject—what we have called its first sense—and to use some new expression for the field covered by the second sense. The difficulty is to propose a suitable word. In our present-day vocabulary, there is a distinct dearth of terms touching on this territory, and on this side of the Atlantic we seem to have a decent reticence about assisting in the birth of a brand new, ready-made word. In any case, verbal habits only change slowly and even if there were agreement in principle, it would probably be several years before any newly created expression was accepted at all widely.

Word-coining

Perhaps the only constructive suggestion that can be made at the moment is to encourage the wider use of the word *circuitry*, which at present is still on the wrong side of the boundary between jargon and respectability, but which can prove most useful in

[1] W. L. Everitt, *Proc. I.R.E.*, August, 1952, p. 899.
[2] B. E. Noltingk, *ibid*, May, 1953, p. 668.
[3] *Electronic Engineering*, May, 1953, p. 177.

expressing an idea not covered by any other word. Admittedly, there is as yet no adjective derived from *circuitry* which would be acceptable as a replacement for *electronic* (for instance, in R.E.C.M.F.). Perhaps such an adjective could be evolved.

While considering etymological invention, mention may be made of another word that is still completely missing from our vocabulary, and whose absence can prove a definite embarrassment. This is one to describe the actual physical object which is the embodiment of the "circuitry." Sometimes the object can be called an "instrument," but if, as is often the case, it is desired to distinguish between the "pick-up element" (which may be, say, a strain gauge or the temperature-sensitive resistor of an "electronic" temperature controller) and that part of the equipment which its connecting wires lead back to, there is just no word to describe the latter. "Electronic unit" can sometimes be used, yet it is certainly not correct.

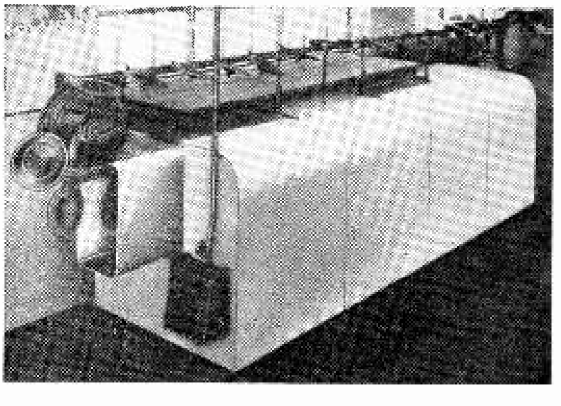
But here let the would-be coiner beware. If he follows the convenient American precedent set by *Spam*, he will find that he has telescoped a "circuit house" into a *circus*!

Drying Loudspeaker Cones

Use of Infra-red Projectors for Moisture Extraction

IN the normal process of manufacturing loudspeaker cones a suspension of fibres in a water solution containing a suitable binder is drawn through a wire mesh mould until a layer of the required thickness has been deposited. The mould is then withdrawn from the bath and after a period of drying and curing the diaphragm can be easily stripped from the wire foundation—provided that the drying process has been properly controlled.

At the works of Acoustic Products, Ltd., an infra-red drying plant has recently been installed by Metropolitan Vickers in which eight infra-red projector elements with a total loading of 30kW are controlled, in conjunction with the conveyor belt speed, to give a wide range of drying times suitable for cones of different types. The emission spectrum of the radiating elements has a peak at 2.8×10^4 Angstrom units which nearly coincides with the peak selective absorption wavelength of water at 3×10^4 A.U.



"Metrovick" infra-red drying equipment for use in loudspeaker cone manufacture.

Brain Waves by Radio

(*Courtesy The Lancet*)

The apparatus in position on the patient.

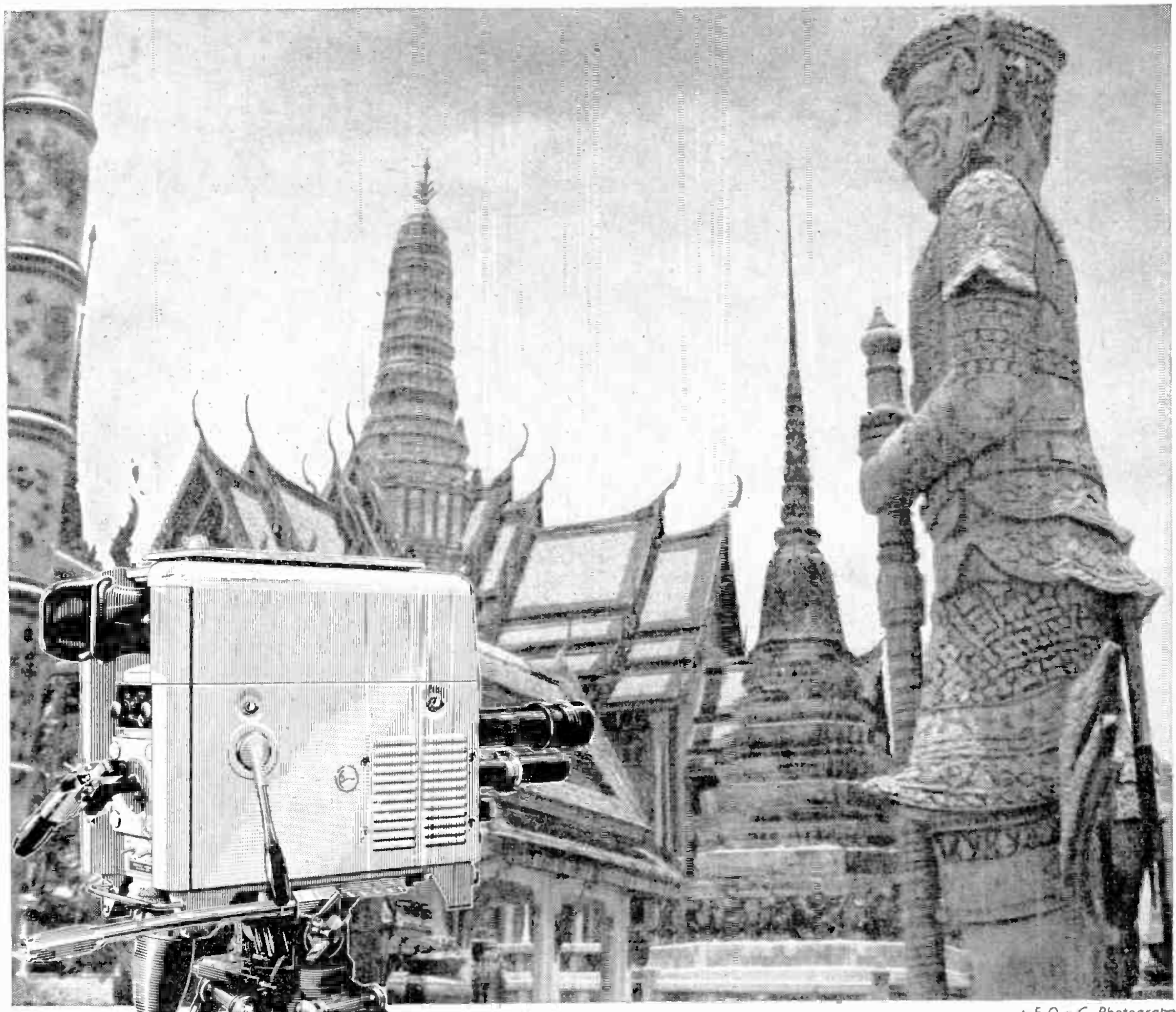
RECORDINGS of the electrical activity of the brain—or electro-encephalograms—are very useful to psychiatrists because they provide definite physical evidence of a patient's mental condition. The scope of the technique is limited, however, by the fact that the patient has to stay more or less inactive while the electrodes of the electro-encephalograph are attached to his head. More valuable information would be gained if he were able to move about freely and engage in everyday activities. Writing in *The Lancet* for 27th June, C. S. Parker, C. C. Breakell and F. Christopherson explain how they have overcome this difficulty by providing the patient with what might be described as a "walkie-thinkie"— portable f.m. transmitter which transmits the varying potentials obtained from electrodes on his head to a distant electro-encephalograph.

The transmitter uses frequency modulation because the patient's movements tend to produce variations in signal strength, and with amplitude modulation these would affect the amplitude of the received brain waves. Moreover, a crystal-controlled oscillator has to be used since the temperature rise in the apparatus would cause a free-running oscillator to drift and this would upset the recording base line.

The oscillator, however, is not frequency modulated directly by the 10-c/s brain waves, because with the crystal control there would be a considerable loss of gain at such a slow rate of deviation. It is actually deviated by a 5-kc/s a.f. tone, and the slowly-fluctuating brain waves are applied to this as amplitude modulation. Thus, with no incoming brain signals the carrier frequency (158.75 Mc/s) is deviated a fixed amount at a rate of 5 kc/s. The arrival of a brain signal then causes a change in the extent of this deviation. At the receiving end the signal is reproduced as a 5-kc/s tone with the brain waveform superimposed on it, so it is then only a matter of demodulating to remove the tone and recover the brain waves for recording purposes.

As the transmitter was only built for experimental purposes no attempt was made at miniaturization. Power is supplied by a lightweight silver-zinc accumulator hung on the patient's chest, and h.t. for the valves is obtained from this by means of a small rotary converter.

Marconi Television for Thailand



B.O.A.C. Photograph

Thailand, the first country in South East Asia to install Television, has placed the order for its system with Marconi's Wireless Telegraph Company Ltd.

The order includes vision and sound transmitters, Marconi Image Orthicon television cameras and associated equipment.

The system will operate on the international 625 line standard.

This new order follows those gained by the Company for installations in Italy, South America, Canada and the U.S.A.

Marconi high or medium power transmitters and high-power aerials are installed in every one of the B.B.C's television transmitter stations

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LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Two-band Television Reception

LESS technical readers of your Journal should be on their guard when considering speculative opinion expressed in your correspondence columns regarding the difficulties to be faced in enabling present set owners to receive programmes which may be transmitted in the future on higher-frequency bands. A destructive or defeatist attitude on this subject, if accepted by those who are not fully versed in the technicalities involved, could prove a serious obstacle to progress.

W. T. Cocking (your June issue) does well to point out the difficulties in the design of suitable v.h.f. and u.h.f. TV converters, but it must be realized that manufacturers in this field are well aware of these problems. It is clearly out of the question to produce a universal converter which will deal with all existing receivers and conditions of use, and the aim of the designers is to achieve the best compromise between the cost of the converter and the number of set users whom it can satisfy. This may result in the production of one or more relatively simple and inexpensive converters which will cater for most needs. When this has been done, more elaborate arrangements will be necessary to deal with more difficult cases, and there will undoubtedly be a residue of cases in which the use of a converter is not applicable at all.

Unfortunately the development and proving work which is required, though this can in part be carried out in the laboratory, is handicapped by the lack of any facility for the extensive field testing which will be necessary before designs can be completed and put into production with confidence. This is the main reason for the apparent unwillingness of designers and manufacturers to discuss these converters in any but the broadest terms.

What is required is the earliest possible commissioning of a high-power v.h.f. transmitter in the London area to enable the engineers concerned to be completely satisfied that the conclusions reached in the laboratory are borne out in practice in the field. Such a transmitter could be experimental in character, in the first place at least, and need only radiate a test pattern.

Cambridge. J. W. DALGLEISH,
Chief Engineer, Pye, Ltd.

Broadcast Transmitter Distortion

YOUR correspondent, T. S. Marshall (July issue) may be assured that the possibility of distortion from all sources in the receiver was not overlooked. I have tried a number of arrangements, there being no significant difference in results from the several best; the detector at present in use is a diode working into a *minimum* a.c. : d.c. load ratio of 98.9 per cent (at full volume control setting). The B.B.C. have not, however, attempted to deny that they do transmit distorted signals. It is not claimed that the severe distortion that is the subject of this correspondence is or was constantly present, but it was extremely common throughout the winter. The considerations set out by the B.B.C.'s Deputy Chief Engineer (in the June issue) would apply to any system, and he appeared to describe only the process of limiting, which is normally only a precautionary measure and is by no means the same thing as automatic compression, to which the B.B.C. had previously confessed. The distortion introduced by the latter would not be confined to the rare transient peaks which reach overload level, and the effects in fact observed would appear consistent with those expected when this technique is used.

It is too early for a listener to draw definite conclusions, but there appears to have been just recently a marked improvement in this respect, not confined to the daylight hours when interference is slight. If automatic compression has been abandoned, may it be for good.

As A. A. Cotterell says (July issue), programme quality in the widest sense is so variable as to indicate that not all the links in the audio chain are faultless. Direct broadcast programmes originating in London studios and transmitted by the London Home Service transmitter are sometimes inferior to comparable programmes relayed from distant regions by landline. In this respect, however, the maintenance of the highest standards is not to be secured by the adoption or rejection of any particular techniques, but simply by continual vigilance on the part of the individual programme engineers.

London, N.10. IAN LESLIE.

IN support of T. S. Marshall's remarks on the subject of the quality of B.B.C. transmissions, I would like to add that the detector circuit of the "No-Compromise R.F. Tuner" (*W.W.*, Oct., 1952), is the best I have tried, and the type of distortion complained about by other readers is not noticeable.

The B.B.C. quality *is* a variable factor, but in general the best quality seems to be obtained from concerts of a symphonic nature or from chamber groups, but in my experience one can *never* guarantee a high-quality transmission, even though a previous concert, by the same player combination, from the same studio, may have been first class.

A simple t.r.f. receiver seems to be essential for best results, but this necessitates being near to the wanted transmitter.

Stone, Staffs. H. BARKER.

Technical Qualifications

IN these days of severe shortage of technical staff, it is regrettable that employers have such an outdated view of the qualifications offered by a holder of the City and Guilds full technical certificate, and, to a lesser degree, of the final certificate.

The holder of a full technological certificate in telecommunication engineering is in as strong a position as any holder of better-known qualifications.

I have attended a "full-time" course for the above qualifications; some of my colleagues in the final year have been physics and engineering graduates wishing to obtain more advanced knowledge of communication theory not covered in degree syllabuses.

The mathematics syllabus covered in our final year was well up to standard required by any engineering degree of any British University, and much more relevant to communication engineering problems.

When the syllabuses, lecture and laboratory notes have been shown to employers by candidates being interviewed for a position, they have frequently been agreeably surprised at the high standard required.

It is deplorable that candidates should have to do this, when a few words from recognized authorities in the radio industry could instil general confidence in the City and Guilds qualifications in the minds of employers.

London, W.9. J. S. A.

"Some Aerial Queries"

I HAVE read with interest "Cathode Ray's" well-written article in your May issue. His remarks on the relative inefficiency of short radiators are deserving of clarification. The reader receives the impression that the inefficient operation of short antennæ is inherent in their length. Actually, there is little difference in the radiation efficiency of dipoles a half-wave or less in length. In practice, the apparent inefficiency of the shorter antenna is caused by the difficulty of properly feeding its comparatively low radiation resistance. In most cases it is either impractical or impossible to devise a coupling network whose ohmic losses are low enough to suit. When one considers the efficiency of the radiating system alone, the familiar relationship of power out/power in to the antenna proper holds. This, referred to an isotropic radiator, gives 1.5/1.64 for the relative efficiency of the limiting case; a dipole of infinitesimal length compared to a half-wave radiator. The difference is insignificant.

Riverside, Calif., U.S.A.

ALBERT WEISS (W6UGA).

"Cathode Ray" writes: I am much obliged to Mr. Weiss for removing any wrong impression that may have been made by my remarks on the relative ineffectiveness of aerials that are very short compared with half a wavelength. As the length is reduced, the radiation resistance falls—at something like the square of the rate—and if nothing is done about it the radiated or received power falls steeply. But, as he points out, if by ideal coupling and tuning arrangements the load and loss resistances could be reduced in the same proportion, the fall in radiation resistance would be offset by rise in current, and the power thereby kept constant.

This interesting theoretical possibility, however, bears very little relationship to what is practicable, otherwise the B.B.C. might have been able to save a lot of money by radiating their medium- and long-wave programmes from a few inches of aerial!

Ear Training

AS a commercial wireless operator with eight years' experience I should like to add a footnote to the comments on the apparent difference in sensitivity of the ear to sounds originating in headphones or from a loudspeaker ("An Aural Anomaly," p. 239, May issue). In my opinion any discrepancy which may be found will be influenced by the degree and circumstance of the previous training which the listener may have received.

I learned telegraphy exclusively with earphones, and when I had to use a loudspeaker it was necessary to run it well nigh full bore in order to get signals down. One of my favourite parlour tricks was to let a visitor listen to some phones with the signal level too low for him to detect sound; after that, to copy traffic from them without altering the signal level. My ears are not exceptionally sensitive, but just well-trained to the use of phones.

To hear well one must "relax" the ears, and this is not achieved with five minutes' practice. It didn't happen to me for thousands of operating hours. With ears covered, head noises are magnified, and these distract the attention of the inexperienced. Head noises include pulse, creaking muscles and bone, breathing and saliva noises. Two conditions must be met without conscious effort: (1) Controlled breathing to stop "waterfall" noise. (2) Breath free enough to stop blood pumping noises.

Blocking the ears has a slight hypnotic effect like wearing spectacles or a broad-rimmed hat. It brings a sense of security and a fancied isolation from the realities of life—so you go to sleep!

In two words, the anomaly is explained by "inexperienced listening."

Arborfield, Berks. J. WORTON.

"Stereoscopic Television"

REFERRING to your article in the July issue, the B.B.C. could start showing stereoscopic images to-morrow if it cared. No alteration to existing transmitters or alteration or attachments to existing receivers would be needed; only a few minutes' practice by the viewer.

The method has been known for decades to photographers, the Ordnance Survey, range-finding instructors, and the like. The right-hand image of the stereo pair is displayed on the left of the screen, the left-hand component on the right. The spectator converges his eyes on an intermediate spot, such as the finger of his extended hand, and then transfers his attention to the screen. A solid image will then appear, nearer than the screen but apparently smaller, flanked by two satellite flat images which are mentally invisible. The extended hand and similar aids are unnecessary after a trial or so.

With current screens the stereograms thus displayed would be of "upright" format, or, if not, would have to be rather small. Against this they would have the advantage of needing no apparatus, other than that needed to form the original stereo pair, and of giving far better quality (without any loss of illumination) than any system that interposes optical equipment between screen and eye.

Farnborough, Hants. R. A. FAIRTHORNE.

Lamp Interference

REFERRING to the letter by A. P. Hale in your June issue, it is scarcely true to say that the use of vacuum lamps is confined to the special applications he mentions; in fact, a large proportion of the lamps used in domestic installations are of this type.

Nor is the gas-filled lamp so innocent as he believes; a number of these have been found to cause interference. It may be that the interference from the gas-filled lamp is not so strong as that from vacuum lamps, and in a TV reception area enjoying such a high field strength as does Enfield its interference is not noticed.

It is found that lamps of different wattages have different frequencies on which their peak interference output is produced. I am to believe that manufacturers are aware of this trouble and that research is being conducted with the aim of producing lamps which would be free from this fault.

Tenby, Pembs. W. B. MANSELL.

Function of the Valve

"DIALLIST" contends (June issue, p. 292) that the thermionic valve is a power amplifier rather than a voltage amplifier. Strictly speaking, it is neither.

By mechanical analogy, no system of gears, levers or controls can itself increase the power (rate of doing work) of an engine. Additional power can be obtained only by a corresponding increase in fuel expenditure, assuming the efficiency is unaltered.

The thermionic valve can perform only as a valve, or, if preferred, a form of electronic relay actuated by the incoming signal. It controls power that is derived solely from the supply mains or battery.

Radlett. O. M. BRUCE PAYNE.

"Meter Shunts"

THE article in your July issue wisely calls attention to the possible danger to the meter during adjustment of the shunt.

I suggest that a safer and simpler method is to use the so-called constant current circuit. In this a resistor of the order of a thousand times the instrument resistance is connected in series with a battery of sufficient voltage to produce full-scale deflection, an additional variable resistance being used for fine adjustment. If now a variable resistance is connected across the meter and adjusted so that the deflection is exactly halved, its value when separately measured will be equal to that of the instrument.

Without actually ascertaining the value of this resistance various shunts may be set up by adjusting the meter deflection to the required fraction of the full-scale value. Accuracy in this case will be limited by the ability to read small deflections and it may not be possible to extend the range by more than a factor of 10. However, by repeating the process one may extend the range further but unless extreme care is taken accuracy will tend to suffer.

Chipstead, Surrey. E. G. DANN.

T.A.C. REPORT

Summary of the Considerations and Recommendations

THE long-awaited report[1]—or at least the first of a series of reports—of the Television Advisory Committee was published on July 7th. When appointing the committee[2] in October, 1952, "To advise the Postmaster General on the development of television and sound broadcasting at frequencies above 30 Mc/s and related matters, including competitive television services and television for public showing in cinemas and elsewhere," the P.M.G. asked the members to give priority to the consideration of domestic television both by the B.B.C. and competitive organizations; the present report is confined to this subject. Subsequent reports will cover v.h.f. sound broadcasting and cinema television.

The report is primarily concerned with the technical considerations involved, particularly the question of frequency allocations, and does not go into the politics of sponsored television. As already recorded in *Wireless World* a technical sub-committee[3] was set up by the T.A.C. to study the bands available for television and v.h.f. sound broadcasting which also comes within the purview of the T.A.C. The internationally allocated bands for broadcasting above 30 Mc/s are:—

BAND 1

Channel	Station	E.R.P. (kW)	Polar'n	Limit of Service Area
1	London .. .. N. Ireland.. ..	500 50	V H	----
2	Holme Moss .. S. Devon ..	500 50	V V	—·—·
3	Isle of Wight .. Kirk o'Shotts ..	50 500	V V	———
4	Aberdeen .. .. Isle of Man .. Sutton Coldfield .. Channel Islands ..	50 25 500 5	H H V H	.....
5	Pontop Pike .. Wenvoe	50 500	H V	x x x x

BAND 3

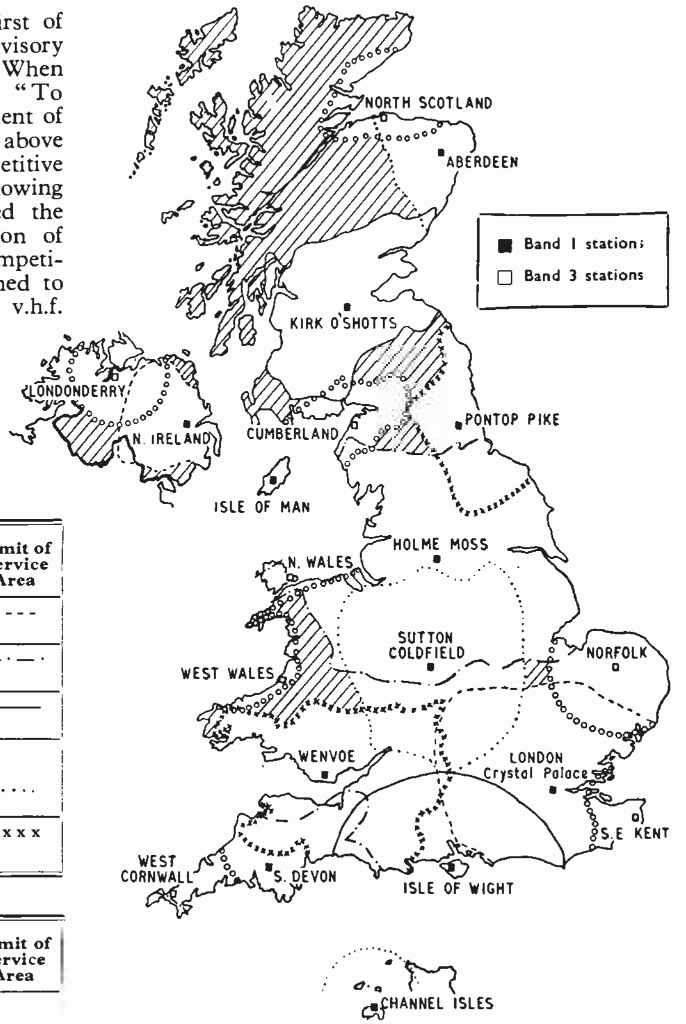
Channel	Station	E.R.P. (kW)	Polar'n	Limit of Service Area
7	Cumberland .. S.E. Kent .. .. W. Wales	50 5 50	H V H	o o o o o
8	Londonderry .. Norfolk .. .. N. Scotland .. N. Wales .. .. W. Cornwall ..	50 50 50 50 50	H V H H V	

E.R.P.—Effective Radiated Power.

(1) 41 — 68 Mc/s }
(2) 87.5—100 Mc/s } v.h.f.
(3) 174 —216 Mc/s }
(4) 470 —585 Mc/s }
(5) 610 —960 Mc/s } u.h.f.

It should be stressed at the outset of this summary that the report is based on the assumption that the present 405-line system will continue to be used for future services. Howeve-, by the recommended initial allocation of only every thiru 5-Mc/s channel in Bands 4 and 5 provision is made for the introduction of a higher-definition system if desired.

So far as Band 1 is concerned it will be virtually fully utilized on the completion of the B.B.C.'s plans for 12 stations—the existing 5 high-power stations, 5 medium-power transmitters (Belfast, Newcastle, Aberdeen, Plymouth and Isle of Wight), and 2 low-power stations in the Channel Islands and Isle of



Estimated coverage of the stations planned by the B.B.C. for a single-programme service using the whole of Band I and two channels (205.5 and 215·5 Mc/s) in Band 3. Shaded areas will receive a median field strength of less than 225 μV/m from Band I stations and less than 500 μV/m from Band 3 stations. It will be noted that the estimated service area of the London station is based on the new high-power transmitter being erected at the Crystal Palace.

Man. The committee does, however, recommend that "every effort should be made to allocate a Band 1 frequency to any user [presumably competitive] when the location and power of the proposed station makes this possible."

Band 2 is considered to be too narrow to be of much use for television and is left—as agreed at Stockholm—for sound broadcasting. The committee does, however, take cognizance of the possibility of the future integration of the television and v.h.f. sound services.

The crux of the whole situation is undoubtedly Band 3. This would provide eight 5-Mc/s television channels, but at Atlantic City (1947) the U.K. asked for and obtained permission to use the upper 16 Mc/s in this band for air navigational aids and the lower 26 Mc/s for both broadcasting and *fixed* services. As is well known, the band between 174 and 184 Mc/s is being used in this country for *mobile* services and many business radio users and public services are now working in it. The complete clearance of the band at the expense of the other services—which would have to be found other places in the spectrum—is regarded by the T.A.C. "only as a future possibility," but it has been advised that two channels (between 184 and 195 Mc/s) could readily be made available for television. The committee recommends that a third channel should be cleared quickly either in the band or adjacent to it and that the whole of Band 3 should be eventually made available for television. The committee envisages the possibility of widening this band.

A map is incorporated in the report showing the possible disposition of four high-power stations (London, S. Wales, N. Midlands and Central Scotland) and six low-power transmitters (S.E. Kent, Norfolk, W. Wales, Cumberland, Londonderry and Inverness) using the two channels readily available in Band 3.

In the light of our present knowledge of propagation at u.h.f. and of the development of valves for use at the higher frequencies, it is considered that by comparison with Band 3 twice as many stations would be required to give substantial coverage of the whole country using Bands 4 and 5. Allowing 5 Mc/s bandwidth, 93 channels could be provided in Bands 4 and 5, but, as already stated, it is proposed that only every third channel should initially be allocated.

It is stressed in the report that whatever use is eventually made of Band 3, whether by the B.B.C. or competitive stations, any extensive development of television will demand the starting of transmissions in Bands 4 and 5.

The B.B.C.'s plans for a two-programme service for the whole country using the whole of Band 1 and the eight channels in Band 3 allocated at Stockholm are given in the report. A list of the proposed stations was published in our June issue, page 291.

An analysis of the applications so far received for licences for competitive stations gives the approximate number of transmitters required as 88.

A short statement on the present position of the development of colour television is given as an appendix to the report with the recommendation that any colour system to be adopted in this country must be compatible.

A reservation by C. O. Stanley is appended to the report as he was "unable to agree that the limited conclusion which the Television Advisory Committee has reached forms an adequate basis on which to plan alternative television services." He draws attention to "the unsound basis of frequency allocation in this country" and proposes the establishment of a system of collaboration between the licensing authority and industry in order to prevent a recurrence of the present chaotic condition, or, alternatively, the setting up of an independent commission on the lines of the American Federal Communications Commission to control all frequency allocations.

References

[1] "First Report of the Television Advisory Committee, 1952," H.M.S.O., price 1s 6d.

[2] Members of reconstituted T.A.C.: Admiral Sir Charles Daniel (Chairman); E. W. Playfair (Treasury), F. C. Musgrave (Min. of Supply); Sir Ben Barnett (Post Office); Sir Ian Jacob (B.B.C.); G. Darnley Smith and C. O. Stanley (R.I.C.); Sir Edward Herbert; Lord Aberconway; E. M. Fraser, and R. J. Broadbent (Secretary).

[3] Members of technical sub-committee: Dr. W. G. Radley (Engineer-in-Chief, G.P.O., Chairman); H. Bishop and R. T. B. Wynn (B.B.C.); H. Faulkner (Post Office); G. E. Condliffe (E.M.I.); B. J. Edwards (Pye); K. I. Jones (Cossor); Professor Willis Jackson (Imperial College, now Metro-Vick); Dr. R. L. Smith-Rose (D.S.I.R.), and C. W. Sowton (Secretary).

Experimental TV on U.H.F.

G3CTS/T is the call sign of the 405-line experimental television transmitter which has been built by the Television Society and will operate on 427 Mc/s with a peak power of 12W. The equipment has been installed at the Norwood Technical College, where it was recently seen at the "Open Day," and, in addition to providing a test signal for members of the Society interested in u.h.f. reception, it will serve as a demonstration for the students.

The Society is also considering the design of a 625-line transmitter which will be operated in collaboration with the radio industry to enable receivers built to the continental standard to be tested under working conditions.

It is stressed by the Society that neither transmitter will be operated as a commercial station as has been rumoured in some quarters. The construction of the station is being undertaken as part of the Society's policy of aiding the development of television technique.

Educational Filmstrips

WHAT are believed to be the first filmstrips to be produced covering a specific course of study have been prepared by Mullard, Ltd., as part of its educational service. It consists of a series of 20 strips covering the two final years in the Ordinary National Certificate course in electrical engineering.

Although prepared primarily for the assistance of lecturers and teachers in technical training establishments, many of the strips will undoubtedly be found useful for senior science classes in grammar schools and for staff and apprenticeship training.

In producing this series of filmstrips Mullard's have had the assistance of an advisory panel composed largely of teachers in technical colleges.

In selecting the diagrams the tendency has been to concentrate on those that would normally involve laborious blackboard work and a greater degree of accuracy than can be generally obtained by freehand drawing.

Details and prices of the filmstrips in the series, which were made and will be distributed by Unicorn Head, Visual Aids, Ltd., are obtainable from Mullard, Ltd., Educational Service, Century House, Shaftesbury Avenue, London, W.C.2.

WORLD OF WIRELESS

Organizational, Personal and Industrial Notes and News

Radio Show Plans

MANY of our readers overseas will have received the booklet "British Radio Leads the World," which has been circulated abroad by the Radio Industry Council. It includes an invitation to the National Radio Show at Earls Court, London, which opens to the public on September 2 for ten days. The booklet consists almost entirely of photographs with captions in English, French and Spanish telling the story of British achievements in radio and electronics.

The technical training display which was introduced at last year's show is being enlarged this year. The B.B.C. Engineering Training Establishment; King's College, London; Borough Polytechnic; E.M.I. Institutes; Marconi College and Norwood Technical College are participating in the display which will be devoted to "careers in radio." S. N. Ray, of the Borough Polytechnic, will be in charge of the stand.

There will be some 80 manufacturers exhibiting at the show, plus Government Departments, the B.B.C., banks and publishers. A considerable amount of space will be devoted to combined displays of electronic gear.

Admission to the exhibition, which will be open daily (except Sunday) from 11 to 10, will be price 2s 6d (children under 16 years of age 1s).

In our next issue we shall include an illustrated, tabulated guide to the main exhibits at the show.

Stereoscopic Television

A DEMONSTRATION of stereoscopic television was given recently by the American Broadcasting Company in Hollywood. According to our contemporary, *Radio-Electronics*, the system used a synchronized mirror rotating 30 times per second in front of the television camera to produce two images with an apparent spacing equivalent to that of the human eyes. These were reproduced on separate c.r. tubes at the receiver and projected on to a screen 3ft by 4ft. Viewers had to wear polarized glasses. After some initial confusion caused by the picture coming in upside down, the audience found the results strikingly effective.

According to *Electronics*, the Radio Corporation of America are working on a "three-dimensional" television system using a wide-angle camera lens, giving a 142-degree field of view, and a spherical-screen projection receiver. This is presumably the television equivalent of the film industry's "Cinerama" or "Cinemascope."

PERSONALITIES

Harold Bishop, C.B.E., B.Sc., is to be president of the I.E.E. for the coming session. A year ago he succeeded Sir Noel Ashbridge as Director of Technical Services in the B.B.C., which he joined in 1923. He was previously with Marconi's and was associated with the installation and operation of the original 2LO transmitter in Marconi House, London. Mr. Bishop is now serving on the T.A.C. Technical Sub-Committee

J. A. Smale, C.B.E., B.Sc., the new chairman of the Radio Section of the I.E.E., has been engineer-in-chief of Cable & Wireless since 1948. He received his apprenticeship with B.T.-H., and after service in the Royal Naval Air Service in the 1914-18 war joined Marconi's W.T. Co. in 1919. He transferred to Cable & Wireless in 1929. Mr. Smale was largely responsible for the introduction of the system of frequency shift keying. He was appointed a C.B.E. in the New Year Honours this year, and has been a member of the Radio Research Board since 1951.

G. S. C. Lucas, O.B.E., M.I.E.E., who has succeeded **Hugh McC. Jack**, B.Sc., as chief electrical engineer of the British Thomson-Houston Co., joined the company in 1915 but left to continue his studies. He rejoined as an assistant to the head of the B.T.-H. Research Laboratory in 1925. He became head of the Electrical and Development Section of the laboratory in 1932 and for his contribution to the development of centimetric fire-control equipment was appointed an O.B.E. In 1945 he was appointed manager of the newly-formed Electronics Engineering Department and subsequently became assistant chief electrical engineer.

P. E. Trier, M.A., who joined the Mullard Research Laboratories in 1950 as head of the Communications and Radar Division, and **G. Knott**, M.A., A.M.I.E.E., who joined the Mullard organization in 1940, have been appointed joint-managers of the Mullard Research Laboratories. Mr. Trier,

P. E. TRIER, M.A. *G. KNOTT, M.A.*

who graduated as a wrangler in the mathematical tripos at Cambridge, was at the Admiralty Signal and Radar Establishment from 1941 to 1950. He was head of the V.H.F. Communications Group when he left. In his new position he will direct the Electronics Laboratory. Mr. Knott, who was at Clare College, Cambridge, and was subsequently engaged in research on X-ray crystallography at the University, was appointed a development engineer with the Mullard Radio Valve Company in 1940 He took charge of the Mullard Vacuum Physics Laboratory when it was formed in 1946, and in his new position will continue to direct its activities.

Hugo Gernsback, editor and publisher of our New York contemporary *Radio-Electronics*, was recently presented with a trophy by the American radio industry "in grateful appreciation of his 50 years of pioneering and inspiring leadership in the spectacular development of the radio-electronic art." The trophy, which is a silver globe mounted on a base on which are inscribed graphical radio symbols, the names of radio pioneers and of the donors, is to be established as an annual industry award "for outstanding accomplishments in the field of radio-electronics."

E. W. Hayes, M.I.E.E., author of the article in this issue on mobile television stations, joined the B.B.C. from Siemens Bros. in 1933 and became engineer-in-charge at the Rampisham short-wave station in 1945. For three years from 1948 he was in Malaya as senior planning engineer for the British Far Eastern Broadcasting Service. On his return to the United Kingdom in 1951 he was appointed head of the Transmitter Equipment Section of the Corporation's Planning and Installation Department.

The Marconi International Marine Communication Co. announces the appointment of **J. R. C. Johnson** as manager of its Contracts Division. He joined the company as a sea-going radio officer in 1917.

T. F. Hargreaves, B.Sc. (Eng.), A.M.I.E.E., has left Standard Telephones & Cables, Ltd., where he started in 1938 in the Development Department, and has joined the Equipment Division of Mullard, Ltd. He will be concerned with the overall planning of radio and telephone communication systems. While with S.T.C. he was engaged on the development of multi-channel carrier equipment.

W. A. Penkman, the new manager of the Service Division of the Marconi International Marine Communication Co., Chelmsford, was a sea-going radio operator from 1918 until 1926 when he returned to shore duties. Two years later he transferred to the Marconi Marine Service Division in London and became assistant service manager in 1948. With the reorganization of the company's divisions in 1951 he was appointed deputy manager of the division of which he is now manager.

C. E. Skerrey, M.Brit.I.R.E., Assoc. I.E.E., communications engineer with the Basrah Petroleum Co., Ltd., Iraq, is on leave in this country. He asks us to mention this as there may be members of the radio industry who would like to discuss with him the question of the behaviour of equipment in the tropics. His postal address while in London is BCM/Travel, London, W.C.1.

OBITUARY

Charles Le Maistre, C.B.E., M.I.E.E., who was well known in the field of international standardization and was the first director of the British Standards Institution (1929-1942), died on July 5th in his eightieth year. He was also general secretary of the International Electro-Technical Commission from its formation in 1904 until his death.

Charles Francis Phillips, M.I.E.E., died suddenly at Blackheath on July 1st at the age of 67. Shortly after the first world war, in which he served as a Lt.-Cdr. in the Royal Navy, he collaborated with W. W. Burnham in founding Burndept, Ltd., one of the first companies to manufacture receiving apparatus specifically for broadcasting. In 1921-22 he was a member of the G.P.O. Committee which considered the formation of the B.B.C. In 1928 he transferred to Graham-Amplion, Ltd., as chief engineer and director.

Charles Pinkham, who retired from the G.E.C. in 1950 after 37 years service, died on July 12th at the age of 64. He joined the company as personal assistant to the late Lord Hirst and was for 23 years manager of the publicity organization of the G.E.C.

Stanley G. Rattee, A.M.I.E.E., who joined the editorial staff of *The Electrician* (now *The Electrical Journal*) in 1927, and since 1948 had been editor, died on June 27th. He was for some years in the Marconi Co. and from 1920 to 1923 was assistant editor of the publications issued by the company which then included *Wireless World*.

IN BRIEF

Receiving Licences.—12,945,828 broadcast receiving licences, including 2,316,600 for television and 188,501 for sets fitted in cars, were current in the U.K. at the end of May. During the month, the number of television licences increased by 113,257.

Welsh Transmitter.—The new B.B.C. Home-Service transmitting station at Towyn, Merioneth, on June 21st took over the service on 881 kc/s from the temporary transmitter which had been operating from a caravan on the site since September last year. The 5-kW transmitter is designed for unattended operation with remote control from another B.B.C. centre. Both the main transmitter and the 2-kW stand-by equipment were manufactured by Marconi's.

Aberdeen TV.—The site of the television station for Aberdeen, which is one of the five medium-power transmitters to be erected by the B.B.C., is to be Core Hill. It lies mid-way between Buckie on the Banff coast and Aberdeen.

Aero-Electronics.—The first students specializing in electrical engineering have just passed out of the College of Aeronautics, Cranfield. The course, which is at graduate level, is against a general background of aircraft engineering, and naturally the emphasis of the electrical section is heavily on radio and electronics.

Daventry's Reduced Power.—A fault in the aerial system of the Third Programme transmitter at Daventry (464 metres) has made it necessary to bring the reserve aerial into operation and to reduce the power to approximately 60 kW until the fault has been rectified; this may take some weeks. Some fading after nightfall may possibly be experienced by listeners living at considerable distances from the transmitter as the stand-by aerial is not of the most modern anti-fading type.

Radio Banquet.—The annual banquet of the Radio Industry Council will be held at the Savoy Hotel, London, on November 18th. It will be at this function that Sir Noel Ashbridge will be presented with the portrait painted by Frank O. Salisbury which was reproduced in our June issue. It bears the inscription "Presented to Sir Noel Ashbridge, M.I.C.E., M.I.E.E., by the Radio Industry Council in recognition of his contribution to the growth of British broadcasting, January 5, 1926, to July 31, 1952."

I.E.E. Council.—In addition to the election of H. Bishop as president of the I.E.E. (referred to earlier) the six vacancies for ordinary members of the Council for the coming session have been filled by members of the Radio Section. They are: Dr. Willis Jackson, F.R.S. (Metro-Vick); G. S. C. Lucas, O.B.E. (B.T.-H.); Dr. R. L. Smith-Rose, C.B.E. (D.S.I.R.); G. O. Watson ("Lloyd's Register of Shipping"); R. T. B Wynn, C.B E. (B.B.C.); and A. T. Crawford (Reyrolle).

Radio Section, I.E.E.—The new members of the Radio Section Committee of the I.E.E. elected to fill the vacancies occurring on September 30th are: chairman, J. A. Smale, C.B.E. (see "Personalities"); vice-chairman, H. Stanesby (P.O. Research Station); ordinary members: Professor H. E. M. Barlow (University College, London); Dr. C. G. Macfarlane (T.R.E., Malvern); H. Page (B.B.C.); and Dr. R. C. G. Williams (Philips).

Radio Control is to be a major feature of the All Britain Model Aircraft Rally to be held at the Handley Page Aerodrome, Radlett, Herts, on September 20th instead of August 23rd as originally announced. Admission is by programme obtainable, price 9d, from J. J. Greening, 25, Mandeville Drive, St. Albans, Herts.

Army Wireless Reserve.—The first 15-day annual camp of the recently-formed Army Wireless Reserve Squadron, of which Major D. W. J. Haylock (G3ADZ) is in command, was held near Chester in June.

Italy's National Radio and Television Exhibition is to be held in Milan at the Palazzo dello Sport from September 12th to 21st.

Pen Pal.—A reader in France, Monsieur René Coué, aged 23, of Radio St. Maurice, Le Girard (Vendée), France, would like to correspond with somebody interested in radio in this country.

BUSINESS NOTES

Kelvin & Hughes, Ltd., supplied the four echo sounders to be fitted in the floating fish factory "Fairfree II" which was launched a few weeks ago. Two of the sounders have been specially developed for fish detection over a wide range. The basic scale is from 40-400 fathoms, but this can be extended to 2,250 fathoms. The frequency used is 15 kc/s.

Marconi's have received the contract from the Government of Burma for the supply of more than a quarter of a million pounds' worth of radio equipment for the linking of 12 main centres in Burma. The system will not only link these main centres, but they in turn will be connected to a large number of smaller centres. The equipment will provide a completely new system of radio inter-communication for the country.

Coaxial Switches, relays and waveguide sections are among the products of the new firm of Besson & Robinson, Ltd., manufacturers of electro-mechanical apparatus, whose address is 6, Government Buildings, Kidbrooke Park Road, London, S.E.3.

The Du Bois Co., Ltd., have produced a new non-corrosive cored solder called "33 Tri-Sol," which complies with both the M.O.S. specification DTD599 and the G.P.O. specification M44/D.

Mullards have opened a Valve Service Depot at Renfrew Chambers, 20. Renfrew Street, Glasgow, C.2 (Tel.: Douglas 7772). The Depot manager is A. H. Adie.

Furzehill Laboratories, Ltd., announce that they have appointed Hawnt & Co., Ltd., of 59, Moor Street, Birmingham, 4, to be their exlusive agents for eleven Midland counties.

Transistor Circuits and Applications

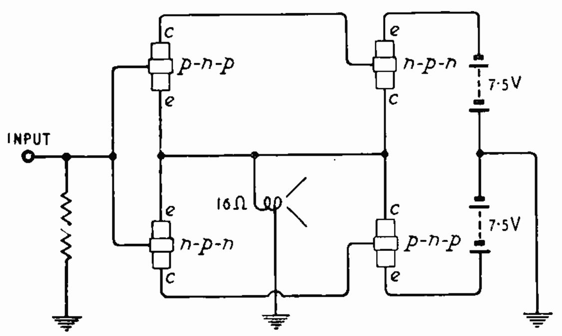
Recent Developments from R.C.A. Research Laboratories

THIS is the season of visiting experts, and inevitably the transistor has been taken by many as the subject for the lectures which it is customary to expect of them.

The latest missionary was Mr. G. C. Sziklai, of the Radio Corporation of America, who delivered a lecture at the Royal Society of Arts on July 1. There was an audience of over 250, and an unknown number were turned away after the gangways were filled. Dr. Smith-Rose was in the chair.

Transistors are semi-conductor systems, and it is now normal to define a semi-conductor by its resistivity, of the order of 10° ohm-cm, compared with the conductors, 10^{-6} ohm-cm and the insulators, 10^{6} ohm-cm. Elements in Group IV of the periodic table are our present typical semi-conductors, but a considerable amount of research is being conducted into the properties of the compounds of Group III and Group V elements. These form similar crystal lattices, but offer a much wider choice of electron energy levels and carrier mobilities. Furthermore, it is hoped that temperature effects will be less pronounced than with germanium, so that inefficient biasing circuits can be avoided. Mr. Sziklai showed a graph relating resistivity to impurity content for germanium, on which the types TA153 and TA163 were indicated as having about 1 part in 10^{-8} of impurity, the same order as that used for high-voltage diodes and several orders purer than the ordinary germanium diode.

R.C.A. and their licensees use the alloying technique for the production of junction transistors, and Mr. Sziklai claimed that it provided better mechanical and electrical conditions at the contact than the grown crystal technique. In reply to a question by Mr. G. M. Wright he said that R.C.A. hoped the transistor would ultimately have more reliable life figures than conventional valves, and that the price would fall below a dollar within two years. Among the types of which photographs were shown, was a liquid-cooled 1-watt unit.



Class-B push-pull amplifier with complementary symmetry, using n-p-n and p-n-p junction transistors.

It was clear that R.C.A. are particularly interested in high-frequency applications, and the circuit of a bridge for measuring the input impedance of earthed-emitter transistors was notable for the use of square waves. A description of this bridge technique has appeared in *Wireless World**, and in the transistor case a satisfactory representation up to 12 Mc/s is obtained by the use of a resistor in series with a parallel RC circuit. A new R.C.A. "beam-deflection" system for high frequencies was described, for which advantages were claimed over transistors using the unipolar field effect, in which drift velocities even higher than those of the point transistor are encountered. The new arrangement, which was sketched, showed a single emitter spot between two gold deflector plates on one face of the germanium, while the opposite face carried two collector spots. Push-pull input to the deflector plates provided a push-pull output at the collectors.

Mr. Sziklai showed a photograph of a number of transistorized units of popular appeal, including a transistorized ukelele, with acoustic feedback, and a transistorized television receiver. This latter uses 37 transistors and a 5-inch cathode ray tube, and it has a total power consumption, from batteries, of 13 watts. The circuits have already appeared in the June, 1953, issue of *Proc. I.R.E.* The chief interest lies probably in the complementary symmetrical systems, described in a separate paper by Mr. Sziklai in the same issue of *Proc. I.R.E.* Those are used for waveform generation and for Class-B amplification, and a typical circuit, which gives 500mW or audio power at 2 per cent distortion with a gain of 28db is shown in the accompanying figure.

* "New Bridge Technique," by Thomas Roddam, Jan., 1950, p. 8.

RADIO INTERFERENCE

Analysis of Complaints Investigated by the G.P.O.

VERY nearly 100,000 complaints of interference to sound broadcasting and to television reception were investigated by the G.P.O. during 1952 and a study of the analysis of these brings to light some very interesting facts. Complaints of interference to television reception were slightly in the lead.

The cases investigated are summarized in various tables, but the two most interesting are those reproduced on the following page. The first column gives the most frequent causes of the interference, the second the number of complaints and the third the percentage this represents of the total number investigated, identified and disposed of.

In both tables unknown causes head the list. This is perhaps inevitable as much of the interference commonly encountered is of a transitory kind and owing to its capriciousness never occurs when the investigating team is on hand.

Modern broadcast receivers being so sensitive the thought of using a good outdoor aerial rarely crosses the listener's mind and often sales appeal emphasizes the ability of the set to operate without one. Thus it is not surprising that 17.3 per cent of the complaints conclusively investigated were due to inefficient aerial and earth systems. As it is generally realized that "something on the chimney stack" is needed for television reception

TELEVISION

Cause	Number of Cases	Percentage of Cases
Unknown; not observed by P.O. staff	13,972	26.5
Sewing machine motors	9,936	18.9
Faulty receivers	4,273	8.1
Hair dryers	4,155	7.9
Inefficient aerial-earth systems	1,827	3.5
Motor car ignition	1,778	3.4
Motors, miscellaneous	1,647	3.1
Drills	1,521	2.9
Vacuum cleaners	1,452	2.7
Lamps (filament type)	1,193	2.3
Fan motors	1,069	2.0
Overhead power lines	1,062	2.0
Refrigerators	937	1.8
Bed-warmers	766	1.5
Thermostats, miscellaneous	755	1.4
Radio transmitters	698	1.3
Radiation from super-het local oscillator	650	1.2
Neon sign tubes	645	1.2
Medical apparatus (valve)	439	0.8
Mis-operation of receivers	410	0.8
Hair clippers	361	0.7
Faulty wiring of buildings	301	0.6
Electric toys	281	0.5
Dental motors	254	0.5
Bells	241	0.5
Fluorescent tubes	176	0.3
Rotary convertors	163	0.3

SOUND BROADCASTING

Cause	Number of Cases	Percentage of Cases
Unknown; not observed by P.O. staff	10,528	22.4
Inefficient aerial-earth systems	8,140	17.3
Radiation from TV receiver time bases	5,697	12.1
Faulty receivers	5,284	11.2
Faulty wiring of buildings	2,408	5.1
Sewing machine motors	1,641	3.5
Fluorescent tubes	1,559	3.4
Refrigerators	1,110	2.4
Drills	996	2.1
Motors, miscellaneous	946	2.0
Bed-warmers	800	1.7
Vacuum cleaners	647	1.4
Overhead power lines	539	1.2
Radio transmitters	524	1.2
Hair dryers	471	1.0
Smoothing irons	436	0.9
Neon sign tubes	362	0.8
External cross modulation	305	0.6
Sodium lamps, street lighting	282	0.6
Fan motors	252	0.5
Calculating machines	238	0.5
Generators	192	0.4
Dental motors	150	0.3
Lamp flashers	148	0.3
Washing machines	144	0.3

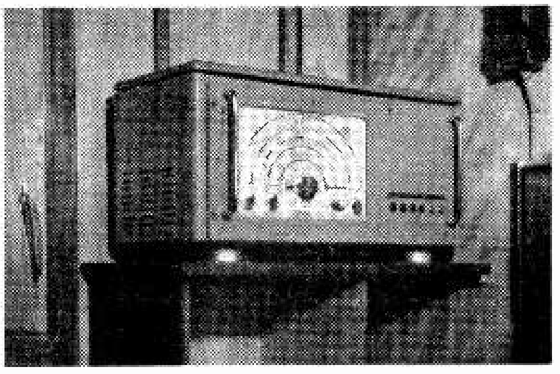
aerial deficiencies amounted to 3.5 per cent only in this section.

Radiation from television receiver time bases proved a nuisance to sound reception in 12.1 per cent of the completed investigations and this seems unduly high. However, the report says television set makers are alive to the nuisance and as time goes on the interference from this source should subside.

Radio transmitters, professional and amateur combined, accounted for 1.2 per cent of the cases investigated of interference to sound broadcasting and 1.3 per cent to television. This should go some way towards vindicating the amateur transmitter especially as hair dryers were proved to be responsible for over 6 times the amount of television interference and sewing machines nearly 15 times.

Surprisingly enough, motor car ignition systems only produced 1,778 complaints from television viewers; this may be accounted for by the fact that most viewers recognize the interference when it appears, and so do not report it.

MARINE BROADCAST RECEIVER



The Mimco all-wave marine broadcast receiver.

A RECEIVER designed specially for use in all classes of sea-going vessels, from passenger liners to trawlers, so that broadcast programmes may be received and relayed to different parts of the ship, has been introduced by The Marconi International Marine Communication Company, Marconi House, Chelmsford, Essex.

The receiver, which is known as the Mimco, consists of a sensitive 9-valve superheterodyne receiver and an audio power amplifier. The receiver unit is common to all installations, but the power amplifier is chosen according to the number of loudspeakers to be employed. A 10-watt unit suffices for small installations with up to 10 extension speakers and these and the receiver can be housed in a single cabinet measuring $25\frac{1}{2} \times 19 \times 13\frac{1}{2}$ in and weighing 90 lb.

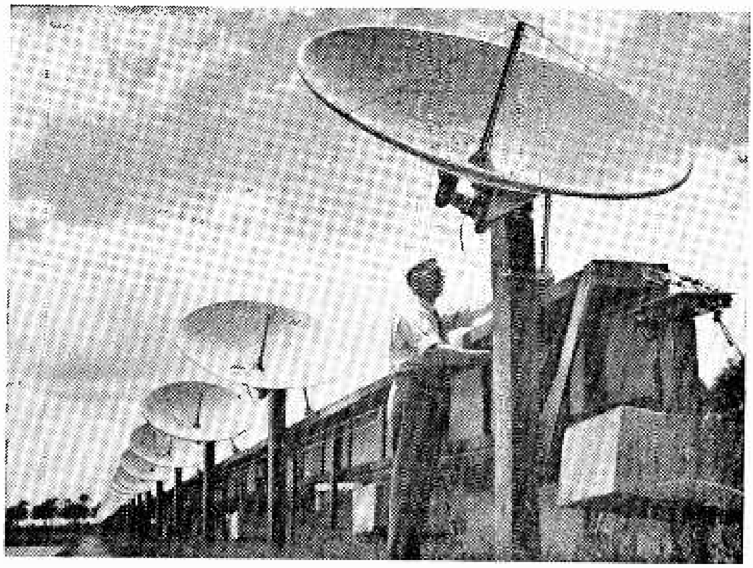
Short, medium and long waves are covered in four bands, their respective tuning ranges being 10 to 32 metres, 30 to 85 metres, 180 to 570 metres and 800 to 2,000 metres.

A tuned r.f. stage is employed, also variable bandwidth in the i.f. amplifier, the five switch positions corresponding to 5-, 10-, 15- and 20-kc/s bandwidth. There is a tone control.

The receiver takes 95 watts from a.c. mains of either 115 V or 230 V of 40 to 80 c/s. A converter can be supplied for operation on 110 or 220 V d.c. if required.

Narrow-Beam Radio Telescope

Decimetre-Wave Aerial System for Radio Astronomy



View from one end of the aerial system at its site near Sydney. Although it is a fixed radio telescope the paraboloids can be steered individually.

FOR studying localized sources of radiation on the sun, an Australian radio astronomer, W. N. Christiansen,* has designed a highly directional aerial system with a beam width of only one-twentieth of a degree. This extremely narrow beam is necessary because of the small angular width and spacing of the radio sources. The angular width of the sun itself is only about half a degree, so obviously the beam must be considerably less than this if the aerial is to respond to the radio sources separately and not receive them all at once.

The system is actually a kind of interferometer, and operates on a wavelength of 21 cm. It consists of 32 paraboloid elements, each 5ft 6in in diameter, spaced out in a straight line for about 700ft in an east-west direction—all of them being connected in phase to the same receiver. This arrangement produces a family of thin flat lobes or beams rather like a group of opened-out fans, spaced apart by about 1.7°; and as the earth rotates each beam is swept in turn flatwise across the disc of the sun. When a beam encounters a localized source of radiation there is a sudden increase in the received noise signal (see Fig. 4) and by noting the time at which this occurs it is possible

* Radiophysics Laboratory, Commonwealth Scientific and Industrial Research Organisation, Sydney University.

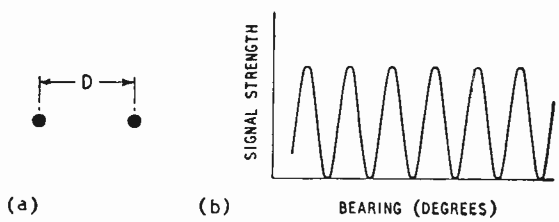
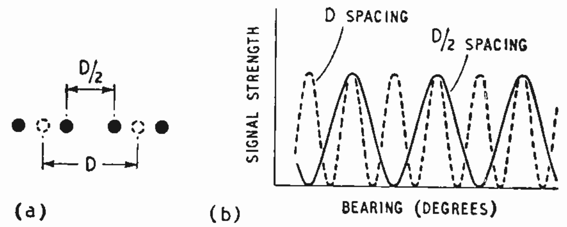


Fig. 1. At (a) is an interferometer aerial system consisting of two elements with spacing D, while (b) shows the type of directional radiation pattern it produces. The received signal has maxima and minima depending on the angle of incidence of the incoming waves.



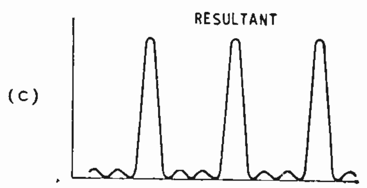


Fig. 2. At (a) the two elements in Fig. 1 have each been split into two, producing in effect two interference patterns (b), with the result shown in (c).

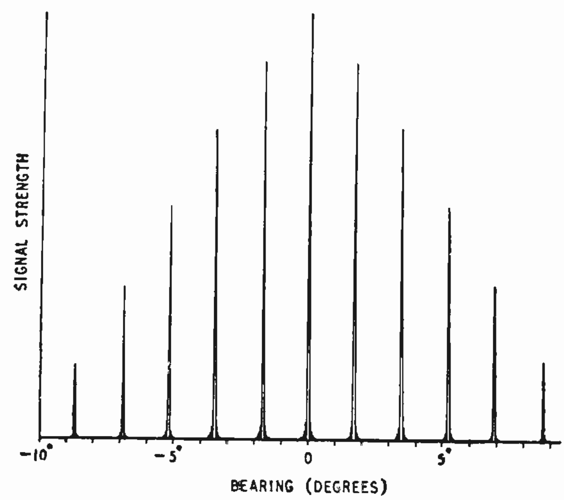
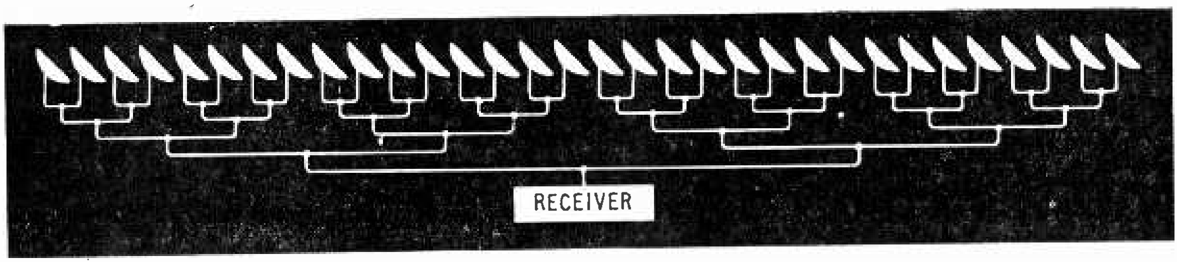


Fig. 3. Directional radiation pattern of the radio telescope, showing the extremely narrow width of the beams. The lower intensity of the beams off centre is due to the directivity of the individual paraboloid elements.



Branching system of lines connecting the paraboloids to the receiver is arranged so that the length of line from each element to the receiver is the same. Changes in line length due to temperature variations affect all elements equally and so do not disturb the phase relationships.

to calculate that the radio source lies along a certain line on the solar disc.

The thin widely spaced beams of the aerial system are produced, roughly speaking, by the interaction of a number of interference patterns. If there were only two spaced aerial elements connected to the receiver the interference pattern would be as shown in Fig. 1 (b). (This type of pattern is produced by the differences in path length to the two elements for waves coming from different directions. From some directions the waves arrive in phase and so combine to produce maxima, while from other directions they arrive in opposite phase and cancel out to produce minima.) If each of the two elements were now split into two others as shown in Fig 2 (a) there would be, in effect, one interference pattern corresponding to the original spacing, D, and another corresponding to the new spacing, D/2. These would combine as shown in Fig. 2 (b) to produce the resultant pattern (c). If this splitting process were continued, each doubling of the number of elements would suppress half the lobes, until eventually there would be 32 elements, giving the resultant shown in Fig. 3—which is, in fact, the radiation pattern of the actual system.

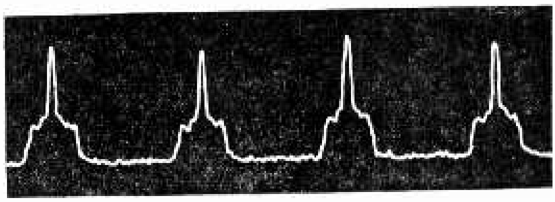


Fig. 4. Typical record of the received noise signal as the sun is scanned by several beams in succession. On each beam response the shoulder indicates the level of the general "background" radiation from the sun while the peak on top shows when the beam passes through a concentrated source.

Mobile Television Transmitters

Description of the B.B.C.'s Temporary Stations

By E. W. HAYES, M.I.E.E.*

As is well known, mobile television transmitters have been used as radio links at outside broadcasts for several years but their use in maintaining daily broadcast transmissions for public reception is new.

The use of mobile transmitters in this way permitted the introduction of a television service for N.E. England, Northern Ireland and in the Brighton area much more quickly than would have been possible by the construction of permanent stations. The equipment used at each of these stations (Pontop Pike, Belfast and Brighton) conforms to the general plan to be described in this article with adaptation and modification as necessary to take advantage of any local features at each site or to overcome any difficulties arising out of unfavourable local conditions.

In planning mobile television broadcasting equipment the design must satisfy a number of basic needs which may be summarized as follows:—

(a) Accommodation: The equipment should be housed in a van providing adequate shelter and heat insulation for plant and operators. It must be sufficiently rugged to protect the equipment in moving on unprepared sites and durable in resisting the weather during prolonged exposure in service.

(b) The vision transmitters must readily be capable of carrier frequency change over the whole of the present television broadcasting band (41-68 Mc/s). The vestigial sideband characteristic must comply with previously published standards.

(c) The equipment provided must include adequate provision for prolonged operation and in addition it may be necessary to arrange for the reception of programmes by radio link when normal cable incoming programme routes cannot be provided.

(d) In some cases power may have to be supplied from mobile diesel generating plant.

In planning this mobile television transmitter

* B.B.C., Planning and Installation Dept.

equipment it was decided, for reasons of economy in both money and time, to use existing designs of vans which were immediately available. Two types of vehicle were found to satisfy the requirements and to permit close adherence to a basic plant design. One of these types is self-propelling and the other a trailer providing a floor area of 7ft × 17ft with a satisfactory headroom of 7ft. The floor plan of the vehicle showing the layout of the transmitting station equipment is given in the diagram on page 334.

The mobile transmitting stations established in this way to provide a broadcast service over a prolonged period are equipped with sufficient spares and test apparatus to ensure the maintenance of a reliable service.

Programmes can be received from coaxial cable input, if this is available, but in addition there are duplicate television receivers which can provide a programme by reception of the nearest high-power transmitter. Picture monitoring is provided at the television receiver output with a similar picture monitor indicating the output of the vision transmitter. The two monitors are mounted side by side to permit immediate comparison of the incoming and the radiated picture quality. Duplicate television transmitters are provided, each capable of an output power at peak white of about 500 W.

In the sound programme chain provision is also made for reception by radio link if necessary, but normally sound would be received by land line. After equalization to remove any frequency/amplitude distortion which may be present, the sound signals are amplified and radiated by one of a duplicate pair of sound transmitters which have a maximum carrier power of 200 W. For test purposes the mobile transmitter is provided with video signal test generators and a gramophone as a sound programme test source.

A combining filter constructed from coaxial feeder sections permits the use of a single transmitting aerial for both vision and sound signals and a test load can be switched at will to sound or vision transmitters or alternatively to the combined output of both.

The power distribution scheme is arranged to separate the load of the transmitting equipment from the lighting and heating loads in order to permit the former to be energized economically through a voltage regulator provided to protect the performance of the apparatus against variations in the incoming supply mains. If necessary the whole of the power supply for the station may be taken from a mobile diesel generator but this is avoided wherever possible to prevent difficulties due to any residual hum which might exist in the equipment.

Vision Transmitters

The television transmitters used in this equipment can produce between 400 and 500 W of power at peak white with a video frequency characteristic conforming to the B.B.C.'s published asymmetrical sideband characteristic. The r.f. circuits of the transmitter were designed and developed by the B.B.C. The modulator was adapted from a stabilizing amplifier of an existing design produced by the Designs Department of the B.B.C. for use in the video frequency distribution system at studios and elsewhere.

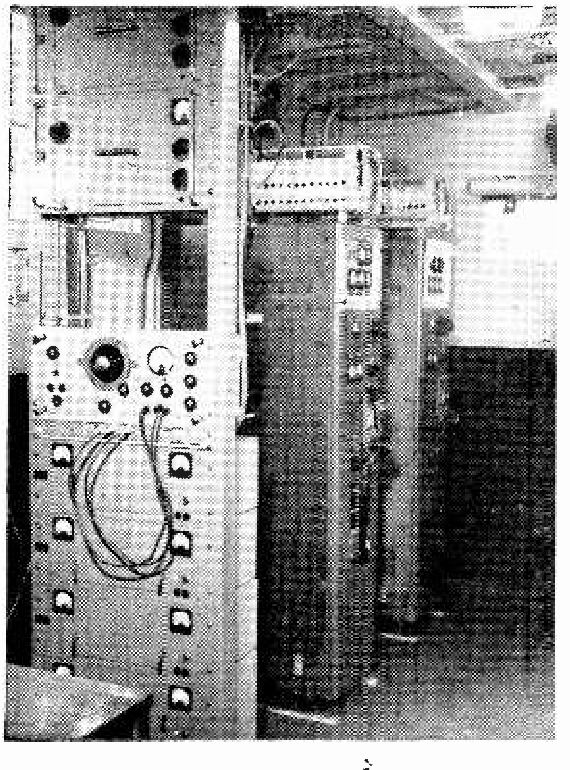
The master oscillator is followed by two stages of frequency multipliers each with a multiplying factor of three to produce a carrier nine times the master oscillator frequency. The modulated amplifier consists of a QQVO6-40 double-tetrode valve used in push/pull with a 350V stabilized h.t. supply. This is followed by the output amplifier stage which consists of two QY4-250 power tetrode valves in push/pull. In this stage the screen supply is stabilized but the anode h.t. supply is taken from the smoothed h.t. The r.f. inter-stage coupling circuit and the output circuit are arranged to produce the shaping for the asymmetrical sideband characteristic and the transmitter is connected to a 50-ohm unbalanced feeder which is provided with further sideband suppression filters and harmonic radiation suppressors.

The amplifier stage is grid modulated from a television distribution amplifier modified to give a d.c. restored output of approximately 30V peak to peak. This amplifier also provides stabilization of the amplitude of the synchronizing pulses with good linearity and negligible change in black level with changes in picture amplitude.

Sound Transmitters

The sound transmitters are required to produce a carrier frequency appropriate to the vision channel with which it is associated, and, where the frequency is shared with a high-power transmitter, a carrier frequency offset by −20 kc/s is used to minimize interference in fringe areas. The power output from the sound transmitters is adjusted to be related to the peak white power of the associated vision transmitter in the ratio of 1:5 with correction for any differences in gain

Duplicate 500-watt vision transmitters and, left, distribution amplifiers installed in the vehicle which houses the Brighton temporary station.



between the aerials used for vision and sound if these are separate structures.

The sound transmitters used were modified by the B.B.C. from existing h.f. transmitters. These modifications included the replacement of the r.f. stages which with the addition of a frequency multiplier stage extend the frequency range of the transmitter from about 20 Mc/s to 70 Mc/s. The transmitter is anode modulated in the final stage and is arranged to be coupled into an unbalanced feeder.

Transmitting and Receiving Aerials

The planning of transmitting and receiving aerials for use with this mobile television broadcasting equipment is influenced considerably by such factors as the shape of the desired service area, the plane of polarization required and the height of mast required or available, etc. Remarks in this paragraph will be restricted, therefore, to a general description of typical equipment, and more detailed specific installations will be referred to later.

Where the programme to be radiated by the local transmitter is received by radio from an existing B.B.C. transmitter, the receiving aerial used is mounted on a 70ft mast and consists of a four-element Yagi. This aerial is composed of a folded dipole element with solid conductor, directors and reflector; it is connected to the feeder through a balancing transformer to which is connected a low-loss receiving type cable with spiral insulation and aluminium sheath. This feeder has a loss of 0.33 db/100ft. At its designed frequency the receiving aerial described has a front-to-back ratio of 20 db. The locally transmitted frequency will of course be in a different channel to that of the station being received but even so this characteristic of the receiving aerial gives a useful reflection of the locally transmitted frequency provided that transmitting and receiving aerials are suitably sited with reference to the station to be relayed.

The forward gain of such an arrangement can be expected to be about 7.5 db with a satisfactory sideband characteristic.

An alternative array consists of four "inverted V" aerials suspended from a triatic at half wavelength intervals.

The receiving equipment is protected against interference from the associated transmitter by rigorous screening of the sets, by discrimination in the polar diagram of the receiving aerial and by filters in series with the aerial feeder. Noise limiters are also fitted.

At each of the sites of the present mobile television transmitters—Pontop Pike near Newcastle-on-Tyne, Glencairn near Belfast and Truleigh Hill near Brighton—there are a number of factors which have influenced the basic plan already described.

The site selected at Pontop Pike is approximately ten miles from Newcastle-on-Tyne and has the important advantage of being 1,000ft above sea level. At this site there is already established one of the radio relay stations forming part of the Post Office chain which links the Scottish television transmitter at Kirk o'Shotts with the B.B.C. network. This enables the programme for Pontop Pike to be obtained readily and without the necessity of using direct reception from Holme Moss.

Having regard to the large number of potential viewers in this area around Tyneside the most effective aerial practicable was necessary. There has been erected, therefore, a 250-ft lattice mast surmounted by a three-stack batwing aerial supplied by Marconi's Wireless Telegraph Co., Ltd. This aerial has a circular polar diagram with horizontal polarization and a gain of about 5 db over a half-wave dipole.

Horizontal polarization was used in order to reduce to a minimum the mutual interference between Pontop Pike and the Wenvoe high-power station, with which it shares Channel 5 (vision 66.75 Mc/s and sound 63.25 Mc/s). Wenvoe uses vertical polarization. A further reduction in interference is ensured by Pontop Pike's operation on a vision carrier frequency offset by −5 kc/s.

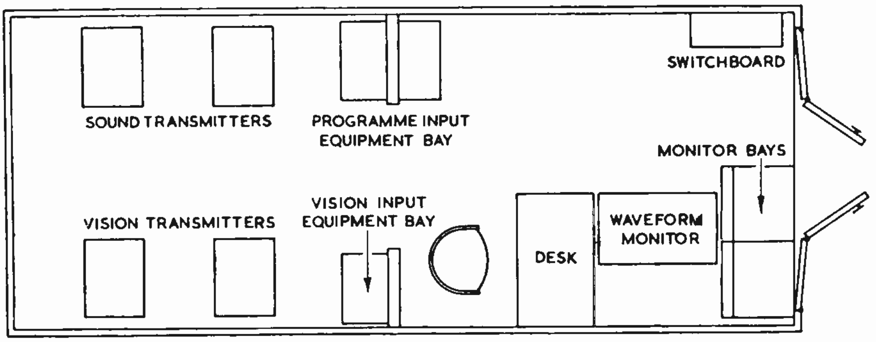
Offset Carriers

The use of offset carrier frequencies to facilitate simultaneous use of a single channel by more than one station was approved by the Stockholm Convention in July 1952, in which Great Britain participated. The amount of the offset must be related to the line frequency of the transmissions and a value of either 0.5 or 0.66 times the line frequency is used.

The output of the vision and sound transmitters at Pontop Pike is combined and conducted to the batwing aerial through a concentric tube feeder.

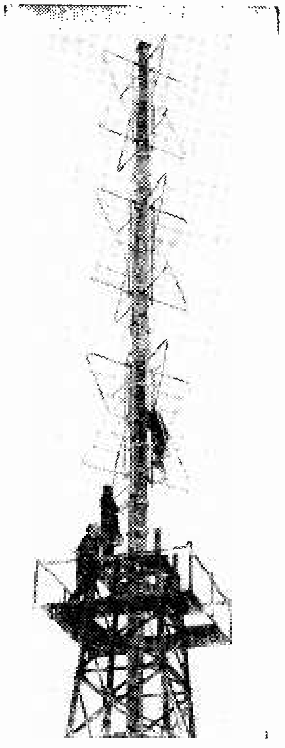
The van containing the mobile television broadcasting equipment at Pontop Pike, is enclosed within a precast concrete sectional building. The use of a light and speedily erected building in this way ensures reasonable working conditions for staff operating the equipment during winter months on this high and exposed site, and makes possible the use of a van not specifically designed for prolonged exposure in this way. In addition, part of the sectional building can be arranged to provide storage space for bulky spares.

The arrangements made for providing a television service in time for the Coronation for Belfast and dis-



Layout of the equipment in the transmitter trailer in use at Truleigh Hill, near Brighton.

Three-stack batwing transmitting aerial, supplied by Marconi's, which surmounts the 250-ft lattice mast at Pontop Pike.



trict have followed the general pattern described for the Newcastle area.

The transmitters are arranged to radiate on Channel 1 (vision 45 Mc/s, sound 41.5 Mc/s) which this station shares with the London station.

The site selected for this station is approximately four miles from Belfast City centre. It is about 400ft above sea level and the aerial is further elevated by a 250ft stayed steel lattice mast. The aerial is a single-stack batwing and provides a circular polar diagram. The radiation is horizontally polarized which gives discrimination against interference from the vertically polarized Alexandra Palace transmitter.

Sound programme for radiation from this station is received in the conventional manner by G.P.O. land line. Temporarily the vision programme is obtained by the direct reception of the Kirk o' Shotts transmitter until such time as a permanent programme link with the mainland can be provided by the Post Office.

The Brighton station, established on the South Downs about five miles north-west of the town, to improve the service in the area is basically similar to those already described. It is approximately 600ft above sea level, which gives unobstructed line of sight transmission to the target area with relatively short masts, and in addition makes possible reception at good quality of vision signals from the Alexandra Palace transmitting station. Although provision is made for reception of sound transmissions directly from Alexandra Palace this arrangement is used only in an emergency and normally sound programmes are received on a rented G.P.O. line. There is no alternative available, however, to the reception of vision signals directly from Alexandra Palace and tests have shown that a satisfactory standard of picture can be obtained in this way. The receiving equipment uses a Yagi aerial directed on Alexandra Palace, which, in addition to providing 7 or 8 db of gain in the required direction, provides valuable discrimination against the local relaying transmitter as well as against the transmissions from the Eiffel Tower, which uses approximately the same frequencies as Alexandra Palace.

The transmitters feed a vertically polarized dipole fitted with a reflector and mounted on a 70ft mast. The Brighton station shares Channel 3 (vision 56.75 Mc/s, sound 53.25 Mc/s) with Kirk o'Shotts, and at Brighton the frequencies have been offset 5 kc/s and 20 kc/s respectively.

Purchase Tax on Loudspeakers

FROM 1st July the purchase tax on all loudspeakers other than cone types of 10-inches nominal diameter or less has been lifted. The relevant wording of the notice is as follows:

"1. The following will be regarded as *not* chargeable with tax:—

"(a) Loudspeakers of other than the cone type, e.g., pressure units.

"(b) Cone type chassis of sizes exceeding 10 inches nominal diameter, and

"(c) Mounted (i.e., baffled) loudspeakers incorporating such chassis.

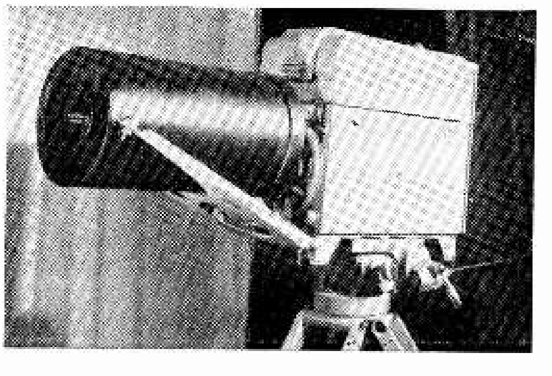
"2. All unmounted cone-type chassis of sizes up to and including 10 inches nominal diameter will be regarded as *chargeable* with tax, irrespective of the purpose for which they are supplied and of the quantity supplied, and whether or not they are supplied with other apparatus.

"3. Mounted loudspeakers incorporating cone type chassis of sizes up to and including 10 inches nominal diameter will be regarded as *chargeable* with tax unless they are housed in an industrial casing and are shown to the satisfaction of the Commissioners to be designed and advertised for sale only for use with equipment of public address and/or communication type.

"4. Loudspeakers incorporated in wireless receiving sets are not separately chargeable with tax, but the tax value of a chargeable set must continue to include the value of any incorporated loudspeaker whatever its type and size.

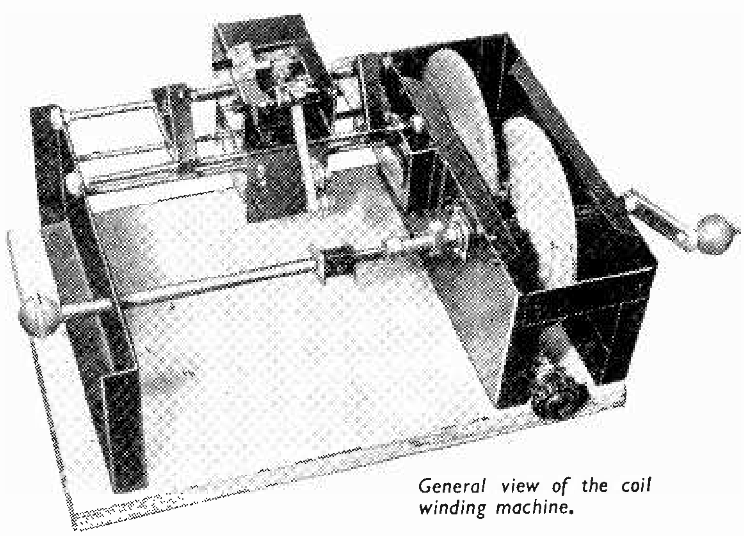
"Manufacturers who wish to claim exclusion from tax under paragraph 3 above in respect of particular models of loudspeaker should notify either their local Officer of Customs and Excise or Section 20(E), Secretaries' Office, H.M. Customs and Excise, King's Beam House, Mark Lane, E.C.3, giving full details of the loudspeakers concerned, together with copies of any advertising matter issued in connection therewith."

The changes in the regulations will be welcomed by manufacturers and users of high-quality reproducers, the majority of which are clearly exempt from tax. Superficially, paragraph 3 would seem to discriminate against the use of small-diameter cone units for high-frequencies in multiple-unit, wide-range reproducers designed for high-quality reproduction; but it is possible that a claim for exemption may be established on the grounds of power-handling capacity and suitability for use in p.a. systems.



This new telephoto lens for television cameras being used by the B.B.C. has the exceptionally long focal length of 80in. Instead of the usual refracting system it uses a reflecting system consisting of a concave main mirror and a convex secondary mirror. The lens was designed by Marconi's in co-operation with Cox, Hargreaves and Thomson.

A.F. Coil



General view of the coil winding machine.

Design of a Machine for Making Mains Transformers and Chokes

By B. V. NORTHALL

SOME form of automatic winding machine is a most useful aid for winding small transformers and chokes of the kind used in radio and audio equipment. The primary requirement is that the wire must be made to traverse a former so that succeeding turns lie parallel. The author has constructed a machine using threaded rods geared to the spindle driving the bobbin to give a controlled movement of the feed of the wires and the basic design of this machine is shown in Fig. 1.

A wooden core of appropriate size supports a coil bobbin on the main drive shaft while wire is reeled on to it. Backward and forward motion of the wire feed is given by a double half-nut (inset Fig. 1) switching between two contra-rotating feed screws. The half-nut controls the position of a wire feed carriage which moves above the feed screw on silver-steel guides. A toggle mechanism and cam engage the half-nut with one or other of the feed screws.

The variable friction drive consists of a driver roller running between two $5\frac{1}{4}$-in diameter discs mounted at 3-in centres. The position of the drive roller determines the rate of traverse of the wire feed assembly. The gear ratio is given by:—

$$\frac{\text{Radius described by drive roller on feed disc}}{\text{Radius described by drive roller on drive disc.}}$$

A maximum ratio of 5 to 1 and a minimum ratio of 1 to 5 are obtainable. As it is both cheap and easy to obtain, two pieces of $\frac{1}{4}$-in b.s.f. studding (26 threads per inch) are used for the feed screws. These are coupled by two 50-tooth gear wheels so that they rotate at equal speeds in opposite directions. A 10-tooth gear wheel on feed-disc shaft drives this gear train. This 5 to 1 fixed reduction gear increases the effective threads per inch to 130 and the machine can thus wind between the limits of 26 and 650 turns per inch.

Wire-feed Assembly

The design of the wire-feed assembly is influenced by the $\frac{1}{4}$-in b.s.f. studding. If the feed screw is bowed by side pressure the number of contacting threads is reduced and wear is increased. The mechanism is designed so that the half-nut does not exert direct side pressure on the feed screw. However, the thrust of a triangular thread is at an angle producing a side pressure proportional to the resistance of movement of the wire-feed assembly.

The friction of the wire-feed carriage on its guides, the sideways pull of the wire as it is fed from the spool and the force required to actuate the changeover mechanism all contribute to the total resistance. The design of the machine attempts to reduce these forces.

A cross-section of the wire-feed carriage is shown in Fig. 2. The main carriage is made from a 2-in wide strip of steel sheet, bent to shape and mounted on two pieces of $\frac{1}{2}$-in × $\frac{1}{4}$-in mild steel bar drilled to accommodate the guide rods. The bearing holes are countersunk at each end to reduce the total bearing surface and lessen friction. A subsidiary carriage made in a similar manner slides on silver-steel guides bolted to the skirts of the main carriage. This carries the half-nut which is made from $\frac{1}{2}$-in square mild steel bar drilled and tapped $\frac{1}{4}$-in b.s.f. at centres $\frac{3}{32}$-in less than those of the feed screws. The half-nut's travel is small and the momentum gained during changeover is low, reducing the chance of impact damage to the threads.

An exploded view of the changeover mechanism is shown in Fig. 3. Two horizontal and two vertical

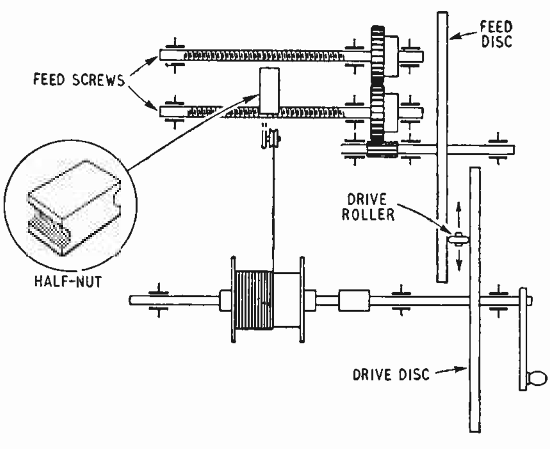


Fig. 1. Basic design of the coil winder.

Winder

guides A at each end of the sliding cam B allow it to move in one plane only. The centre of the cam is shaped as illustrated so that it fits between the two projecting shanks C of the bolts which fix the half-nut to its carriage. As the cam moves the half-nut is thrust over. In this way the drive is transferred from one feed screw to the other. The curves of the cam are cut so that the half-nut cannot be pressed beyond the point of full engagement. Thus the changeover mechanism does not bow the feed screw. Two studs D are fixed along the centre line of the cam and a toggle-joint E operates between them to change the cam's position. Two stops F actuate the changeover. The top section of the toggle-joint is a curved wedge shape. When it is raised to the vertical by a stop the spring-loaded wheel G is lifted. Just after the point of balance is reached the wheel runs down the opposite face of the wedge, giving a snap action and so ensuring that changeover takes place at precise points. The minimum traverse is $\frac{1}{4}$ in.

Two channel-shaped pieces of steel sheet are screwed to the top of the wire-feed carriage and form the mounting for the wire feed and switching wheel. Further pieces of sheet soldered across the top and back make a rigid structure. Holes for the stops to pass through are drilled in the sides. Two V-pulleys mounted on a square-section bar form the wire feed. A clamp pivoted at the top front of the carriage allows variation of the bar's projection. The complete assembly is illustrated in Fig. 4.

Construction of the Stops

The stops are clamped on the carriage guides and their position is adjustable. The construction of a stop is shown in Fig. 5. A length of square-section bar is drilled at the centres of the guide rods. It is cut longitudinally through the centres of the holes so making a slide for each stop. A piece of steel sheet bent to a triangular box lid shape is screwed and soldered to the slide. These screws project below and serve as guides for the clamping bar. A thumb screw in the centre tightens up the bar. The stop proper,

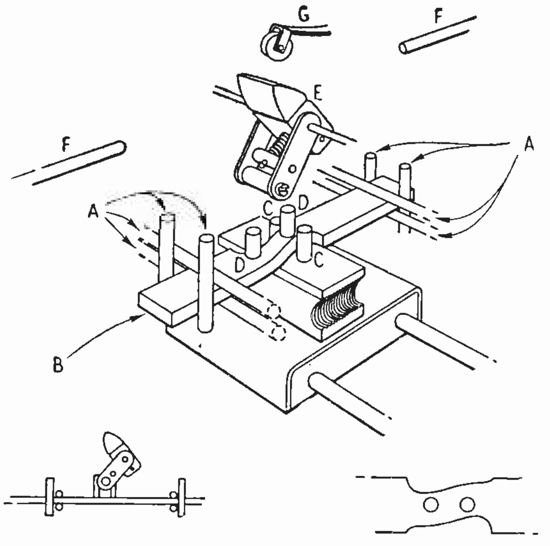
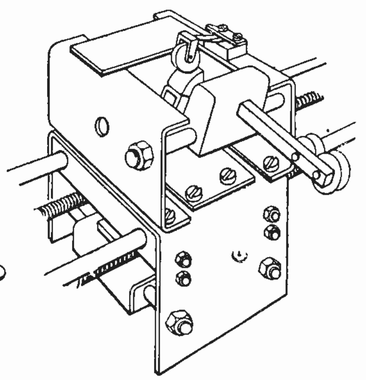
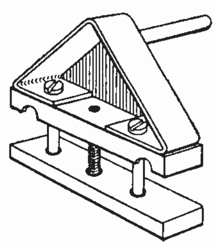


Fig. 3. Exploded view of the changeover mechanism.



Right: Fig. 4. Complete assembly of the changeover and wire-feed mechanism.



Left: Fig. 5. Details of the stops (two required) actuating the toggle changeover mechanism at the end of each layer of wire.

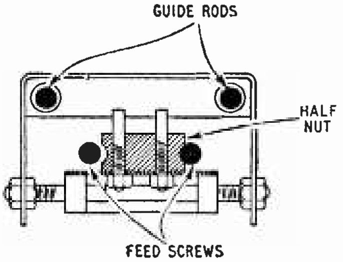
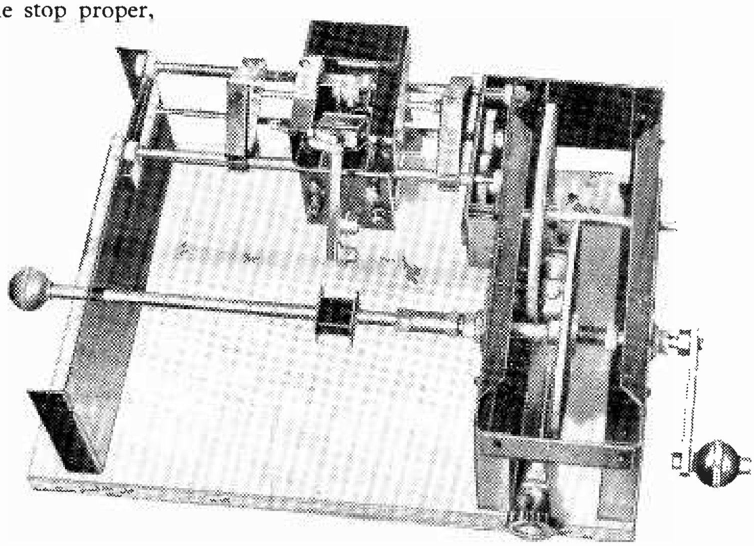


Fig. 2. Cross-section of the wire-feed carriage.



This view of the coil winder shows the friction drive on right and traversing gearing at the right rear.

which is bolted near the apex of the triangle, is made from silver-steel rod. It is rounded at the operating end.

Details of the complete machine are given in Fig. 6. The various assemblies are screwed to a 9-in × 14-in wooden baseboard. The main mountings are made from steel sheet bent to box lid shapes. Those enclosing the variable friction drive have further pieces of sheet soldered across the ends to make a rigid box. A smaller box soldered to this surrounds the fixed reduction gear and it is used as an oil bath. The bearings are made from $\frac{1}{8}$-in thick brass soldered to the mountings.

The collar A joins the two sections of the main drive shaft. Both sections of the shaft are made from $\frac{5}{16}$-in dia silver-steel rod and a flat is filed along the section which supports the transformer bobbin. The cam B operates a mechanical counter.

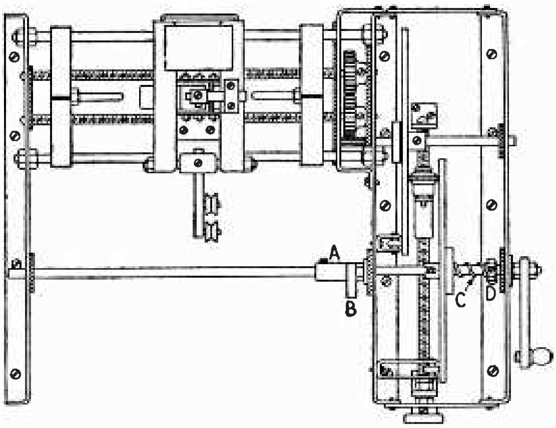
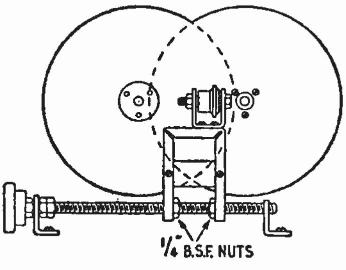
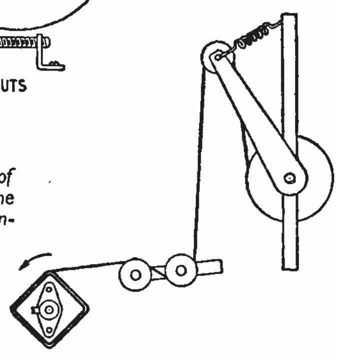


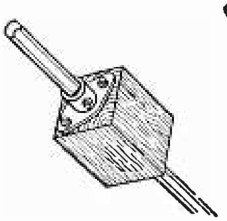
Fig. 6. Details of the complete machine.



Left: Fig. 7. Side view of the friction-drive mechanism.



Right: Fig. 8. Method of feeding the wire. The spring maintains a constant tension.



Left: Fig. 9. Details of the method used to secure the wooden core of the bobbin to the driving shaft.

The friction discs are covered with a thin sheet of cork and the brass drive roller (terminal) is lightly knurled. A 6-BA stud screwed into the drive shaft engages in a slot cut in the drive disc bush. The spring C maintains the driving friction and compensates for irregularities in roller or discs. The collar D adjusts the pressure. When the machine is not in use, or when it is desired to make large gear changes, the drive disc is withdrawn against the spring and rotated slightly. The stud then holds it disengaged. The feed disc is firmly fixed to its shaft and a jockey roller ensures that it runs more truly.

A side view of the friction drive is given in Fig. 7. The drive roller mounting allows side movement so that the spring can compensate for irregularities. The freedom of movement also gives equal pressures between the roller and each disc. The mounting is from a channel-shaped piece of sheet cut and bent to the form shown. Two further pieces of sheet screwed and soldered across the sides reinforce it. Quarter-inch b.s.f. nuts soldered in the lower ends of the mounting couple with the adjusting screw. A pair of small angle brackets fix the assembly to the baseboard.

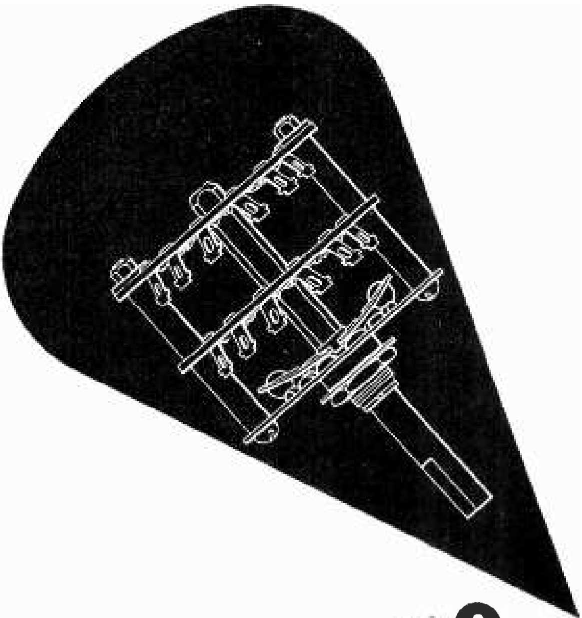
A wooden bridge built over the machine supports a wire operated brake mechanism of a type described in a previous article.* The bridge should be as high as possible since the sideways pull of the wire between spool and wire feed lessens with increase of distance between the brake pulley and wire feed. The method of feeding the wire is shown in Fig. 8.

The wooden core which supports the former to be wound is tightly fixed to the drive shaft. A wood screw through the core engaging with the flat filed along the shaft is satisfactory for small formers. Fig. 9 illustrates one of the pair of clamps used for larger formers. A piece of steel sheet shaped as shown is soldered to a collar. A grub screw through the collar engages the flat on the drive shaft and the clamp is screwed to the core.

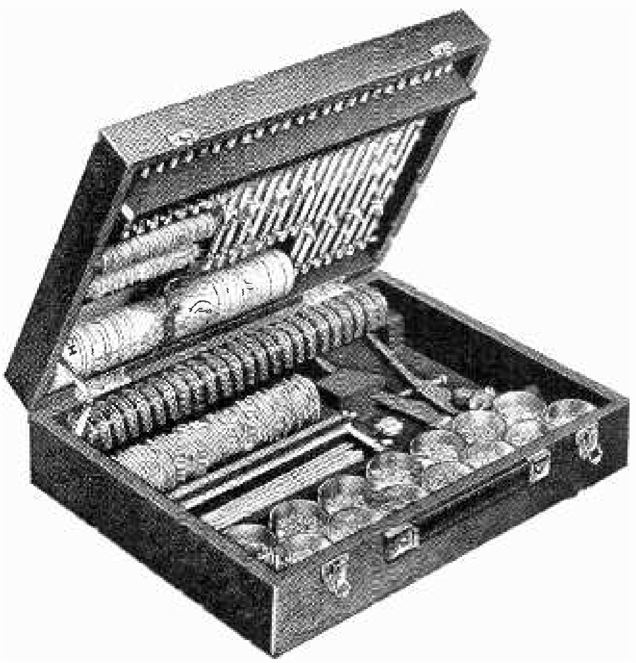
Eighteen gauge steel sheet makes mountings of adequate strength. The pitch of the gears used for this machine is forty, but any closely meshing gear wheels may be used. A change of gear ratio will of course alter the winding limits. The machine is designed for a step-up gear drive such as that used on hand grindstones.

The following method of turning without the aid of a lathe, the ends of the studding to form plain bearings, may be of interest. The items required are, a drill, suitable files, and a simple wooden jig. The drill is fastened in a horizontal position to a baseboard, high enough to turn freely. Two pieces of hardwood of the same size are used to construct the jig. Two holes about three inches apart are drilled through both boards. The positions of the holes in each board should exactly correspond. Their heights should be such that a rod held in the drill chuck passes through either pair of holes when the boards are standing on the baseboard. The boards are fastened so that the first is close to the drill chuck and the second leaves only the section of rod to be turned projecting from it. These wooden bearings are reinforced with cross struts. The end of a second rod passed through the other holes acts as rest for the file. A loose sleeve fitted over the end protects it when filing and acts as a roller. As the work rotates it is turned down evenly with the file.

* "Multi-Layer R.F. Coil Winder," *Wireless World*, April, 1953, pp. 179-181.



prototype headaches?



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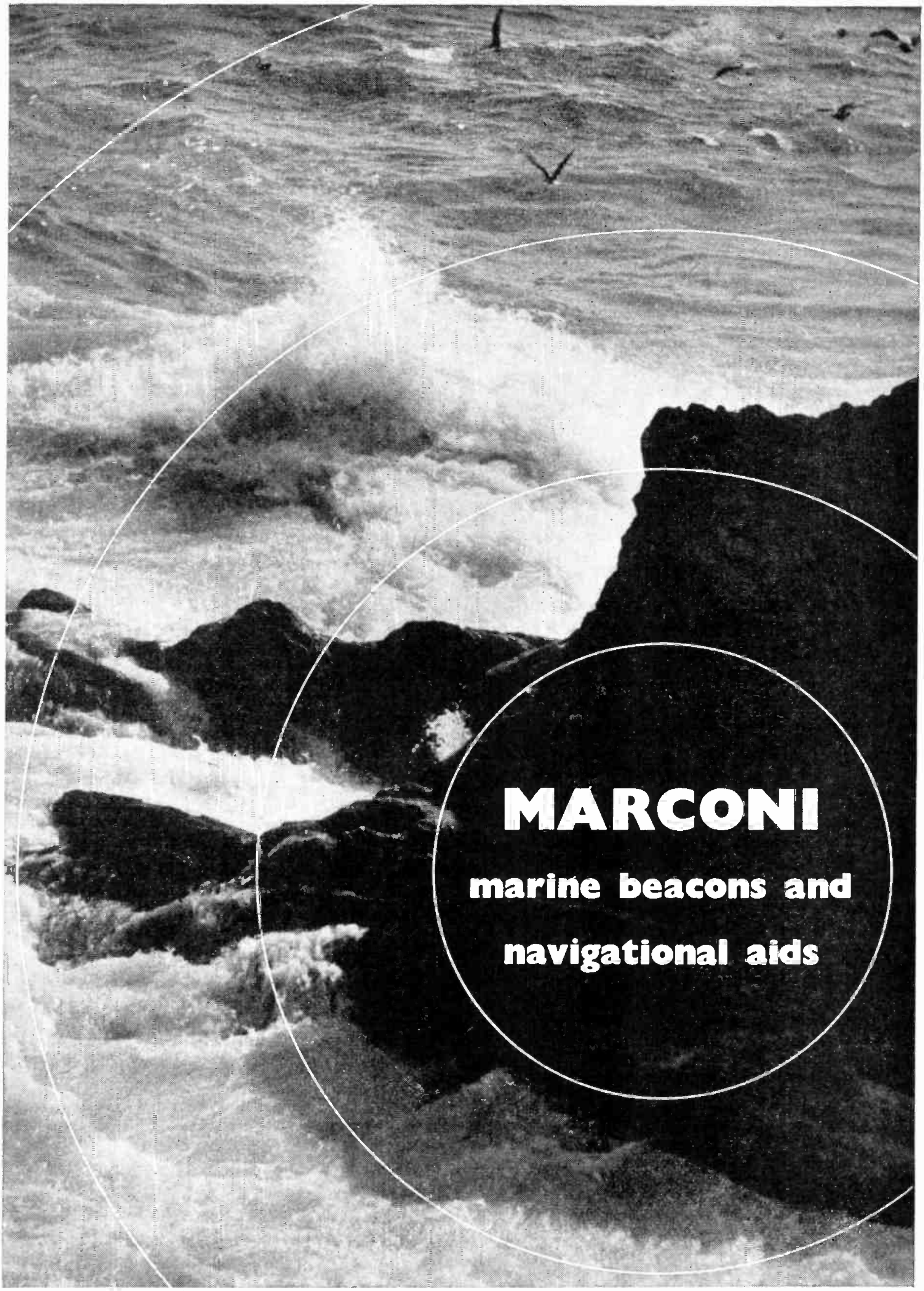

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British Instrument Exhibition

New Measurement and Test Gear

THE instruments now to be described must not be taken as indicating the full scope of communication and electronics test and measurement apparatus on show at the second British Instrument Industries Exhibition held at Olympia last month, or even of those that have appeared since the first exhibition, two years ago. The present report is confined to instruments that are new since the recent Physical Society's and Components exhibitions, and should be regarded as supplementary to the review of those exhibitions in the June issue.

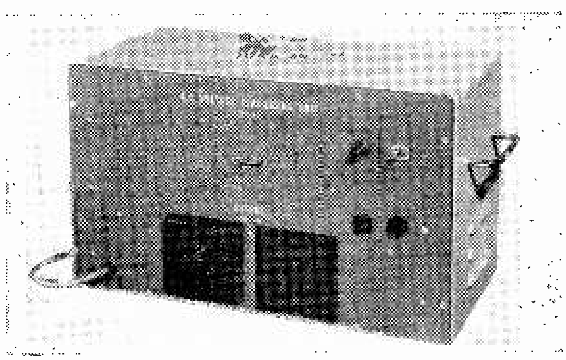
Although all these three exhibitions unfortunately overlap in this field, the B.I.I. show includes the largest number of manufacturers of what are popularly termed meters, especially those of the switchboard class. A decided trend was revealed towards larger angles of deflection, 240°-300° now being almost the rule, this providing more than double the length of scale for a given case diameter. Mains voltage and frequency meters have become a necessity in most laboratories and test rooms since the practice of load shedding began, and many models distinguished for clean design and clear scales are now available. Robustness has obviously been receiving much attention. A demonstration on the Electrical Apparatus Company's stand was sure to appeal to all experimental workers: a switchboard pattern milliammeter reading 0-1 mA was being subjected every five seconds to a suddenly applied current of about 60 mA without detriment to the instrument. Microammeters by the same firm are obtainable with rectifier shunts affording protection against 10,000-fold overload. Crompton Parkinson were showing 3½-in 240°-scale switchboard meters of Admiralty type, proof against severe shock.

Another influence of load shedding on instrumentation is the need for counteracting mains voltage and frequency fluctuations, either by stabilizers incorporated separately in the instruments or interposed in the common supply. A large choice of stabilizers with d.c. output now exists, and their design seems now to have become stabilized, more interest, therefore, attaches to a.c. stabilization, owing to the variety of methods employed. These can be divided broadly into the saturated-inductor and electronic classes. The difficulty with the former is waveform distortion. In a new Furzehill stabilizer, Type X/1 for a.c., the electronic method is used, and the harmonic content is claimed to be less than 1 % for 2nd, 3rd and 5th, and negligible for any other. Output. 320 VA. The waveform aspect was prominent also in an exhibit by the British Scientific Instrument Research Association: an electronic stabilizer with the mean output stabilized by means of a rectifier detector but able at the same time to respond to a.c. signals from a thermal type of detector, modifying the form factor of the output. Thus both rectified mean and r.m.s. voltages may be stabilized at the same time.

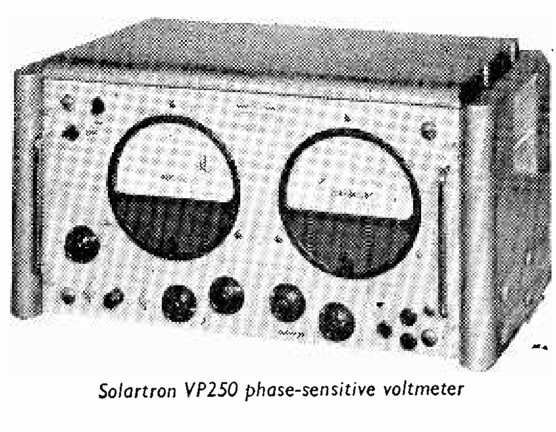
A new Taylor instrument is Model 131A electrostatic voltmeter and megohmmeter. To make it completely portable, the 500-V supply for measurement up to 5,000 MΩ is obtained by means of a vibrator run from three dry cells. Provision is made for testing capacitors.

The B.T-H. gaussmeter, shown some time ago at the Physical Society's exhibition, utilizing the Hall effect, is now manufactured by Sunvic Controls.

An alternative to the electrostatic type of voltmeter for high voltages was shown by the British Electrical and Allied Trades Research Association, consisting of a CV174 tetrode worked "inverted," with fractional μ, that is to say with grid current controlled by anode voltage. Mean values of unidirectional voltages of either polarity can be measured, with input resistance limited only by leakage surfaces inside and outside the valve. Other exhibits by the same Association included a portable a.c. discharge detector for measuring the characteristics of discharges in voids in solid in-



Furzehill a.c. voltage stabilizing unit Type X/1



Solartron VP250 phase-sensitive voltmeter sulation, which are a clue to long-term life of the insulation; a dielectric dispersion meter, for testing the moistness of paper insulation by measuring the variation of instantaneous capacitance with time; a decade amplifier; and an aerial unit for measuring electric or magnetic field strength in the frequency range 0.15 to 30 Mc/s.

One of the most interesting new instruments is the Solartron VP250 phase-sensitive voltmeter. This is intended mainly for deriving Nyquist characteristics of amplifiers in the range 20 c/s to 20 kc/s. Two 6-in centre-zero meters indicate respectively the in-phase and quadrature components of the output of the unit under test with reference to the phase of the input signal. Each of these meters is provided with a separate amplifier channel having input resistance greater than 50 MΩ; one of them has a 90° phase shifter. The meters themselves are wattmeters (to provide phase discrimination) of a new thermocouple type (to cover the wide frequency range). The range of measurement is 15 mV to 15 V in seven ranges.

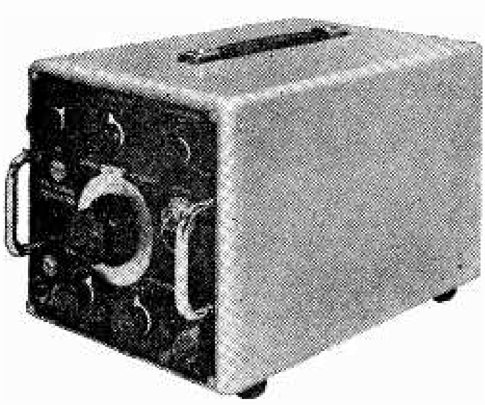
Information is now available on the Solartron wide-band attenuator. It is made up of high-stability carbon resistors in 600-Ω T sections, and covers 0-60 db in 1-db steps from 0 to 5 Mc/s with 0.1 db maximum error up to 1 Mc/s and 0.3 db up to 5 Mc/s.

Also shown by Solartron was a prototype of a T.R.E. general-purpose monitor oscilloscope. It is a good example of modern design, by means of which its predecessor has been reduced to half size and one-third weight, with a gain rather than loss in accessibility. Interesting features are C-core transformers, "potted" assemblies, "Visconol" capacitors, and miniature valves arranged in two rows in V formation to assist convection cooling.

The 20th Century 4-gun precision c.r. tube is now available in a 4-channel oscilloscope by Southern Instruments, characterized by very clear traces, free from intermodulation or defocussing over the whole field.

A new Nagard accessory is an "electrometer" input stage, for applications where the input resistance of the usual amplifier is too low. A Mullard ME1401 miniature electrometer triode is used to keep the resistance upwards of $10^9\,\Omega$. The gain is approximately zero and the bandwidth 1 Mc/s.

Marconi Instruments were showing their TF984/1 S-band spectrum analyser, produced for the Ministry of Supply but to be made available commercially later.



The Mullard f.m. signal generator Type E7572

It covers the range 2,900 to 3,150 Mc/s and displays on a c.r. tube the output of the sender under test as a spectrum of from 1 to 10 Mc/s width. This band is covered by frequency-modulating the local klystron oscillator of the receiver by means of a sawtooth voltage wave applied to the reflector.

The same firm's TF894 audio tester, consisting of a b.f. oscillator and an output meter, is now available as the TF894A with an extended specification: 50 to 27,000 (instead of 12,000) c/s, and output 2 W (instead of 0.3 W), at 15 and 3 (instead of 5,000) ohms.

The well-known Mullard cathode-ray valve tester, with contacts set up automatically for each type of valve by inserting the appropriate punched card, now appears under the type number CT80 as a tropicalized version to Service requirements. For this, the cards are marked with CV numbers, which makes the test procedure even simpler than in the commercial world where basically similar valves bear widely different designations according to the particular manufacturer. Another primarily Services instrument is the Mullard portable battery-driven crystal-controlled frequency calibrator. The crystal oscillates at 1 Mc/s and by means of locked multivibrators produces signals at 1 Mc/s, 100 kc/s and 10 kc/s points up to about 30 Mc/s. Lastly there is the Mullard E7572 f.m. signal generator, covering 80 to 104 Mc/s for the v.h.f. broadcasting band and 2 to 20 Mc/s for associated i.f. stages. The output can be modulated either by a 100-c/s sawtooth waveform for oscillograph work or by a 500-c/s sine waveform.

Manufacturers' Literature

Temperature Indicating Materials in the form of paints and crayons which change colour when applied to heated surfaces. Descriptive booklet from Allied Colloids (Bradford), 11 Great St. Thomas Apostle, Queen Street, London, E.C.4.

Dual Stabilized Power Unit giving two h.t. supplies which can be connected in series aiding or series opposition or in parallel, and can be earthed at any terminal. Descriptive leaflet from Joyce Loebl & Co., Vine Lane, Newcastle upon Tyne, 1.

Television Converter, Type 53, for converting a fixed-tuned receiver to another channel; with amplifying stage and two EF91s as frequency changers, one for vision and the other for sound. Leaflet from the Rainbow Radio Manufacturing Company, Mincing Lane, Blackburn, Lancs.

Armchair Picture Control for television receivers, consisting of a variable attenuator inserted between aerial feeder and aerial socket. Leaflet from Reproducers (Electronic), 82 Great Portland Street, London, W.1.

Connecting Wires insulated with PVC, polythene, silicone rubber or PTFE, in various conductor sizes and colours and conforming to M.O.S. (Air) specification EL1701. Tables and illustrations in a leaflet from British Insulated Callender's Cables, 21 Bloomsbury Street, London, W.C.1.

Brazing Aluminium and "low-temperature welding" using "Sifalumin" rod, which has a melting point 80°C below that of aluminium. Illustrated booklet describing the process from Suffolk Iron Foundry (1920), Sifbronze Works, Stowmarket, Suffolk.

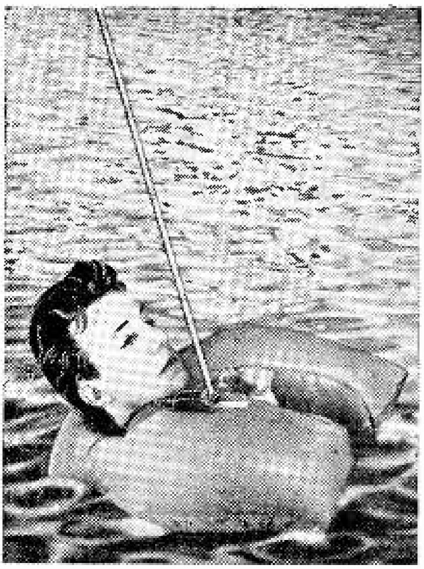
Delayed-action Fuses designed to withstand 75 per cent overload for 120 seconds to avoid unnecessary blowing on surges. These and other components described briefly in a leaflet from A. F. Bulgin & Co., Bye-Pass Road, Barking, Essex.

Tropicalized Receivers for export working on 100-150 V and 200-250 V a.c. Brief descriptions in a leaflet from Pamrex, 41, New Bond Street, London, W.1.

Microphones, carbon, crystal and ribbon, for hand use and on stands; a summarized illustrated list of the types and accessories made by Lustraphone, St. George's Works, Regents Park Road, London, N.W.1.

Radio Rescue Beacon

For Locating Wrecked or Lost Airmen in all Conditions of Weather During Day and Night



"Sarah" beacon transmitter with aerial erected fitted to airman's life-saving jacket.

A V.H.F. radio aid designed for locating the survivors of a wrecked aircraft, but which also could be included as part of the equipment of any expedition of a hazardous nature, has been developed by Ultra Electric. Known as "Sarah" (Search And Rescue and Homing) the apparatus is primarily a small radio beacon, which, when brought into action, continues to transmit an omni-directional pulsed signal until the battery is exhausted.

With the comparatively small battery provided with the air-sea rescue version of the equipment, which is the one described here, the battery capacity is sufficient to give 20 hours continuous operation. The survival probability of "ditched" persons floating in the sea is not likely to be longer than this.

For other purposes it is possible to employ a battery of larger capacity, and consequently of greater weight, but giving a correspondingly longer operating time.

When used by Service flying personnel it is proposed that the equipment be attached to the inflatable life-saving jacket as, even if everything else is lost, this will be on the survivor. Thus a strict limitation is imposed both on size and weight.

Miniaturization is now no novelty, but one cannot help admiring the super-miniaturization applied to the Ultra "Sarah." For convenience of stowage about the person it is broken down into three units connected by cable. These comprise a transmitter measuring $7 \times 1 \times 1$ in weighing 6 oz and including a rolled-up aerial; a speech modulator and receiver unit measuring $4 \times 2\frac{1}{2} \times 1\frac{1}{4}$ in and weighing 12 oz, and the battery measuring $6 \times 4\frac{1}{2} \times 1$ in and weighing 32 oz The whole is fully waterproofed and capable of withstanding wide changes in temperature.

In addition to functioning as a beacon on to which a rescue aircraft, or launch, can "home" by directional receiving technique, one version of "Sarah" also provides for two-way speech communication over a restricted distance.

The beacon is brought into action very simply. It is only necessary to remove the protective cover from the rolled up aerial which unfolds and takes up a vertical position, forming an aerial of about 0.6 wavelength long, this having been found to be the optimum for this particular equipment. The transmitter is also automatically switched on.

Under beacon conditions of operation the transmitter generates groups of pulses at 5 millisec intervals, the pulses in each group being coded for identification by using a different pulse repetition frequency (p.r.f.) for each beacon or group of beacons.

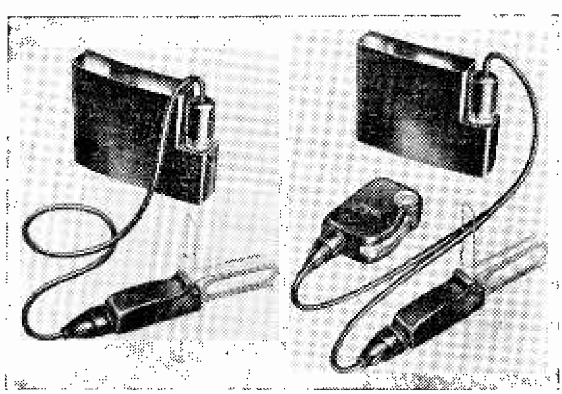
Whilst the average power of the small beacon transmitter is about only 0.5 watt input the r.f. pulse-power output is comparatively high, being of the order of 16 watts. This gives a working range of about 66 miles to a rescue aircraft flying at 10,000 ft altitude, or 6 miles to a vessel with aerials between 30 and 40 ft high. The distress signal at sea can therefore be picked up by a searching aircraft within an area of some 10,000 square miles.

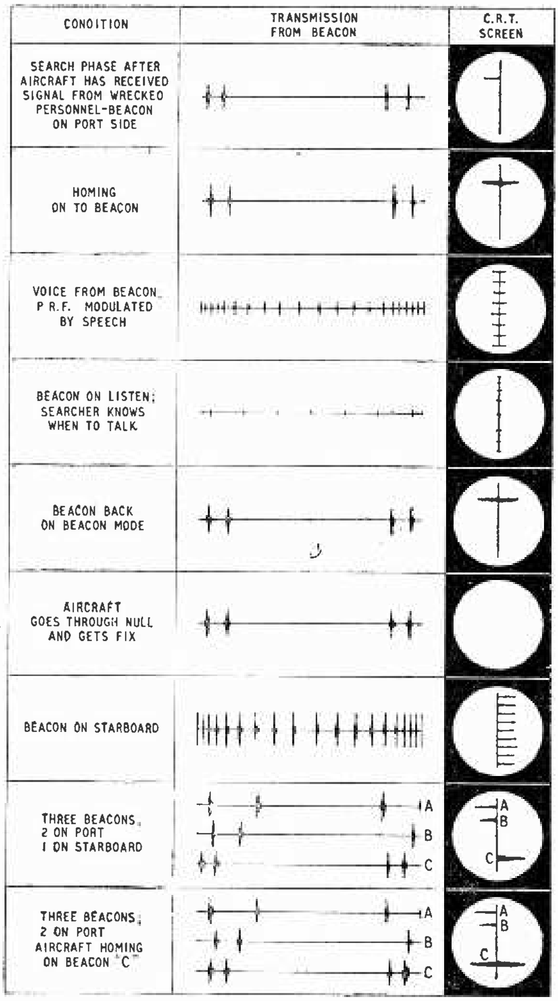
Once in operation the equipment cannot be switched off without folding the aerial and replacing the cover, but the mode of operation can be varied.

Voice Communication

On the speech modulator and receiver unit (when this is included), which also includes a combined microphone and telephone, is a three-position switch normally held by a strong spring in the beacon's "send" position. Pressing it one way converts the transmitter into a super-regenerative receiver with a self-quenching frequency of 60 kc/s and capable of receiving amplitude modulated speech. In the opposite position of the switch the set again becomes a pulse transmitter, but with a p.r.f. of 6 kc/s and a peak

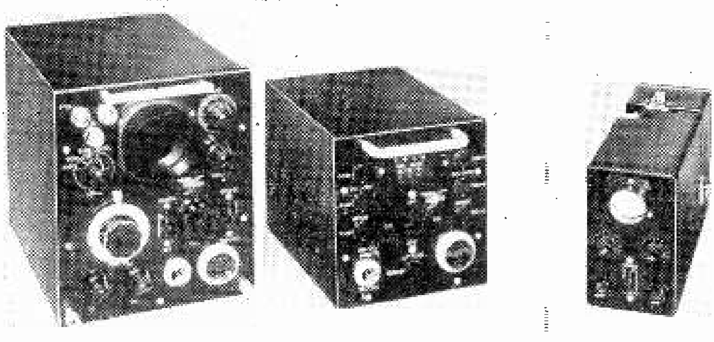
The survivor's equipment of the Ultra lifesaver "Sarah". (Left) beacon only (right) beacon with speech facilities. Aerials shown folded but cover removed.





Sequence and interpretation of displayed signals on cathode ray tube in the searching craft's receiver.

Rescue craft portion of "Sarah" beacon equipment. (Left) receiver with c.r. display tube, (centre) power unit, (right) miniaturized version combining receiver and power unit.



pulse-power of about 4 watts. Speech is transmitted by frequency modulation of the 6-kc/s pulse repetition frequency.

Owing to the lower output power when using telephony this facility is only intended to be used over a short distance, and generally for last-minute instructions when the user of the beacon has been sighted. The h.t. battery consumption rises from 1.1 mA on beacon to 4.5 mA on speech, the l.t. demands jump from 150 mA to 175 mA so that battery life will be appreciably shortened if speech transmission is used indiscriminately.

Rescue Craft Receiver

As might be expected from the foregoing, the receiving equipment carried by the search aircraft or ship is somewhat specialized. It consists of two main units, a search receiver with cathode-ray tube display of the received pulses and a power unit. There is also a miniaturized version of these combined in a single unit and having a smaller c.r.t. Direction finding or homing on to the beacon is effected by the use of two aerials operated on a time sharing basis and mounted abeam on the rescue craft.

Any beacon within range of the receiver displays a horizontal spike on a vertical reference trace on the c.r.t. A sequency of such displayed signals is shown in one of the illustrations here. By time sharing methods the right- and left-hand receiving aerials are arranged to give a spike alternately on the right and on the left of the vertical trace. Comparison of the length of the spikes, which are proportional to strength of the received signals at each aerial, gives a rough indication of direction, while steering to produce spikes of equal length enables homing to be effected on the beacon.

The distance of the spike along the vertical trace is a measure of the distance separating beacon and search craft. It is possible to receive any number of beacons within range simultaneously by employing a panoramic method of search which tunes the receiver back and forth at a slow rate over a 4-Mc/s range of frequencies. In addition to the automatic sweep there is provision for manual tuning over a range of 10 Mc/s.

When visibility is poor, or at night or in fog, a searching aircraft can tell when it is immediately over a "Sarah" beacon by complete cessation of signals. It is under such conditions that the radio-telephone facility possibly has its greatest advantage, since the castaway can be assured he has not been missed and it is only a question of time before a rescue craft will be along to pick him up.

The rescue beacon and its associated search aircraft, or vessel, apparatus was shown at the exhibition of special and military electronic equipment held recently at Farnborough, Hampshire, by the Radio Communication and Electronic Engineering Association. From the length of the aerial seen there we judge the operating frequency to be just over 200 M/cs. We were afforded an opportunity to sample the communication part of the equipment over a short radio path and found the speech quality adequate for its purpose.

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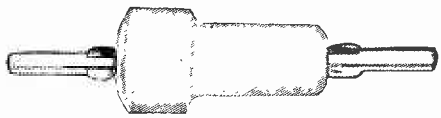
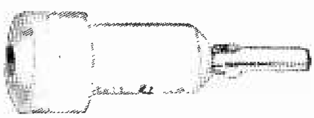
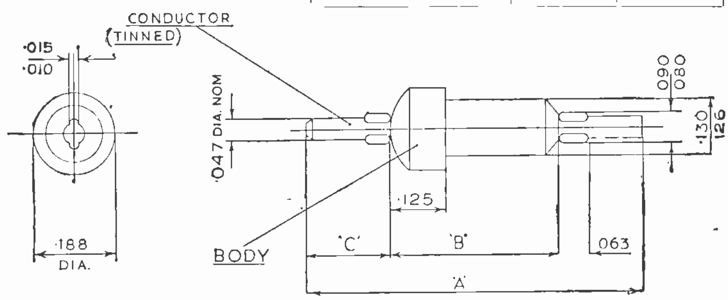
PT 1	.750	.375	.188
PT 2	.875	.500	.188
PT 3	.563	.375	—
PT 4	.688	.500	—

PT 1 & 2. Lead-through

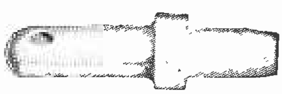


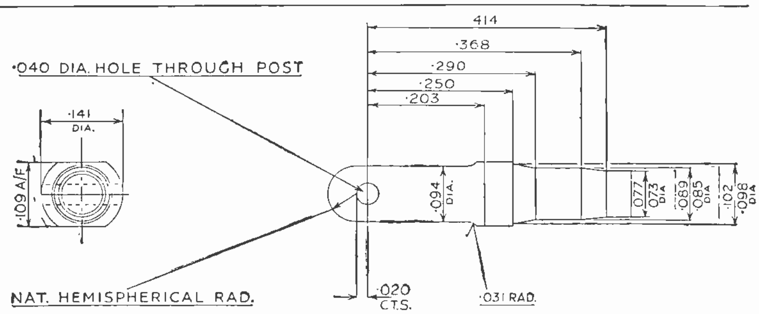
PT 3 & 4. Stand-off





PT 5. Component mounting





Fixing: Polytags are primarily designed for fixing with a 5 B.A. nut—PT 1—4 or an 8 B.A. nut PT 5. They are self-tapping.

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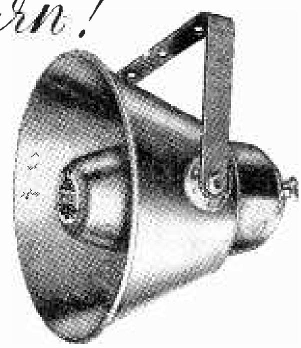

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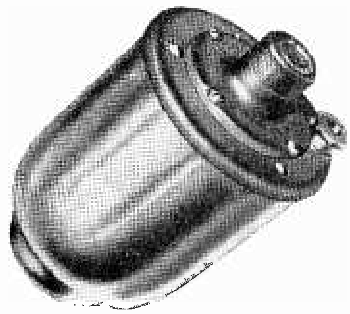

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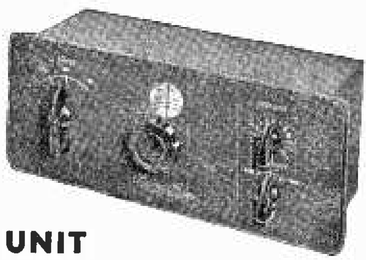

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OHM'S LAW

Do We Know What it Really Means?

By "CATHODE RAY"

To some readers the last few months' discussions may have been rather up in the air. Now that the holiday season is upon us, something a little easier and more familiar may be a pleasant change. What about Ohm's Law? To an electrical man it sounds very much like "ABC." So it may come as a surprise to know that two eminent British authorities on electricity maintained a serious and lengthy controversy on the meaning of Ohm's Law and failed to agree in the end. And since then quite a number of articles have appeared on the subject in several periodicals, including the prodigiously learned *Wireless Engineer*.

To most people, I suppose, Ohm's Law is a simple rule, neatly expressed as

$$I = \frac{E}{R}$$

by which, given any two of the following—current, voltage and resistance—the third can be calculated. What more is there to it?

Well, some may be interested in what it really was that Ohm discovered. Did he deserve to be honoured by the use of his name for one of the basic electrical units? Did his "law" mean the same to him as it does to us? What does it mean to us? What is a law, anyway?

Others may be incapable of caring less than they already do about Ohm and what he thought; they are quite happy to be able to make good practical use of the formula as it stands to-day. To these I would say that the formula as it stands to-day is not so simple that it cannot be misunderstood. One has only to ask a mixed gathering of electrical types "Does Ohm's law hold good for a rectifier?" to start a lively controversy.

Two Interpretations

I think it is now fairly definitely established what Ohm discovered and what he meant. Of course we are not necessarily bound to mean the same thing when we use Ohm's law, but we ought to be quite clear what we do mean. If you think you can settle the matter by looking up the accepted textbooks you are likely to be surprised, not to say disillusioned. The variety of meanings given to Ohm's law is quite remarkable.

However, most of them can be put into two main groups. One comprises those that regard Ohm's law as saying that the ratio of voltage to current is resistance, and if the number of volts is divided by the number of amps the answer is the resistance in ohms. This, they would probably say, applies to any part of a circuit, including a valve or a rectifier; the only exception is a part that includes an e.m.f. The other group would hold that what Ohm discovered was that the current through any conductor kept at constant temperature is directly proportional to the voltage applied, but that many of the conductors used to-day are non-linear so "do not obey Ohm's law"; such conductors are "non-ohmic."

Which side are you on?

Early Experiments

First of all, and in spite of any readers who share Henry Ford's view that "history is bunk," I am going to go back to Dr. Georg Simon Ohm, the date of whose birth is variously given as 1781, 1787 and 1789. There seems to be no doubt that he was born, lived and died in Germany (as it now is), that he was a teacher of mathematics and physics, and that (as usual) his work was little esteemed at the time. One must remember that at that time the generation of electricity by dynamo and other magnetic means was still in the future, and to most people electricity meant chiefly static electricity—catskins, glass rods, pith balls and all that. Current electricity was an imperfectly understood innovation. And of course instruments and even such commonplaces as insulated wire were more or less unobtainable. So unreliable were the batteries Ohm used that his experiments on the conduction of current by metals led him at first to a logarithmic law! It was only when he repeated the experiments using thermo-junctions to supply the current that he came to the conclusion that the current was directly proportional to the voltage. If you are thinking that Ohm can't have been a very clever professor of physics, even 126 years ago, if he couldn't demonstrate correctly what sixth-form boys have been able to for decades, ask yourself how you would demonstrate the truth of Ohm's law without voltmeter or ammeter. Voltmeters assume Ohm's law.

The conclusion he reached was that the current through a conductor is directly proportional to the tension applied and inversely proportional to what he called the equivalent length of the conductor—there was, of course, no unit of resistance then—this equivalent length being proportional to the actual length and inversely proportional to the cross-section area and the conductivity. That the conductivity varied with temperature, whether or not the variation was brought about by the current itself or in some other way, had already been observed by Humphrey Davy, as Ohm acknowledged. But except for this Ohm seems to have regarded resistance as a constant; in particular, not affected by the current or voltage as are certain types of conductor commonly used now. If this was so, then presumably Ohm would regard rectifiers and suchlike as being exceptions to his law, just as there are exceptions to Hooke's (" strain proportional to stress ") law, and the description " non-ohmic " is appropriate to describe the exceptional non-linear conductors.

It is sometimes said that they do not obey Ohm's law. I suppose everybody knows what this means, and does not imagine that these materials are perverse and rebellious, wilfully refusing to obey a law of Nature? Yet it is not so very long since even scientists cherished ideas of this kind, judging from their writings. A law in our sense, however, is just a convenient general statement of observed facts, and is always liable to be found (a) mistaken, (b) inaccurate, or (c) subject to exceptions. (b) or (c) or both may even be admitted from the start. Experience during the last hundred years has confirmed the correctness of Ohm's law, as regards most of the common metals at least, to enormously greater accuracy than Ohm's experiments. But it has also brought to light a great variety of conductors whose resistance is not even roughly constant.

Meaningless Ratio

The alternative view of what Ohm's law means is that if you divide the voltage by the current the answer is resistance. This can always be true, even for rectifiers, because there is no need to assume that the resistance of any particular conductor is constant. If this view were correct, then Ohm's law certainly wouldn't do him much credit. Except for giving a name to the ratio of voltage to current, it tells one precisely nothing. The fact that 100 volts across a certain resistor caused 0.2 amp to flow through it would not enable one to predict the current at any other voltage—unless it could be assumed that the resistance was constant, and that would be going over to the other view of Ohm's law.

I can hardly believe that anybody credits Ohm's law with so little meaning, and I suspect that to them the significance of the law lies in its being

$$I = \frac{E}{R}$$

and not, for example

$$I = 12.36 \frac{E}{R} \times 10^{-1}$$

or even

$$I = 2\pi \frac{E}{R}$$

It is certainly very helpful that there are no constants to be remembered. But that has nothing to do with Ohm; it is thanks to a system of units that came later, when the volt was defined as the potential difference across a resistance of one ohm when one ampere was flowing through it.

What, then, is Ohm's law generally understood to mean? Does it mean a convenient formula, relying on a system of units Ohm never knew, and applicable to any kind of conductor? Or does it mean that the ratio of voltage to current—the resistance—is constant, and therefore has exceptions? I have been trying to think, and have come to the conclusion that I use it in both senses, trusting to the intelligence of those concerned to sort them out. This is admittedly rather a risky practice, and I shall try to avoid any uncertainties of this kind! At the same time I think it is just as well that everyone should realize that at least two meanings do exist, for that should reduce the risk of misunderstanding. The crux of the matter is: Does any given reference to Ohm's law imply that the resistance is constant, or not?

If I were to say, " The current through a 500-ohm resistor is 0.3 amps; use Ohm's law to find the voltage across it," this would obviously mean use the well-known formula, multiplying 500 by 0.3 to give the answer, 150 volts. It is really a misuse of the term " Ohm's law," because Ohm would not know what amps and volts were; as for the ohm, he knew it only as a unit of wine, equal to about 40 gallons, and therefore probably beyond his means. His own contribution to electrical science—proportionality of current to voltage—does not arise in this question at all. Yet I suppose everybody would understand what was meant.

On the other hand, if the problem were " When 150 volts is applied to a resistor the current is 0.3 amp; what is it with 40 volts? " one would have to assume that the resistor was within the scope of Ohm's law (i.e., linear) in order to answer the question at all, whereas a knowledge of the units used would not be necessary. If the current had been given in bongs—a unit of totally unknown magnitude—the question would have been no harder. Whatever the given current is, and in whatever units, the answer must be that figure multiplied by 40/150, if Ohm is to be believed.

While on the matter of units, I suppose everyone realises that the simple formula holds good for certain other combinations of units than volts, amps, and ohms? Take it in the form $E = IR$; obviously it makes no difference if the units of I are smaller so long as the units of R are larger in the same ratio. In our kind of work milliamps are often more convenient than amps, and as they are thousandths of an amp the corresponding unit of resistance must be a thousand ohms—the kilohm. So volts, milliamps, and kilohms are what is called a consistent set of units. If we were interested in small fractions of a volt it would be convenient to use millivolts; to make this right the other side of the equation would have to be changed in the same ratio, say by reckoning in ohms and milliamps. In work connected with ammeter shunts, amps and milliohms would probably be better. And so on.

Right at the beginning I mentioned that it is no good trying to apply Ohm's law to a circuit containing an e.m.f.—at least, not without allowing for the e.m.f. This seems to be very seldom pointed out, even in the most elementary books. I wonder if it is always safe to assume that it goes without saying? Take Fig. 1, for example. If $E = IR$ were applied to find the voltage between the terminals the answer would be $0.5 \times 20 = 10$V. But the measured voltage would be 14. The reason for this discrepancy is obvious, and even a beginner would have to be rather dim to fall into the trap; but Fig. 2 may be a little more subtle. It is supposed to depict a transformer winding consisting of a single turn of thick copper, having negligible

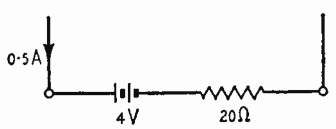


Fig. 1. The voltage between the terminals is not equal to the current multiplied by the resistance. The reason is the e.m.f. of the battery, which must be added in order to get the correct answer.

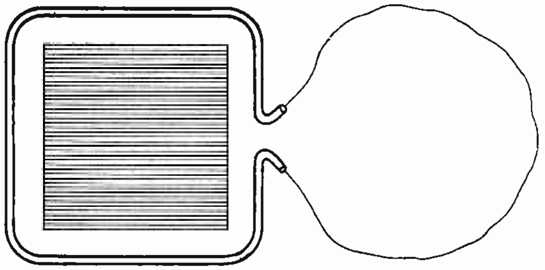


Fig. 2. Here the source of e.m.f. is a single-turn transformer winding, whose voltage can be measured between the terminals.

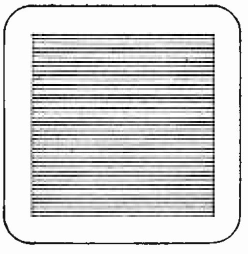


Fig. 3. This is the same as Fig. 2 except that the resistance wire itself is the transformer winding. Although the same current flows through it, no voltage can be measured between any two points on it.

resistance, connected to an equal length of thin Eureka wire, having a resistance of say 10 ohms. Then if the e.m.f. were 0.5 volt, one could apply Ohm's law (!) to the Eureka wire and say that the current was 0.05 amp. The 0.5 volt could actually be measured by connecting a suitable voltmeter to the terminals.

But now suppose that the Eureka wire itself is used as the transformer winding (Fig. 3). Having already performed the Fig. 2 experiment, one can be confident that a current of 0.05 amp is flowing in the wire. Given a sufficiently low-impedance milliammeter, this could be confirmed by experiment. But one would be quite unable to measure the voltage applied to the wire without disconnecting it, except, of course, indirectly by measuring the voltage obtained from another single turn. We would have a current flowing through a resistive circuit, with no difference of potential between any two points on it. This situation can give rise to a good deal of discussion. The only aspect I want to stress just now is that using E = IR to calculate the voltage between any two points on the wire is apt to be misleading.

Voltage Symbol

And that leads to another little argument. The symbol used in the Ohm's law formula for voltage is (I think) usually E. But I am inclined to agree with those who hold that it ought to be V. E is the symbol for e.m.f., and we have seen that when e.m.f. comes within a part of a circuit to which the formula is applied it must be taken out or allowed for if the answer is to be correct. What one is really concerned with is the potential drop across the resistance R when the current I flows through it, and where a distinction is drawn between e.m.f. and p.d. it is generally accepted that the symbol for p.d. is V. I don't think it is anything to get very excited about, but perhaps worth considering.

With d.c. the idea of resistance seems simple. One can measure the current and the voltage drop as in Fig. 4, and from these readings calculate the resistance. It may not be realized that what one is really doing is comparing two resistances. Voltmeters (except the electrostatic type) are actually current indicators, responding to the current passing through a known resistance incorporated in the voltmeter and relying on Ohm's law for their ability to tell the voltage between their terminals. This fact is obscured by the convenient practice of scaling the meter directly in volts rather than in milliamps. But the knowledgeable buyer enquires not only about the voltage range but also the "ohms per volt." What this tells him—whether he realizes it or not—is the range of the instrument as a current meter. Why the information should be presented in the form "ohms per volt" instead of simply in milliamps, heaven knows—I don't. Strictly speaking, it is "ohms per volt *of full scale-value*," otherwise it doesn't make any sense at all. If an instrument is specified as "1,000 ohms per volt," this simply means that its full-scale current is 1 mA. Then why not say so, instead of quoting a ratio of two quantities? Personally I think voltmeters ought to be scaled in current—perhaps with smaller figures—as well as voltage, so that the current drawn by the instrument at any reading can be read off and deducted from the reading of A in Fig. 4 to give the correct current through R.

Fictitious Resistance

When one progresses from d.c. to a.c., complications multiply. One learns that the procedure shown in Fig. 4 tells one not the resistance but the impedance, which is something more comprehensive, including resistance as one of its parts. Moreover, the resistance to a.c. is usually quite different from the resistance to d.c. It is often affected by things not directly connected to the circuit at all; for instance, an iron core around which the wire may happen to be wound. Then there is the "radiation resistance" we have mentioned in recent months. These things seem to be altogether different from the resistance in Ohm's law. So one is often taught to regard them as "fictitious" resistances. I suppose it must be left to psychologists to say whether or not the introduction of "fictions" into electrical engineering tends to undermine one's confidence in it. But actually there is no need to bring in this element of doubt if resistance is suitably defined. The idea of resistance as E/I breaks down in any case, with a.c.

In d.c. one has been taught that power (in watts) is equal to current (in amps) multiplied by e.m.f. (in volts) — $P = IE$. From "Ohm's law" $E = IR$, so $P = I^2R = E^2/R$. This gives alternative ways of arriving at R: $R = P/I^2 = E^2/P$. There is no particular advantage in them with d.c., because P itself is usually found by multiplying I by E, so one might as well get at R direct, as I/E; but defining resistance as P/I^2 does still cover d.c. and has the advantage with a.c. that it includes all the "fictitious"

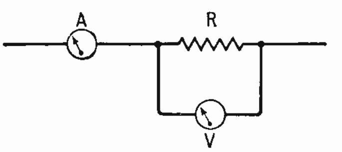


Fig. 4. This simple method of measuring the resistance R is really a comparison of R with the resistance of the voltmeter by comparing the currents through them.

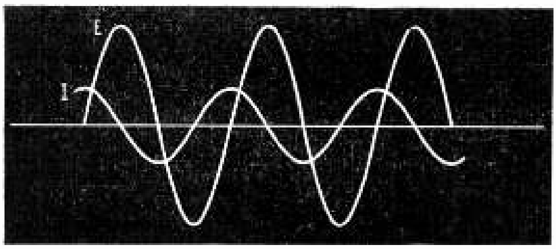


Fig. 5. Oscillograms of current through and voltage across a loss-free capacitor. Although power is flowing all the time, its direction changes twice per cycle, so the average is nil, which means that the a.c. resistance is nil.

resistances, such as core losses, secondary load, dielectric losses, and radiation resistance.

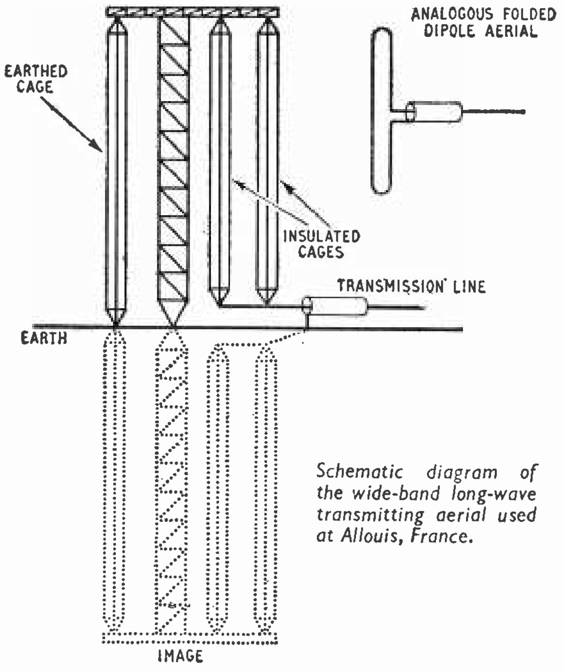
Several conditions have to be understood, however. Unless anything is said to the contrary, " power " in electrical engineering means only one-way power. Suppose you connect a capacitor across the a.c. mains. If an oscillograph were arranged to trace the voltage and current, the picture would be something like Fig. 5. Note that except at the instants when either E or I is zero there is power all the time. But if the capacitor were completely loss-free, the power half the time would be positive and half the time negative, and over any and every whole cycle they would cancel one another out, leaving an average of nil. In other words, during half of each cycle power flows from the mains into the capacitor, charging it, and during the other half the capacitor discharges into the mains, returning the power. For most purposes, including the reckoning of resistance, it is the average over a cycle, not the instantaneous power, that is counted.

In a real capacitor or other circuit, the current is not exactly 90° out of phase with the voltage, and when the average power is taken over a cycle it is found that there is a positive balance—" positive " being understood to mean the direction from source into circuit. Resistance, defined as this average power divided by the average current-squared, includes everything that runs away with energy from the source. In a.c. circuits it is compulsory to think of resistance as a permanent runner-away of energy (as distinct from reactance, which accepts only short-term loans), rather than as the ratio of voltage to current (which it obviously is not). In d.c. circuits it is not compulsory, but one might just as well accept it as the basic definition; then one is covered for all situations.

One must, however, always be prepared for the possibility that R may be non-linear or " non-ohmic "; that is to say, not a constant. But it can still be defined as P/I^2 or E^2/P, so long as it is remembered that the value so found holds good only at that particular value of I or E. Another thing to remember is that I or E may not be the same everywhere in the circuit. This is especially so at high frequencies; think of an aerial, for instance. So it is necessary for I or E to be the values at the place where P is measured, and the resistance calculated from them is the resistance *at that place*. Elsewhere in the circuit it may be quite different. At the centre of a half-wave dipole, where the current is a maximum, the resistance is about 73 Ω; at the end, where the current is small, it may be about 2,000 Ω.

WIDE-BAND LONG-WAVE AERIAL

Novel Type Installed for New High-Power Station in France



Schematic diagram of the wide-band long-wave transmitting aerial used at Allouis, France.

AN aerial of unusual design is in use at the rebuilt French long-wave broadcasting station at Allouis. According to a description in *Radio Informations Documentation*, a house publication of Radiodiffusion et Télévision Française (RTF), the problem of designing an effective long-wave transmitting aerial is by no means as simple as it may at first seem. The band width radiated is an appreciable fraction of the carrier frequency, which in this case is 164 kc/s, and the band to be radiated is 154 to 174 kc/s.

The design chosen takes the form of a vertical centre-fed folded dipole loaded at the extremities and it consists of a stayed lattice mast 308 metres high having three radial arms at the top each 20 metres long and spaced 120 degs. From each radial drops a vertical wire cage, two being insulated from earth at ground level, but the third, like the mast itself, is earthed.

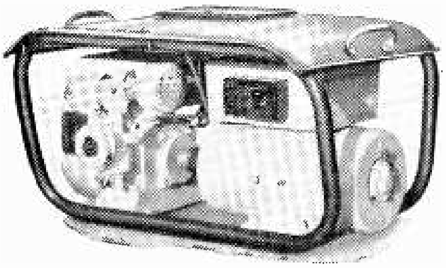
When the " image " in the earth of the quarter-wave vertical assembly is taken into account the whole represents a half-wave folded dipole as shown in the accompanying drawing. The physical part of the aerial above ground level might be more accurately described as a folded unipole although electrically it behaves as a folded dipole.

Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

Home A.C. Generator

THE electric generating set illustrated will supply all the domestic needs of a farm or cottage in the country not connected to the supply mains and it has the additional advantage of being reasonably mobile.



Morrison portable 500-watt, 250-V a.c. generator.

It is powered by a compact Villiers Mk 10 petrol/paraffin engine for which service and spares are obtainable in most parts of the world. The a.c. output is 500 watts at 230 V and the generator is capable of supplying a television set, radiogram and various electric appliances, as well as providing light.

Obtainable with either hand starter, automatic starting or remote control, it costs £85, and is made by A. C. Morrison (Engineers) Ltd., Loughborough, Leicestershire.

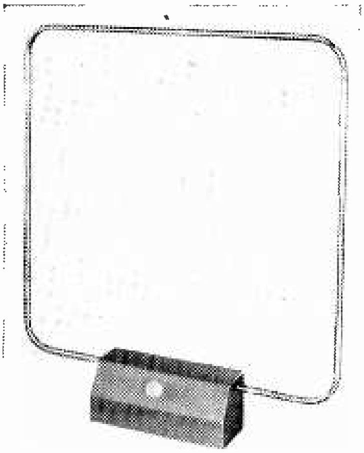
Noise-reducing Loop

A LOOP aerial intended primarily for reception of local broadcast stations under conditions of severe electrical interference has been introduced by Telecraft, Ltd., Quadrant Road, Thornton Heath, Surrey. Consisting of a single turn of self-supporting light-alloy tube about $2\frac{1}{2}$ft square, it is tuned approximately by switching in fixed capacitors for reception of three stations, two in the medium waveband and one in the long. Each is broadly tuned. The three frequency bands available are centred on the Home and medium and long waveband Light programmes.

Apart from being frequency-selective, and so restricting the pick-up of local electrical interference to narrow bands of frequencies, the directional properties of the loop can be utilized further to discriminate between signal and noise.

This indoor aerial is described as the "Telecraft Radio Square" and costs £3 10s.

Telecraft anti-interference loop aerial.



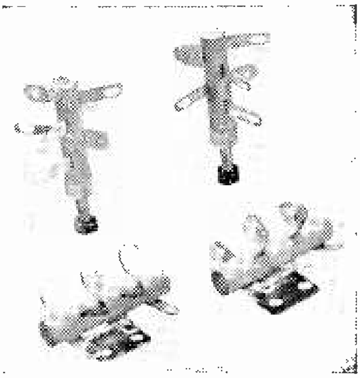
Insulated Tag Mountings

ARRANGING for suitable anchorages of components and wires is always a problem in designing radio and electronic equipment. Two insulated tag mountings, the "Cactus" and "Porcupine" introduced by United Insulator Co. Ltd., Oakcroft Road, Tolworth, Surbiton, Surrey, should go some way to solve most of these difficulties.

In each case the bodies are porcelain, all metal parts are silver-plated and the metal tags are easily removed, reversed or arranged to suit individual requirements.

The "Cactus," for vertical mounting, measure 1.1 in high and the "Porcupine" for horizontal mounting 0.8 in high. The insulation resistance is said to be better than 100 MΩ and both are suitable for 750-V working. The flash-over voltage is 4.5 kV r.m.s.

Porcelain-insulated tag mountings made by United Insulators.



RANDOM RADIATIONS

By "DIALLIST"

Well Done!

THOUGH IT MAY SEEM a bit late in the day, I must offer the B.B.C. my congratulations on the fine job of work it did on Coronation Day. Both the sound and the vision broadcasts were first-rate and I can't remember a single hitch, technical or otherwise. For the engineering staff it must have meant an immense amount of careful planning and of hard work; one only hopes that the millions in this country who saw both the ceremony and the procession (to say nothing of the fly-past and the fireworks), or heard the commentaries on them, realize this and were duly appreciative. B.B.C. engineers weren't the only ones concerned either, for the G.P.O. did a grand job in linking sound and vision O.B. points, control centres and transmitters—and keeping them linked.

Relays Abroad

A still more remarkable feat from the electronic and engineering points of view was the relaying of the vision programmes to France, Belgium, Holland and Germany. The first essential was to provide (and maintain) first-class 405-line images on the master screen at the Télévision Française centre at Cassel. Hundreds of amplifying stages must have been at work between the cameras in London and the conversion station in France and, until someone invents (amongst a few other things) a valve with really straight "straight portions" of its characteristics and a mutual conductance which stays put as the working point moves about, every such stage is a potential source of distortion. Add to that changes from land-line to radio-link as well as several carrier-frequency conversions and you'll see what a triumph it was to deliver an excellent picture not only with 405 lines at Cassel, but with 441 and 819 lines to French transmitters and with 625 lines to Holland and Germany.

Worth Thinking About

Two technical friends who saw the 819-line picture (one was in Paris and the other near Versailles) tell me that the quality was very nearly as good as that of normal transmissions made direct by means of 819-line cameras. That seems to bring out two points worth thinking about. The first is that our 405-line image is proved to have what has long been claimed for it: perfectly balanced horizontal and vertical definition and as much detail, even after being spot-wobbled, as the normal eye can resolve. Were that not so, the 819-line images wouldn't have been up to the mark. The only thing amiss with the usual unwobbled 405-line image is its lininess. The second point is that the tears shed over the adoption of different scanning systems on the Continent were largely wasted. Conversion from one system to another (or to several others) has turned out to be a comparatively straightforward business and the adoption of different standards is no menace to international television broadcasting, though it was confidently predicted that it would be. As a matter of interest, though, a 405-line image transmitted with a 2.7-Mc/s modulation range will probably give far better results on conversion than will a 625-line image with a 3.5 or even 4-Mc/s range.

Reversion to Type

WE HAVEN'T, up to now, heard a great deal about the layer-built dry Leclanché cell in this country, though it's a good many years since it made its appearance in the United States. So far as I know, its only large-scale application here is to be found now in the combined h.t. and l.t. batteries for hearing-aids and "all dry" portables. I fancy, though, that it will have much wider uses in the future. The layer-built cell is in some ways a reversion to ancestral type; for it is made on the "sandwich" lines of Volta's Pile, the sandwich here consisting of thin plates of zinc and carbon. One big advantage is that the zinc is given its proper job and no other. By that I mean that it is not largely wasted by being made to act as the container of the cell. All of it is available to react with electrolyte and by so doing to convert chemical into electrical energy. Yes, I believe that the layer-built cell has a big future for many purposes.

The Valve

WHEN I SUGGESTED in June that the valve is a power, rather than a voltage, amplifier I didn't mean to imply that the power appearing in its output circuit was so many times that in the input circuit. I ought, probably, to have written: the valve amplifies because it enables a minute power input to control a very much larger power output. The tiny amount of power in the input circuit is so used as to apply voltage variations to the grid. How you use the power in the output circuit depends on what you want it to do. One kind reader suggests that the valve is a voltage-operated generator with a power output. I don't quite like that for two reasons. First, that definition says nothing about amplification; and secondly, the valve is more of a convertor of d.c. to a.c. than a generator —despite the μV_g "generator" of equivalent circuits.

Time and Earth Connections

A GOOD MANY LETTERS have come in on the subject of the reduction in range undergone by l.w. and m.w. transmitters with the passing of the years. All the writers agree that stations ashore suffer in this way; but there is a difference of opinion about ships' transmitters using such wavelengths. Most of those who mention ships argue in this way: no loss of range occurs as years go by; a ship constantly renews her earth contact as she travels and there can be no deterioration here; therefore, the reduced ranges observed for similar transmitters ashore must be due to falling effectiveness of the earth contact which has no such renewal. On the other hand, there are some—including a retired R.O.—who hold that time does bring about a reduction in the range of ships' transmitters! Experiences would be welcome.

The Useful Poker

THERE ARE one or two useful tips in the new Multicore leaflet "Hints on Soldering," a copy of which was handed to me by the owner of my local wireless shop. One that appeals to me concerns small "sweating" jobs: If your electric iron isn't hot enough to make the solder run, try applying a black-hot domestic fire poker for a few moments. Another kind of poker has also served me well at times as an aid to soldering, that blessed aid to fire-lighting, the gas poker. This is in effect a handy form of Bunsen burner, giving a strong, hot flame which deals admirably with quite large sweating jobs. Considered just as a fire-lighter, it is admirably designed for its intended task; but as an emergency tool it has the drawback of giving you two flames, splayed out like the arms of a V. That, however, is very easily remedied: simply push a nail of the right size into one of the holes through which the gas comes—*et voila.*

UNBIASED

By FREE GRID

Labours of Hercules

NATURALLY I am completely unbiased in the matter of sponsored TV but I cannot help feeling that as it is a newcomer in the field it should be made to prove its worth before it is let loose on us. But it cannot do that unless it is given a trial, but why not make use of the old principle of trying it on the dog first?

Let the would-be TV sponsors

Quite useless

erect a station in the Hebrides or in the sterner and colder parts of the Caledonian mainland. If they can put out "advertising" programmes good enough to sell things to the canny Scot they will have won their spurs (or should it be their dipoles?) and the right to operate on this side of the Scottish economic iron curtain where sales resistance is not so high. It is quite useless to appeal to an unadulterated Scot by direct and blatant advertising. The idea of buying has to be put over to him so subtly and so insidiously that he doesn't realize that something is being put across him and believe me that takes some doing, as St. Columba found out long centuries ago.

Fiat Lux

WRITING IN THE JULY ISSUE, the Editor asks "What precisely is *electronics*?" and he leaves us in no doubt that he is in sympathy with those who feel that the present accepted definition should be widened. This definition, which owes its origin to the American Institute of Electrical Engineers, is "Electronics is that branch of science and technology which relates to the conduction of electricity through gases or *in vacuo*."

I will not attempt to offer an improved definition but will content myself by saying that I hope it will be phrased with more regard to good English than the one it displaces. I cannot for the life of me see why the English expression "through gases" should be followed by the Latin "*in vacuo*"—which is anyway not as accurate as it might be. It would be better rendered as "*per vacuum*," unless we are to suppose that the electrons are not conducted through the glass-enclosed vacuum of our valves but merely float aimlessly about in it, peering stonily at us like a lot of imprisoned goldfish.

It is true, of course, that certain Latin writers, including Cicero, did use the word "*in*" followed by the ablative when they meant "through" in certain specialized contexts; just as Queen Victoria did in the case of the word "ain't," which she never feared to use when it was correct and apt. I have little doubt that the "*in vacuo*" pedants would turn the phrase "through gases" into Latin but unfortunately the Romans didn't have a word for gas, which was coined at the time of Queen Elizabeth I by Van Helmont from the Greek word χαος (chaos).

Surely the word "vacuum" has become as much an English word as the Latin word "tedium" and is entitled to be treated as such? We do not read in Hansard that "overcome by the *tedio* of the debate the Hon. Member fell asleep." Finally we have the authority of the great Dr. Johnson for treating vacuum as a word which has become English by naturalization. He used it as such long before the American Declaration of Independence, let alone the formation of the American I.E.E.

$\sim\ = \flat$ *or* $\sharp$

THERE ARE PEOPLE in this world who are so lacking in musical appreciation that the only tune they can recognize is the National Anthem and even then only because on such occasions all men remove their hats or stand to attention and some women stop talking. I don't pretend to have much of an ear for music myself but I did notice a few months ago (in "drear Februeer," as the poet calls it) that my appreciation of music, such as it is, seemed to vary according to the time of day at which I listened to a recording. At certain times I found a tune lively, sparkling and invigorating and at others the same tune seemed flat and lifeless.

With the coming of summer these symptoms dramatically ceased; I naturally decided that my trouble was a subjective one and put the cure down to the tonic effect of the sun. As a result I have invested in an expensive sunlamp in order to prevent a recurrence of the trouble next winter. However, a musical friend tells me that I have wasted my money.

He offers the simple explanation that the whole trouble is that the e.m.f. and $\sim$ of the mains in my district varies considerably according to the load. Thus at peak-load hours both my voltage and frequency are down and so is the turntable speed of my gramophone; sufficiently so, my friend alleges, to make the music sound flat. I am, however, suspicious of this explanation as my friend is trying to sell me a variable-speed motor to replace the synchronous type I use at present.

Hallelujah Chorus Jammed

THE B.B.C.'s handling of the Coronation was so good and the praise rightly bestowed on it so great that there is some danger of swollen heads in Portland Place unless some fault be found with the head-owners' presentation of the day's pageantry.

Fortunately, the B.B.C. did, in my opinion, make one very bad mistake and I intend to make the most of it. As you will recall, during the progress of the Coronation procession through the streets we were switched from point to point along the route to receive a description of the passing pageant from various commentators.

After a time this began to get monotonous as it was the same procession that was described each time. This could have been avoided if we had been switched over now and again to a commentator in the procession who could have given us a procession's-eye-view of the crowds and street scenes.

It would have been an easy matter to fit one of the coaches with a v.h.f. transmitter, and although the Earl

Economic necessi.y

Marshal would not have allowed an ordinary B.B.C. commentator in the procession I do not doubt that one of the Noble Lords who are compelled by economic necessity to throw open their ancestral homes to us Paul Prys at half-a-crown a peep would have been glad to earn a fat fee for the occasion.