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FEBRUARY 1942

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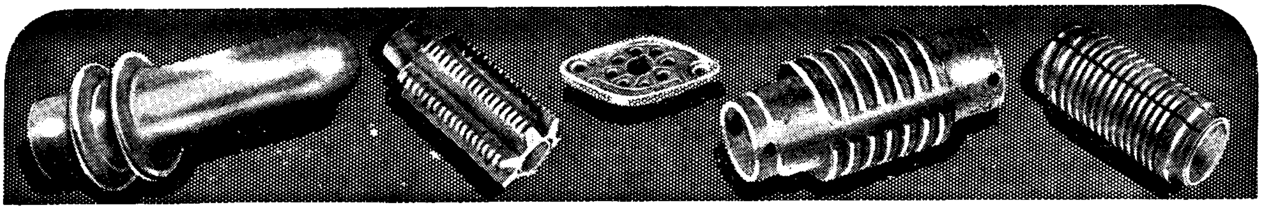
No. 1076 Vol. XLVIII No. 2



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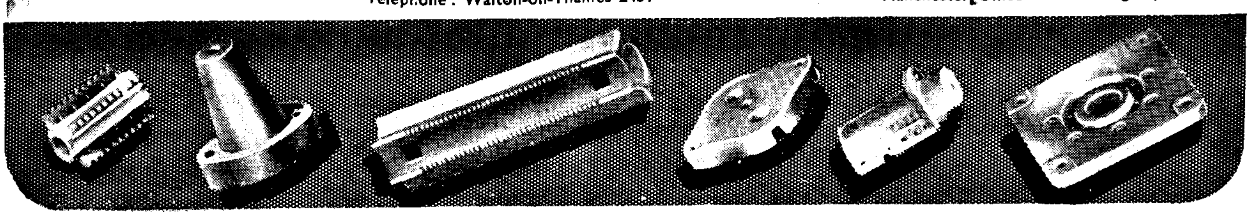

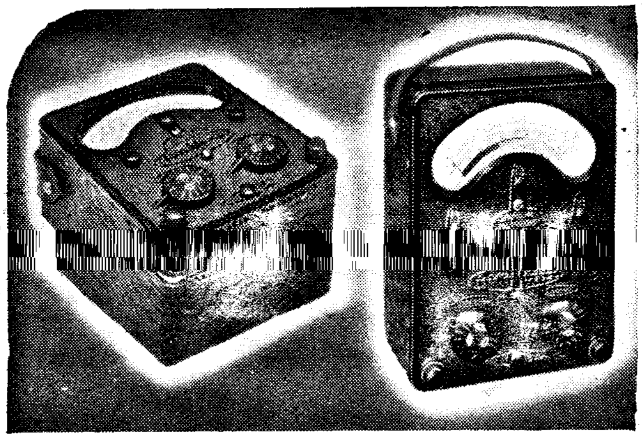

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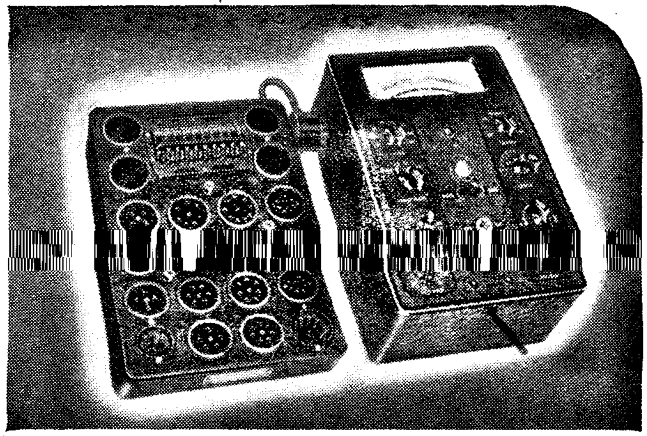

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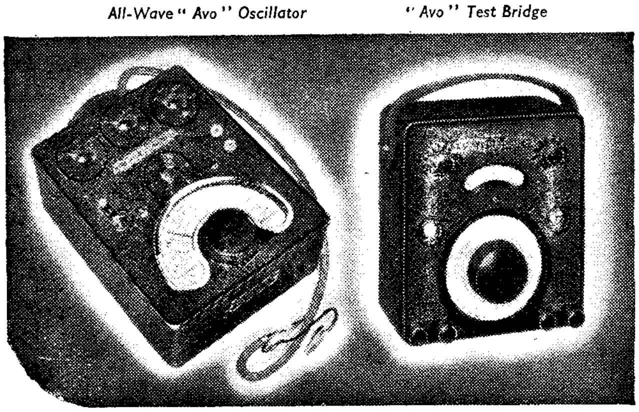

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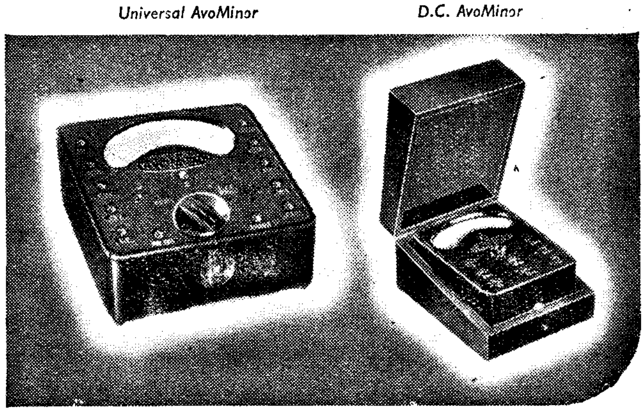

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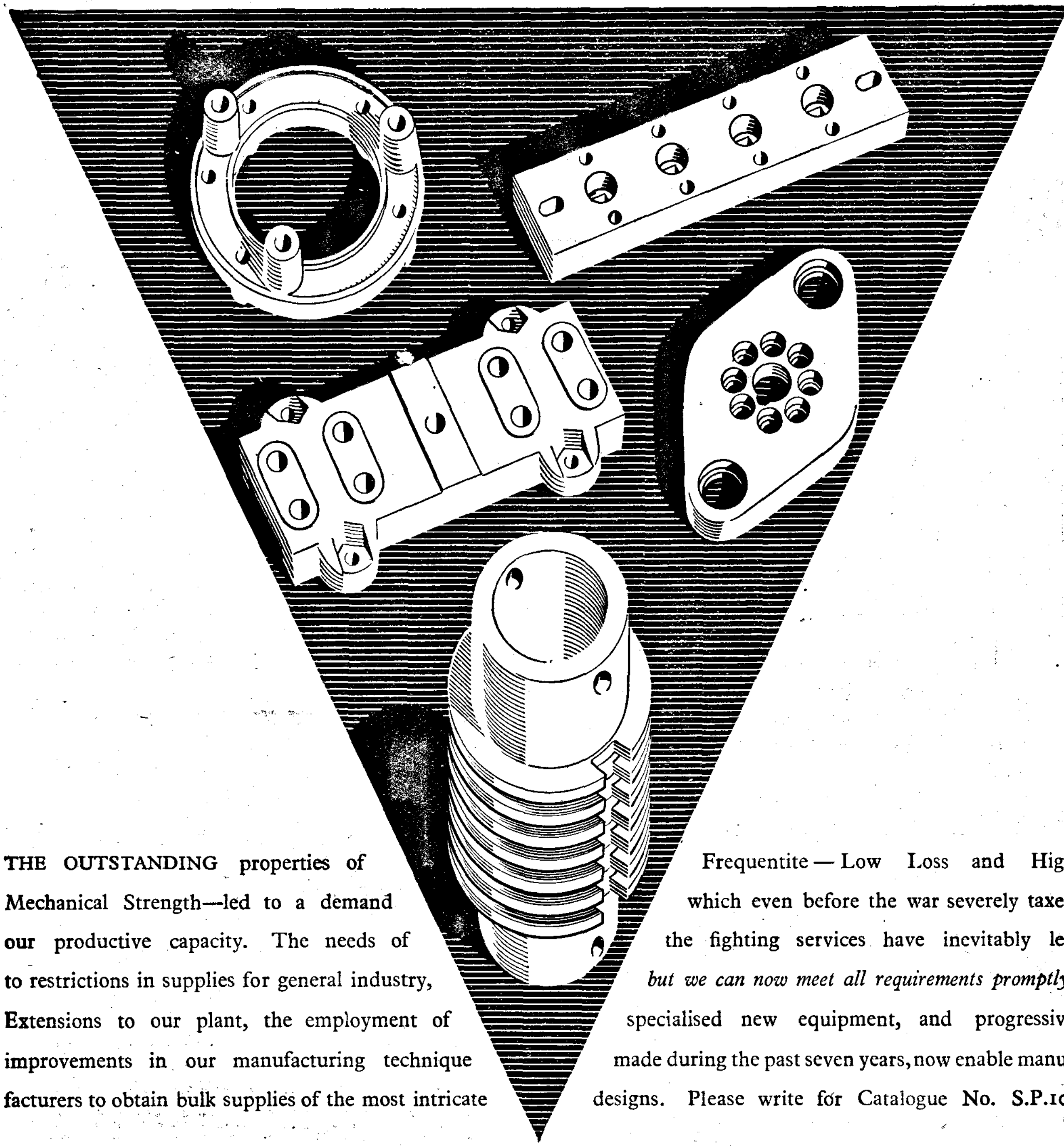

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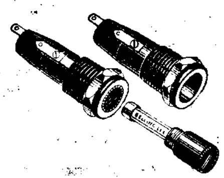

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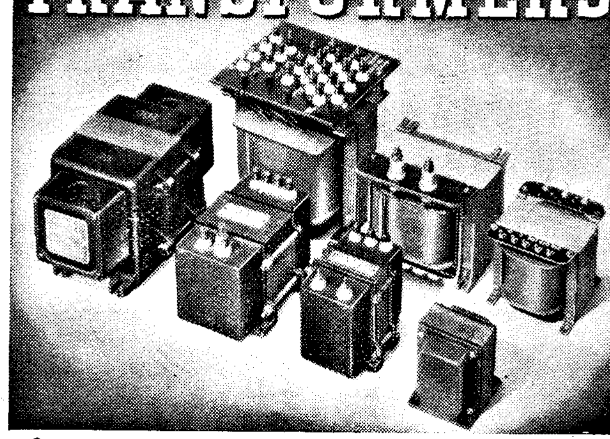

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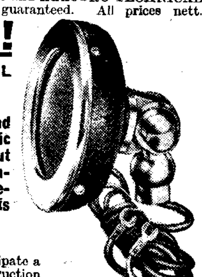

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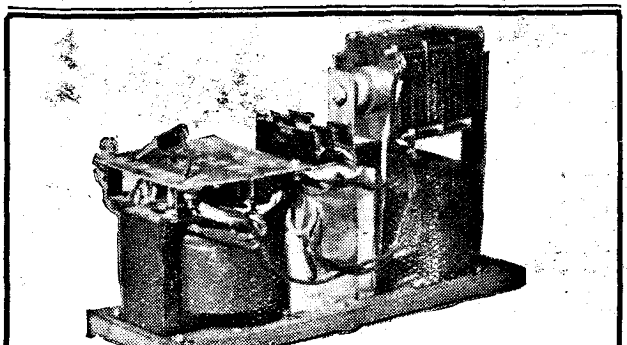

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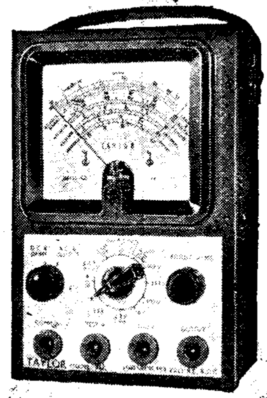

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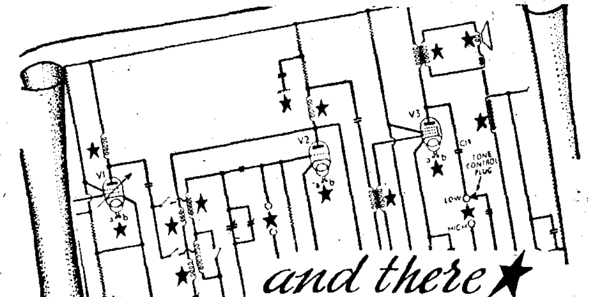

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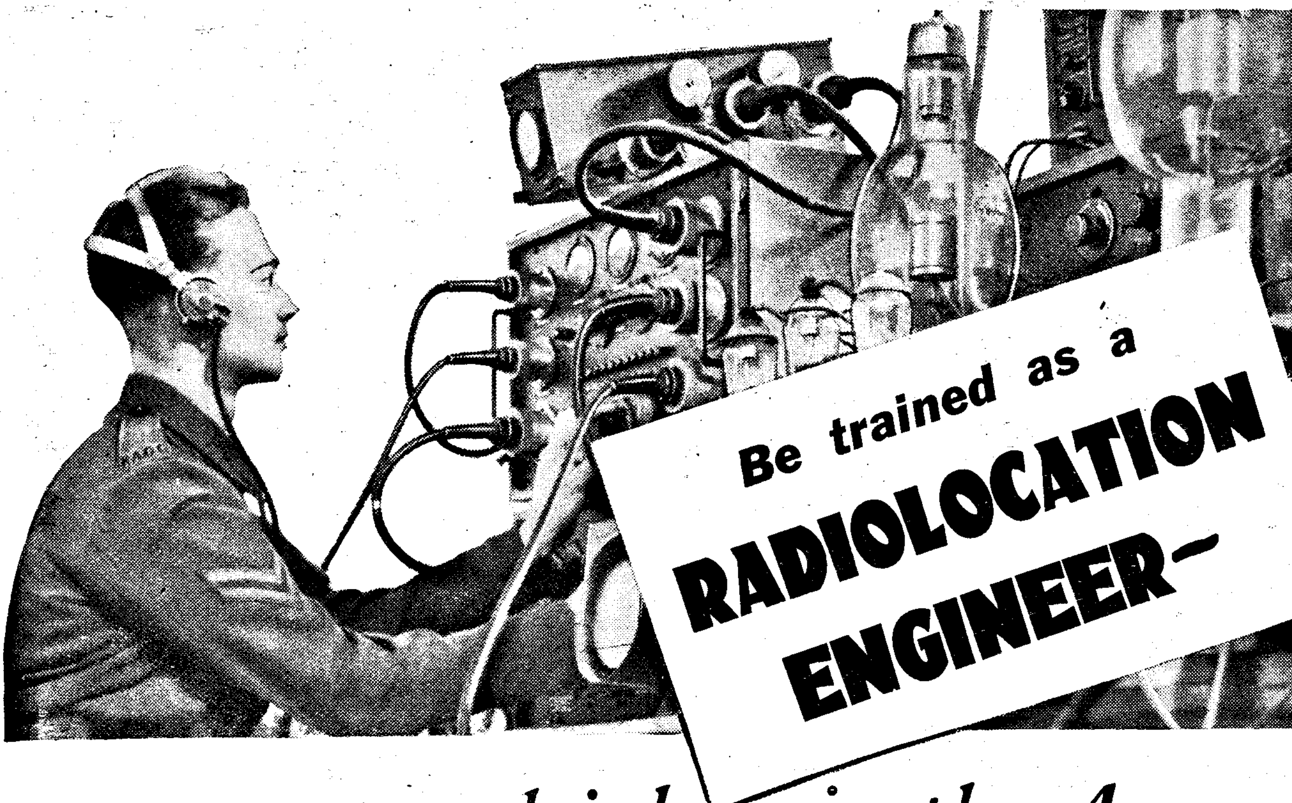

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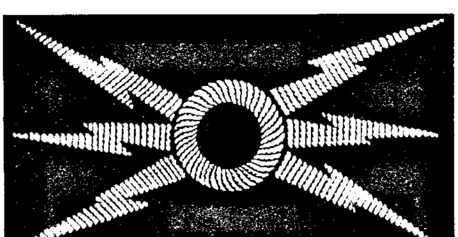

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The
Wireless World

COVERING EVERY WIRELESS INTEREST

ESTABLISHED 1911

Vol. XLVIII. No. 1076 FEBRUARY, 1942 Price One Shilling

Inter-Allied Broadcasting

A Plea for Reorganisation

NOW that the majority of decent freedom-loving folk throughout the world are united as active participants in the struggle against the aggressor nations, it seems opportune to consider whether the time has come for a drastic overhaul of the system of international short-wave broadcasting that has served us—sometimes well and sometimes not so well as it might have done—during the first two years or so of the war.

That circumstances have changed will at once be obvious. The need for convincing potential allies of the justice of our cause has largely disappeared. There remains, of course, the need for propaganda to the peoples of the enemy countries and occupied territories, but, apart from that, the main function of international broadcasting is now to cement friendship between the United Nations; to explain our various points of view to each other, and, above all, to pave the way for the kind of post-war co-operation that will lead the way to a New World Order so different from anything Hitler has to offer.

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Few will deny that the B.B.C. Overseas Service has greatly improved during the past year, both with regard to programme content and technical organisation. But the sweeping changes that might have been expected on the entry of the United States and Japan into the war have not yet taken place, although it must be admitted that some details of programme make-up have been appropriately changed.

Of course, this matter of inter-allied broadcasting must be a two-way affair, and specially beneficial results are likely to result from exchanges between the two great English-speaking nations. There is almost unlimited scope for showing the real Britain to the real America—and vice versa. Broadcasting, with its vast potentialities in the way of living actuality, has advantages over the cinema film and the written word that should be exploited with imagination, courage, and in the spirit of democracy.

Careful study of ionosphere conditions plays an important part in the organisation of long-range broadcasting services. That should be obvious, but the choice of wavelengths could sometimes be happier. Recently there have been indications that broadcasts from the United States to this country would have been better received during the early evening if transmitted on longer wavelengths.

Importance of Timing

There is also the question of time. The organiser of international broadcasting must keep a watchful eye on the world clock and arrange times of transmission so that the more important programmes are receivable at times when the majority of listeners are free to hear them. Many of the American broadcasts for Britain at present come to an end too early in the evening. Clashing of time between home news bulletins and those from overseas must also be taken into account and avoided wherever possible by co-operative planning.

Neither we nor our allies possess an unlimited number of channels nor of broadcasting stations. It is particularly difficult to make the fullest possible use of directional transmission in all the circumstances where it would help to ensure good coverage. All these factors stress the need for considering, on the broadest inter-allied basis, the possibility of reducing those services that are unproductive and strengthening those that give promise of helping to win the war—and the peace.

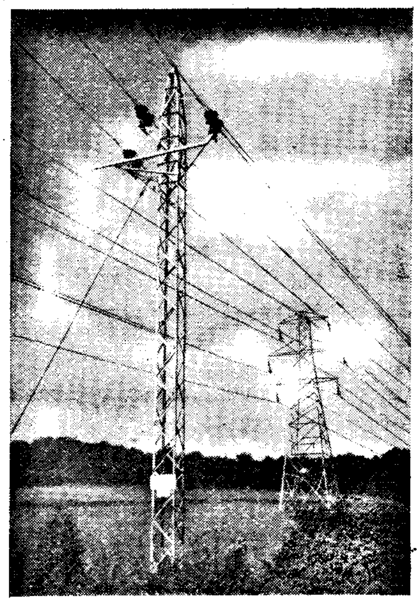
Carrier Current Communication

"Wired Wireless" Over High-voltage Power Lines

By J. S. FORREST, M.A., B.Sc., F.Inst.P.

RECENT articles have dealt with wire broadcasting systems, and in particular with the distribution of programmes at carrier frequencies over the low-voltage electric supply mains. Carrier currents are often superimposed on high-voltage power transmission lines for communication purposes, and it is thought that a brief account of this subject will be of interest.

It is rather paradoxical that from some points of view a high-voltage power line is almost an ideal communication line. The desiderata for communication circuits are low resistance, low capacitance, high insulation resistance; a high-voltage power line fulfils all these requirements. The resistance must be low in order that heavy currents can be carried without excessive losses; the capacitance is low as large conductor spacings must be used at high voltages, and similarly the high voltage necessitates a high level of insulation. In the operation of high-voltage power networks communication facilities are essential for many purposes, e.g., telephone communication is necessary for control and maintenance, while communication channels are also required for the remote indication of switch positions and meter readings, and for the remote control of switching and generating stations. In addition, for certain types of automatic line protection it is necessary to transmit some form of signal from one end of the line to the other in order to ensure that, if a breakdown occurs, the faulty section of line will be automatically isolated by the controlling circuit-breakers with a minimum of disturbance to the remainder of the system. It is natural, therefore, that power companies should utilise high-voltage lines for communication purposes by superimposing the communication signals at carrier frequencies on the power line. Carrier frequencies in the range of 50-150 kc/s are suitable for this purpose, so that a power line is potentially an eleven-channel communication circuit—assuming 10 kc/s spacing between channels. The cost of the high-voltage equipment necessary to couple the carrier apparatus to the line is high, so that carrier current communication is seldom used on very short lines. On long lines, however, say over 50 miles, carrier currents provide very economical and reliable communication channels, and a carrier current installation should be regarded as an essential accessory to a modern power transmission line.



Carrier currents for communication and control purposes can be superimposed on high-voltage power lines. The photo shows 33- and 132-kilovolt lines.

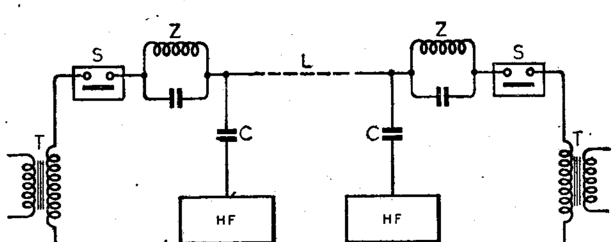


Fig. 1. How carrier currents are superimposed on a high-voltage line.

The basic principles underlying the application of carrier currents to high-voltage lines are shown in Fig. 1. The carrier current apparatus (HF) is similar to that employed in ordinary telephone practice and is coupled to the power line (L) by high-voltage coupling condensers (C). The power transformers (T) and switchgear (S) at the terminals of the line have an appreciable capacitance and a correspondingly low impedance at carrier frequencies, so it is necessary to connect high-impedance tuned circuits or wave traps (Z) in the power line to prevent excessive carrier current losses.

The coupling condensers (C in Fig. 1) usually have a capacitance of 100 $\mu\mu$F. It is essential that the coupling condensers should have a high factor of safety as a breakdown would involve the interruption of the power supply as well as of the carrier current communication. The condensers must be designed to withstand continuously the full line-to-earth voltage of the power system in addition to voltage surges, which may amount to several times this value. Also, the condensers are installed outdoors and must withstand the application of these voltages under all weather conditions. The condensers are normally of the oil-immersed paper dielectric type, and are assembled in a porcelain weather shield. For high voltages several units are connected in series. A photograph of a condenser of this type on a 220-kV system was given on page 8 of the January issue of *The Wireless World*. For use on the 132-kV Grid system in this country three units are connected in series, and the complete condenser withstands a pressure test of 300 kV for one minute. High-voltage coupling condensers having porcelain dielectric have been made in Germany and the United States, but have not been so widely applied as the oil impregnated paper type.

The line trap (Z) consists of an air-cored inductance tuned to the carrier frequency by a mica dielectric condenser. The inductance must be designed to carry the full load current of the power line and must, in addition, withstand the stresses due to heavy short-circuit currents, say, 5,000 A, which may occur under fault conditions on the power system. The parallel tuning condenser must be provided with some form of surge protection, as high voltages are imposed on this condenser by steep-fronted travelling waves on the line. The line traps are usually suspended from the sub-station structure at the terminals of the high-voltage line, but a form of construction has been introduced in this country in which the line trap and coupling condenser are assembled in a single unit.[1] A complete line coupling unit of this type for a 132-kV system is shown in Fig. 2; the overall height is about 15ft. It should

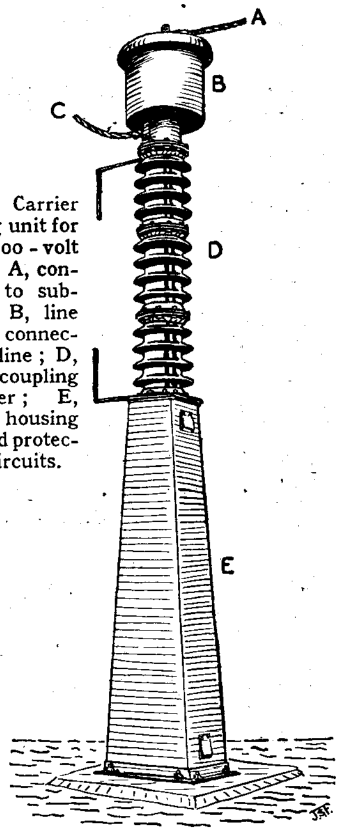


Fig. 2. Carrier coupling unit for a 132,000-volt system. A, connection to sub-station; B, line trap; C, connection to line; D, 3-unit coupling condenser; E, pedestal housing filter and protective circuits.

be noted that any intermediate switching or transforming stations in the line must be by-passed at carrier frequency by means of further high-voltage line-coupling equipments.

The system shown in Fig. 1 is for transmission between one conductor and earth, but as three-phase conductors are always available, the carrier equipment is often coupled to two phases of the power line, as shown in Fig. 3. Such a system necessitates twice as many coupling condensers and wave traps but possesses the following advantages. The transmission efficiency is rather higher and interference from external sources is much reduced; it follows therefore that the radiation of the carrier frequency from the line is also reduced. Another advantage of the two-phase system is that communication can be maintained even if

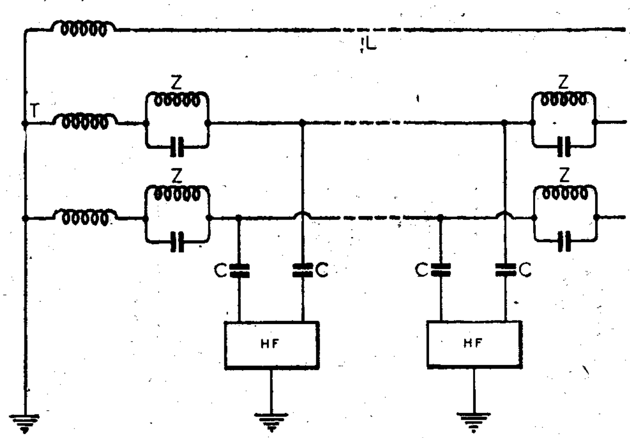


Fig. 3. Carrier current coupling between two phases of a three-phase system.

one of the phases to which the carrier equipment is coupled is broken. In the case of the single-phase system, if the phase transmitting the carrier is broken, communication is interrupted. The necessity for using twice the number of line coupling equipments in the two-phase system is not always a disadvantage, as coupling condensers may in any case be available on all three phases for other purposes, such as providing voltage supplies for metering and automatic protection equipment.

For the case in question the inductive reactance at carrier frequencies is large compared with the line resistance, and the leakage resistance is high compared with the capacitive reactance, so that the attenuation constant is given by

$$\alpha = \frac{R}{2Z_0} + \frac{GZ_0}{2}$$

where R is the line resistance per mile at carrier frequencies,
G the leakage conductance per mile

and $Z_0 = \frac{\sqrt{L}}{C}$ the characteristic impedance,
L being the line inductance
and C the line capacitance.

The power loss is then 8.7α db./mile.

Considering, for example, two phases of a 132-kV line at 100 kc/s—the DC resistance is 0.5 ohm/loop mile, and the resistance at 100 kc/s is approximately twenty-five times this value, or 12 ohms/loop mile. The characteristic impedance is 750 ohms, so that neglecting leakage ($G = 0$), the power loss is 0.07 db./mile. For single-phase and earth transmission the characteristic impedance is 450 ohms and the resistance approximately 9 ohms/mile, giving a value of 0.09 db./mile for the power loss.

The power loss is therefore very low in the case of overhead high-voltage lines, but serious difficulties are experienced if the line contains a section of underground cable. Cable sections are sometimes inserted in overhead lines at road crossings or at the line terminals where the line enters a built-up area. The characteristic impedance of the cable is approximately a tenth of that of the line, so that the attenuation is greater, but a more serious difficulty is that very high losses occur due to reflection at the junction of the cable and the line. For this reason carrier currents cannot be used on power lines containing several sections of underground cable.

Interference Problems

Another difficulty in the application of carrier current to power lines is due to the high noise level. The noise is caused by radio interference due to spark discharges on the power line insulators. Interference of this type occurs over a wide range of frequencies and is relatively intense in the frequency band employed in carrier current technique. Even in dry weather the interference is appreciable, and in humid weather or in fog the line noise may increase to one hundred times the dry weather value. In addition to line noise due to discharges on the insulators, momentary interference is caused by the operation of isolating and earthing switches and oil circuit-breakers on the power system owing to the occurrence of arcing at the switch contacts.

The carrier current apparatus does not differ essentially from that employed in low-voltage carrier current

[1] T. W. Ross and C. Ryder. *J.I.E.E.*, 1938, Vol. 83, p. 228.

Carrier Current Communication—

practice. The essential requirement is that an adequate signal/noise ratio is obtained at the receiver under all conditions. The transmitter power and the receiver sensitivity are fixed on this basis from a consideration of the line noise and the attenuation in the line and coupling equipments. The simplest type of installation is the single-frequency transmitter and receiver used for the transmission of unmodulated signals in connection with automatic protective gear, as mentioned in the first part of this article. A schematic diagram of an equipment of this type is shown in Fig. 4. The transmitter consists of a Hartley master oscillator and a push-pull amplifier having an output of about 10 W; receiving-type valves are used. The receiver consists of one or two amplifying valves and a heavily biased output valve which operates the signalling relay in its anode circuit when the carrier signal is received. Apparatus of this type is kept in continuous operation, and reliability and speed of operation are the main requirements. Alarm relays are usually provided in the anode circuit of each valve in order to give an indication of valve failure, while means are incorporated for the approximate measurement of the mutual conductance of the valves in order that regular tests may be made to ensure that their characteristics are satisfactory.

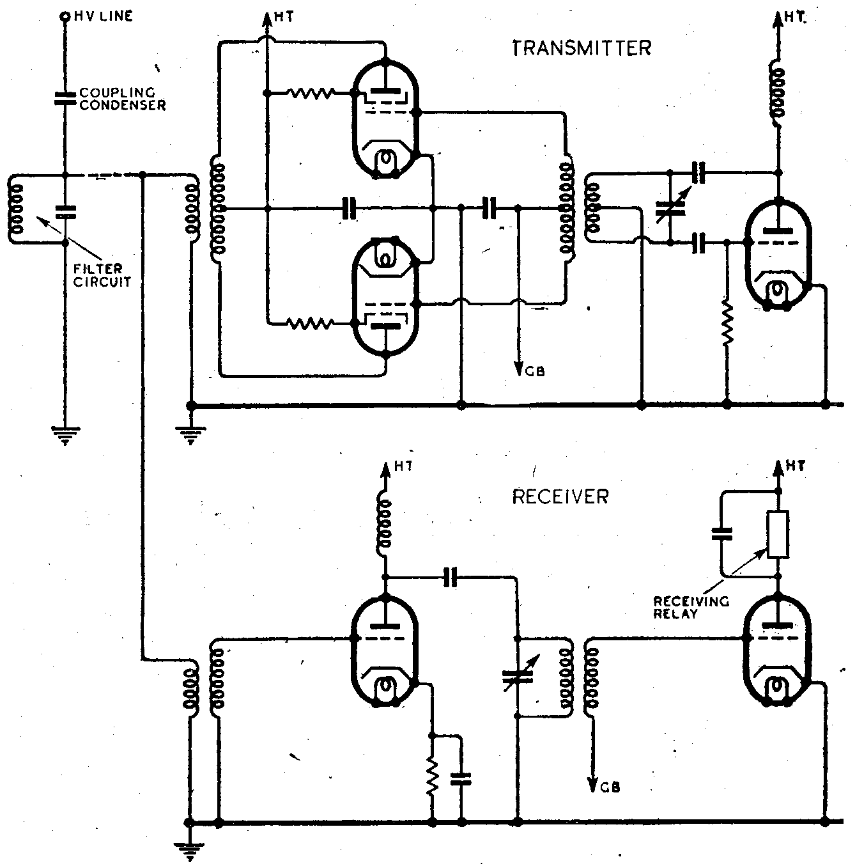


Fig. 4. Schematic diagram of a simple form of "wired wireless" transmitter and receiver.

It is possible to increase considerably the utility of this equipment without interfering with its primary protective function by using it for point-to-point telephone communication. For this purpose the oscillator output is modulated by speech before being applied to the amplifier, and a demodulator and speech amplifier are added to the receiver. Modulators and demodulators of the metal rectifier type are used in accordance with normal telephone practice. As only one frequency is available, the telephone channel is one-way or Simplex, i.e., the operator must change over manually from send to receive as in radio telephone practice. Another method is to effect the change-over automatically by means of voice-operated circuits which put the carrier on the line and block the receiver when transmitting, and *vice versa*. The number of facilities available on single carrier frequency apparatus can be increased still further by making use of modulated frequencies outside the speech frequency band. The useful audio frequency band is, say, 50-2,500 cycles, while satisfactory telephony can take place within a band of 200-2,200 cycles, so that, by using filter circuits several additional audio frequency signals can be transmitted below and above the speech frequencies. Such signals may be used for the remote indication of meter readings and other purposes. Carrier equipments with two or more carrier frequencies are in common use, and for Duplex or two-way telephony different carrier frequencies are used for the "Go" and "Return" circuits. Installations having two or more carrier frequencies, however, have the disadvantage of requiring more complicated carrier equipment and filter circuits. In addition, line traps must have a high impedance at all the carrier frequencies used. It is for this reason that there is a tendency to obtain as many facilities as possible with a single carrier frequency.

On the European continent carrier current communication is widely ap-

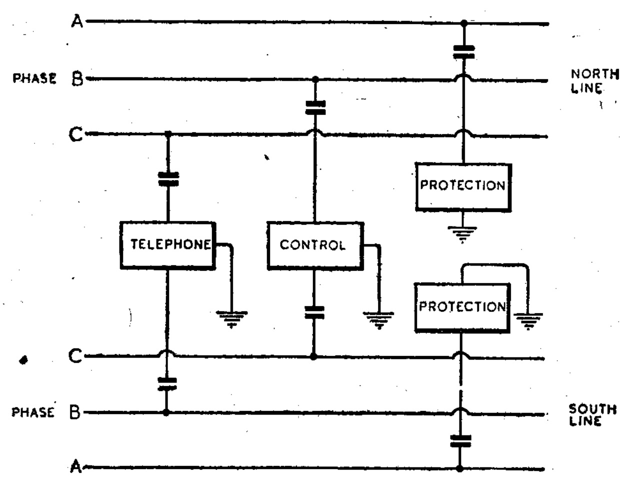


Fig. 5. Arrangement of carrier equipments on the Boulder Dam-Los Angeles lines.

plied to high voltage power systems at voltages up to 220 kV, e.g., on the French 220-kV network interconnecting the water power stations in the South and the steam stations in the Paris region. In Eire a carrier current telephone is installed on the 110 kV line between the Shannon water power station at Ardnacrusha and Dublin—a distance of 110 miles. Automatic exchanges are installed at each end of the line. There are many carrier current installations in the United States, but the most noteworthy is that of the 287 kV line between Boulder Dam and Los Angeles —a distance of 270 miles.[2] The installation is a very comprehensive one employing eight carrier frequencies for supervisory control, telephone communication and automatic protection. Single side-band suppressed carrier transmission is used for telephony. The line has two three-phase circuits, and the carrier sets are connected as shown in Fig. 5, the telephone and supervisory equipments each using two phases, while the protective equipments are connected between a single phase and earth. In the latter case it is only necessary to transmit signals when there is no breakdown on the line section in question, so that the single phase and earth system is satisfactory. Instructions can also be transmitted to maintenance men patrolling the line in cars equipped with radio receivers. The transmitters have an output of from 50-400 W, and the total power loss is about 30 db.

In Great Britain there have been fewer applications of carrier current to power lines, due mainly to the fact that, owing to the small size of the country, long transmission lines are not common. The first application was made in 1931 to the 132-kV line between Rannoch and Abernethy—a distance of 60 miles.[3] This installation is used for telephone and control purposes, separate carrier frequencies being used for each direction, the carrier and both sidebands being transmitted. More recent installations in Great Britain have been carried out primarily for line protection, although a subsidiary telephone channel is sometimes provided, as described in the previous section.

In conclusion, the above survey of a specialised branch of communication technique has necessarily been brief, but it should suffice to give an indication of the potentialities of carrier current superposition on power supply networks.

[2] J. D. Laughlin, *A.I.E.E. Trans.*, 1939, Vol. 58, p. 147.

[3] A. S. Valentine and E. M. Bergstrom. *J.I.E.E.*, 1935, Vol. 76, p. 125.

The Industry in Wartime

Annual Report of the Radio Manufacturers' Association

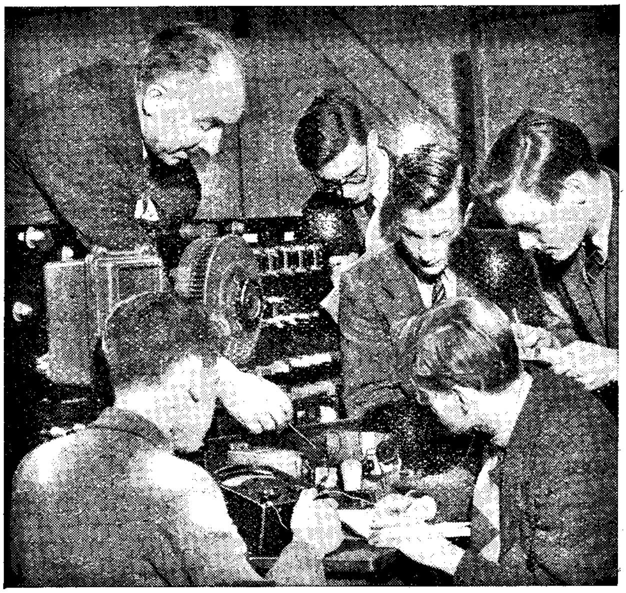
THE year 1941 was notable, so far as the industry was concerned, for vastly increased demands on the part of the Fighting Services for wireless apparatus in various forms. This expansion was such that, as is all too well known by the man in the street, difficulties arose regarding the supply of valves and certain components for civilian use.

It was announced at a meeting of the Radio Manufacturers' Association in August that negotiations were in train to co-ordinate, through the Ministry of Aircraft Production, the requirements of all three Services for specified components and materials in short supply. The scheme of co-ordination centred round the formation of an Inter-Service (Communications) Components Committee, on which the three Supply Ministries and the Post Office were represented, under the chairmanship of Air Commodore Leedham (Director of Radio Production, Ministry of Aircraft Production).

The component requirements of the Services will in the future be co-ordinated and arrangements made by this committee to direct the orders to the manufacturers with available capacity to produce them by the specified dates. It is within the purview of the committee to establish additional capacity for production where the existing facilities are found to be inadequate.

Throughout 1940 the policy of the Government was to develop exports from the United Kingdom to the "inexpansible maximum." In support of that policy it will be remembered that the R.M.A. formed the Radio Manufacturers' War Export Group, the aim of which for its first year's work (1940) was to achieve an export of some 120,000 receivers and maintain export in components and accessories amounting to some £360,000. The results actually achieved, as already reported, were: sets and radio-gramophones, 67,823, valued at £438,119, and components and accessories valued at £280,122.

The R.M.A. Report for 1941 states that because of the valve position, the export programme for the year author-



Trainee fault-finders and repairers at the South West Essex Training College. To create a reserve of trained personnel for future needs of the industry, a scheme providing 16 weeks of free training, fostered jointly by the Ministry of Labour, the Board of Education and the Radio Manufacturers' Association, has been introduced for boys and girls who have reached the School Certificate standard in physics and mathematics, or general science and mathematics.

ised by the Board of Trade amounted to some 75,000 sets. It was clear, therefore, that the original plans "aiming at a large expansion of export business, must be abandoned." The fact, however, is noteworthy that the actual export of both sets and components up to the end of October, 1941, exceeded those of the previous year which, "considering all the difficulties, must be considered as satisfactory."

Production Problems

The problem of civilian production, whether for the home market or for export, has been considered by the Council of the R.M.A. as one problem. So far as the home market is concerned it was considered that a minimum of a quarter of a million sets would be needed during 1941 to avoid serious interference with the reception of the home broadcast service. Production of receivers both for the home and export markets was, however, controlled throughout the year by the availability of essential components, particularly valves, and all plans were overridden by that factor. The report states "The rapid expansion of the Services' demands for radio equipment taxed severely the resources of the industry in many directions. In the case of valves it was apparent in the latter part of 1940 that supplies for civilian purposes would soon be most difficult to obtain. Further large increases in Government requirements of valves were notified at the beginning of 1941, and it then became clear that valves for civilian purposes would have to be drastically curtailed."

The original plan for the production of receivers for export alone involved the use of over a million and a quarter valves.

"It was beyond question," continues the Report, "that the requirements of the Services must come first; and capacity being found to be insufficient to meet all needs, a decision had to be made by the Government as to the extent to which civilian production was essential, and the relative importance of the maintenance of existing receivers and the production of new receivers, both for home and export markets."

Early in the year the Inter-Service Valve Production Committee — an organisation of the Services Departments set up to plan the production of valves for Government needs—and the Board of Trade went into the question of the supply of valves "for the completion of sets in an advanced stage of progress in manufacturers' works and for the continuance of the production of sets for export." At that time any immediate release of valves for civilian purposes could only have been made at the expense of Service needs, "a course which none of the negotiating parties, Government or industry, could contemplate for a moment." It was not until July that the Board of Trade announced the existence of a surplus of valves available for civilian purposes, and a plan of allocation was evolved.

The outcome of the negotiations regarding valves has left quite a considerable quantity of receivers, probably some 250,000, "in progress" still to be completed and equipped with valves during 1942. Negotiations are in progress to plan the programme of receiver production for 1942, based on the principle that this 250,000 "progress" receivers should be completed before expending labour and material on new sets.

It is reported that the R.M.A. Battery Committee has had protracted discussions with the Board of Trade regarding the present shortage of HT batteries required for the maintenance of civilian receiving sets. The various causes of this shortage have been defined to the Board and recommendations made for remedying them.

Seeking Substitutes

The work of the R.M.A. Technical Advisory Committee has, as would be expected, tended to become increasingly centred in the war effort. At the request of the Aluminium Controller, M.A.P., the Committee considered the possibility of using tinfoil instead of aluminium foil in the manufacture of paper dielectric condensers, and to furnish the Controller with an estimate of the amount of aluminium that would be saved by instituting such a change. No details of the outcome of the investigations are, however, disclosed in the Report.

The unsatisfactory behaviour in tropical climates of variable condenser vanes made of zinc, as a substitute for aluminium, was also considered by the Technical Advisory Committee. It is learned from the Report that, after a very thorough examination, the Committee reported that whilst there is no entirely suitable substitute for aluminium in the manufacture of condenser vanes for use in tropical climates, there seems to be no reason why sheet zinc should not be relatively satisfactory if rolled to the required thickness and tolerance, if suitably finished to guard against deterioration, and provided that precautions are taken to ensure that no material treated with linseed oil is enclosed in the same space as the zinc.

Brass of a soft drawing quality has also been found reasonably satisfactory if rolled to the necessary limits of thickness and flatness. The use of steel was not recommended for condenser vanes because of the impossibility of maintaining tolerances with this metal, the general risk of microphonic troubles which it introduces, and the excessive wear and tear on existing types of tools that its use would involve.

Consideration has been given during the year to the possibility of standardising existing bases and sockets for cathode-ray tubes and valves, and negotiations are progressing. It is pointed out, however, that there are many difficulties to be faced, but it is hoped that some advance may be possible.

Radiating Receivers

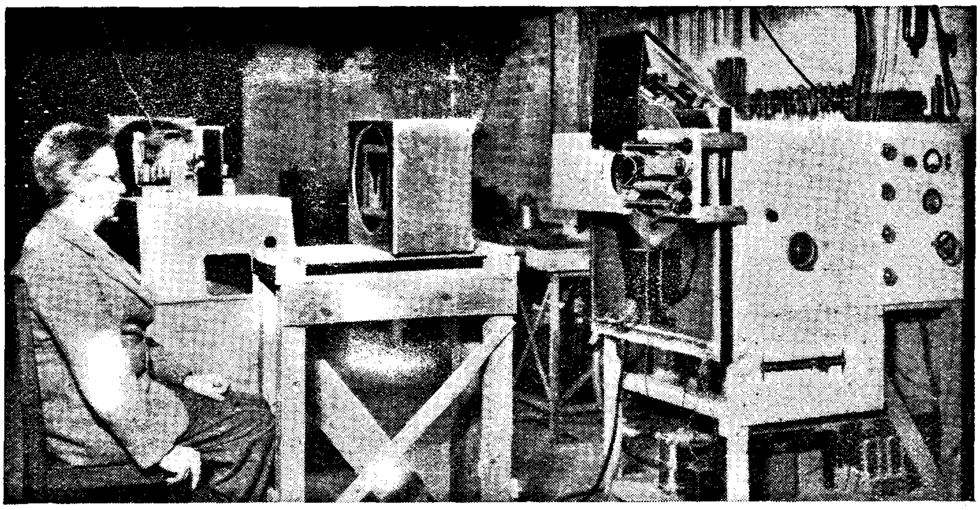
The Ministry of War Transport issued a memorandum in September defining the permissible radiation from broadcast receivers installed in foreign-going merchant vessels as not exceeding 0.1 microvolt per metre at one nautical mile distance, and stated that all receiving sets which do not comply with this condition must be dispensed with. The practical effect of this Order would be such as to place an embargo on the use of all normal domestic superheterodynes on board foreign-going merchant vessels, as it is stated that it is impossible for set manufacturers to give any undertaking that their sets comply with this standard of radiation. It is learned that the R.M.A. is in communication with the Ministry to obtain further information regarding the Order and its probable effects on the radio industry.

Reference is made in the Report to the R.M.A.'s representations to the Ministry of Labour regarding reservation ages of wireless engineers and mechanics, dry battery makers, PA engineers and clerical and office staffs. It is stated that these representations were almost entirely successful.

Post-war problems were also considered during the year under review. The great expansion in production of radio equipment and components for the Services will create for the industry a most serious problem when the war is over. It is pointed out that this problem will arise in three main forms: (a) Disposal of surplus Government stocks; (b) Absorption into the industry of skilled wireless personnel on their demobilisation; (c) Development of transmission systems, both sound and vision.

Stereoscopic Colour Television

Baird Gives Practical Demonstration for Individual Viewers



Mr. Baird checks the alignment of his stereoscopic colour television receiver.

ALTHOUGH much more work remains to be done before colour television in depth can be made available to theatre audiences, Mr. J. L. Baird has recently demonstrated the fact that a practical solution of the problem has been found for the individual viewer.

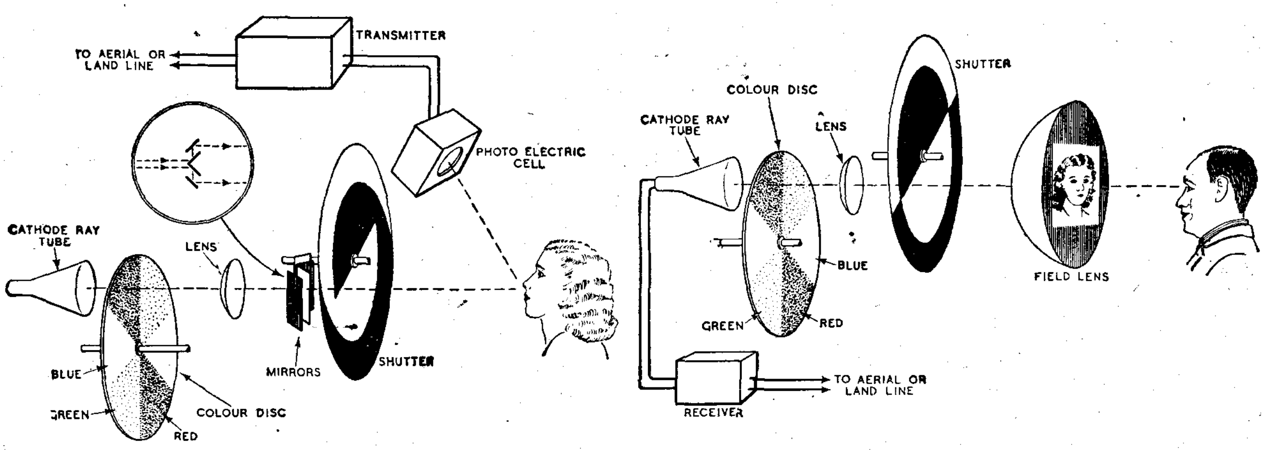
As in some of Mr. Baird's earlier 30-line demonstrations, it is necessary for the viewer to sit directly in front of an image-forming lens, and in this latest development, although the picture quality is vastly superior, the tolerance in the matter of movement of the head is smaller since the left eye must not know what the right eye is seeing, and vice versa. That is not to say that any special skill or endurance is called for in finding and holding the viewpoint which makes the picture "come to life," and one can readily accede to the inventor's suggestion that the system might be usefully employed in a "seeing telephone" system. The addition of colour and a third dimension would be of inestimable value in demonstrating samples, processes and a host of other subjects to which two-dimensional vision cannot do full justice.

A projection-type cathode-ray tube is used for scanning, the image of the spot being focused on the object by a lens. Complete 100-line frames are repeated 150 times per second, successive frames being scanned through green, red and blue filters, and interlaced five times to give a 500-line picture. In a previous Baird demonstration of colour television,[1] designed for broadcasting, a 600-line picture with 50 frames per second was used, there being only two filters, red and blue-green; but for the present purpose of demonstrating the optical practicability of stereoscopic images, no attempt has been made to restrict the side-band frequencies.

The original scanning beam after passing through one of the colour filters and the projecting lens is divided by pairs of parallel mirrors into two subsidiary beams spaced by a distance equal to the average separation of the human eyes. A revolving shutter with a special contour to correct geometrical scanning errors allows first one and then the other beam to scan the object in succession. Light reflected from object is picked up by sensitive photocells and the resulting current is made to modulate the transmitter.

At the receiving end the image formed on the screen of a cathode-ray tube is passed through synchronised

[1] *Wireless World*, February, 1941.



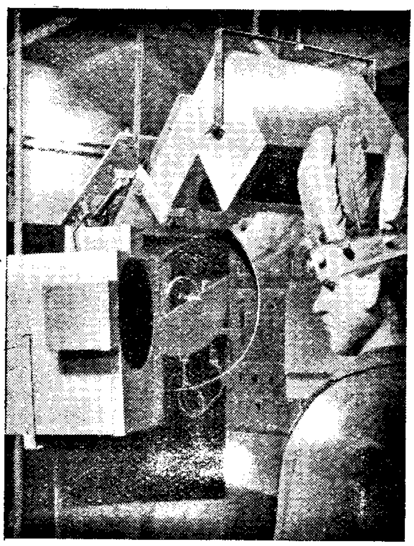
Schematic diagrams showing the principle of operation of the transmitter (left) and receiver (right).

Stereoscopic Colour Television—

colour filters and a revolving shutter which ensures that the alternating left- and right-hand images are reformed by the field lens in line with the appropriate eye of the viewer.

If the colour reproduction lacked the ability in this early experiment to differentiate the subtler shades, it dealt faithfully with the bolder colours. The stereoscopic effects were an unqualified success, and when the person being televised reached towards the "camera," his arm at the receiving end seemed to project out of the lens towards the viewer.

Mr. Baird is to be congratulated upon the success of this new step towards the ultimate ideal of complete illusion in television, and recognition should be given to his perseverance and detachment in keeping this particular line of research alive in war-time Britain.



Dummy figure with coloured head-dress used in experimental transmissions. The revolving shutter used to give alternate exposure to the dual scanning beams will be seen in the centre of the photograph.

Emergency Output Transformers

IN these days of limitations of supplies we are often content to adopt expedients, in order to keep our sets in working order, which in more normal times would cause the technical purist to shudder and pass into merciful oblivion. Thus, if the transformer which couples the output valve to the loudspeaker were to break down in peacetime, we should probably take the opportunity to fit a better one, if possible, than the loudspeaker manufacturer fitted initially. In these days, however, we should be lucky if we got a replacement of any sort.

However, there is no need to despair if a disused mains transformer or even a so-called bell-ringing transformer is available. The mains transformer will, if we are lucky, probably possess two separate filament windings, and these can be pressed into service as the secondary winding for connecting to the speech coil, the mains winding being used as the primary.

We have got quite a range of ratios available for a rough attempt at matching, as we can use one filament winding alone or can use the two in series or parallel. In the latter case, however, be careful to get the two windings connected in the same "sense," or they will cancel out. If a bell transformer is available, we have a tapped secondary labelled 3, 5 and 8 volts, the latter being the full winding. The three- and five-volt tappings will give us other ratios.

TELEPHONIC COMMUNICATION between company and battalion headquarters is maintained during manœuvres by this pack transmitter-receiver which employs a collapsible vertical aerial. This photograph was taken during exercises recently when "enemy" airborne troops landed and occupied a South Wales town.

Book Review

A Text-Book of Electricity and Magnetism. By G. R. Noakes, M.A., A.Inst.P. Pp. 513+x. Published by Macmillan & Co., Ltd., St. Martin's St., London, W.C.2. Price 8s. 6d.

As the author points out in his preface, this book is designed primarily for those taking the Higher School Certificate and University Scholarship examinations. Its usefulness, however, is by no means confined to such students, for it forms a valuable reference book to all in any way connected with electrical matters.

The value of the book lies largely in the stress which is laid upon fundamental matters and in the clarity of the treatment. Mathematics are freely used, up to and including calculus; a large part of the material can be understood, however, even if less perfectly, if the mathematics are skipped.

A valuable feature of the book is the clarity and precision with which the author defines his terms. In one case, however, his precision deserts him, for it is not always easy to find out which convention he is using for the direction of current flow. Since the old convention of a current flow from positive to negative in the external circuit breaks down with electronic devices, it has long seemed to the reviewer that no case can be made out for its further retention.

After dealing thoroughly with the fundamentals of electricity and magnetism, the author goes on to discuss alternating current and resonance phenomena. These are equally well treated, but it should be noted that Figs. 172 and 173 on pages 257 and 258 are reversed.

Among the chapters that follow are those dealing with Magnetic Materials, Thermo-Electricity, Electron Tubes, Atomic Physics, and Radioactivity. These are much less complete, but necessarily so, as many of the subjects call for a book to themselves. The chapter on Electron Tubes is very sketchy, especially the part dealing with the cathode-ray tube. Incidentally, Fig. 253, showing scanning in a television receiver, is incorrect, since it shows the frame scan as starting at the bottom of the picture and going towards the top. In modern television the scan stroke invariably starts at the top. The illustration shows the principle of scanning correctly, but does not agree with modern practice.

The book contains numerous questions for students, and where a numerical answer is required it will be found at the end. Log. tables are included, and there is an index.

The book can confidently be recommended to all seriously interested in the subject. W. T. C.

Constant Voltage Supply

Circuit Combining Partial Stabilisation of AC Input with Full Stabilisation of DC Output

By T. A. LEDWARD, A.M.I.E.E.

A DIRECT-CURRENT test supply of some hundreds of volts and tens of milliamperes is often required, and various means of ensuring constancy of voltage have been devised. Where, as is usual, the basic apparatus comprises a rectifier and smoothing unit, stabilisation is usually applied to the DC output circuit, but in some cases it is applied to the AC input.

If the AC input only is stabilised, the DC output volts will be stable at a fixed load, but will fall with increasing load in accordance with the normal regulation curve of the rectifier and smoothing unit. On the other hand, if stabilisation is applied to the DC output only, the output voltage can be made the same at all loads, but the voltages applied to the valves, including the rectifying and stabilising valves, will vary within the extreme limits of mains voltage variation. This is clearly undesirable in the case of heater voltages if the mains voltage variation is fairly large.

A combination of AC and DC stabilisation will remove the above disadvantages, but this becomes rather an expensive matter if the usual apparatus is adopted. The present writer, feeling the need for a stabilised supply for his own work, evolved the apparatus to be described, the main attributes of which are DC stabilisation within fine limits, following partial AC stabilisation of a much coarser variety. The DC stabilisation has then to operate over a much more restricted range, while the AC stabilisation, being only partial, can be satisfactorily carried out with relative simplicity.

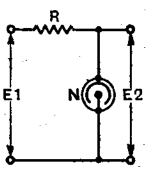
Although there is comparatively little voltage variation on the supply at present used by the writer, it was decided, in order that the apparatus should be generally useful, to aim at covering a range of AC input voltage of 200 to 260 with a normal voltage of 230.

The DC stabilising arrangement forms the most important part of the apparatus, and will be dealt with first. It will, if required, give stabilisation over the whole range of 200 to 260 volts AC input on full load, but without partial AC stabilisation the valves would be overrun at the higher voltage.

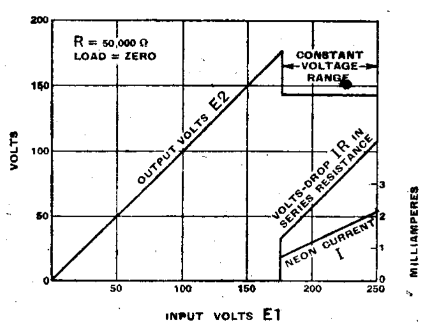
The principal item in the DC control circuit is a neon tube, so, before explaining the complete circuit arrangement, it will be useful to consider exactly how a neon tube behaves under changes of current and voltage.

Simple Neon Stabiliser

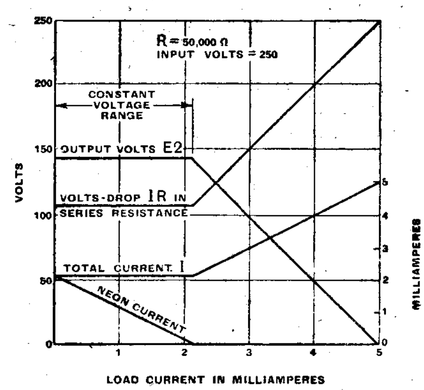
The simplest form of constant voltage circuit employing a neon tube is shown in Fig. 1 (a). The output voltage E_2 is equal to the input voltage E_1, minus the voltage drop in R. The latter drop is equal to IR, where I is the input current. Suppose there is no load connected across E_2, then as E_1 is raised E_2 will rise and will be equal to E_1 until E_1 reaches a value of approximately 170 volts, when the neon tube will glow, and E_2 will fall to 150 volts. The drop in R will then be 20 volts. Round figures are used here for simplicity. Curves illustrating an actual test of an "Osglim" lamp with the resistance removed from the cap are shown in Fig. 1 (b). If E_1 be increased, E_2 will remain at approximately 150 volts, while the current in N will increase so that its value at any instant will cause a voltage drop in R sufficient to compensate for the rise in E_1. R must, therefore, be of such a value that the maximum rise of E_1 will not cause an excessive current to flow through N. If a load be connected across E_2, the current through N will decrease by the amount of the load current, so that the total current, and therefore the voltage drop in R, will remain the same, and E_2 will be constant. This is shown in Fig. 1 (c).



(a)



(b)



(c)

Fig. 1. The neon tube as a stabiliser, with curves showing its operation. (b) Voltage stabilisation with varying input. (c) Voltage stabilisation with varying load.

These conditions are approximate, and this simple apparatus has certain limitations, the principal ones being a fixed output voltage and a very small current rating, the latter being limited by the rating of the neon tube. This circuit can, however, be combined with a thermionic valve in such a way as to control a much higher current and voltage.

Fig. 2 shows how the current rating may be increased. A negative bias is applied to the valve V by means of battery B, sufficient to reduce the anode current to zero with 150 volts on the anode. This negative bias is, however, only fully operative when the current through N is zero. Assume that N is passing current, then the voltage drop in R_1 due to this current opposes the bias due to B, thus reducing the negative potential on the valve V, and, when suitable conditions obtain, causing a flow of anode current. The flow of anode current will cause a voltage drop in R. (The drop in R due to the current through N will, in this case, be negligible.)

Now, if E_2 is to remain constant while E_1 varies, then the change of voltage-drop in R must at all times equal the change of E_1. The current through V must, therefore, change while the anode voltage remains constant. The change of anode current is, of course, brought about by a change of grid potential, and this necessitates a change of current through N and R_1. To increase the anode current, the voltage drop in R_1 must increase, and, if the voltage across N were to remain constant or were to rise, then the total voltage across N and R_1 in series would have to increase. From this reasoning it would appear that if E_1 were increased a small increase in E_2 would be inevitable, as E_2 is equal to the algebraic sum of the voltages across N,

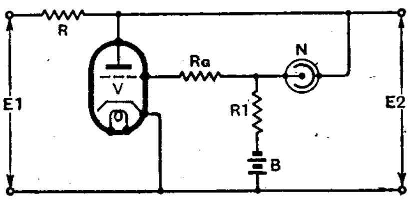


Fig. 2. Obtaining a greater stabilised output by using a neon tube to control a valve.

R_1 and B. *But this conclusion assumes that the voltage across N remains constant, or rises.* If, however, the voltage across N can be arranged to fall when the current through N increases, then the total voltage across N and R_1 can remain constant. That is what happens with suitable circuit conditions, and it is, in fact, possible to obtain a *decrease* of E_2 when E_1 is *increased*.

The diagram of Fig. 3 will serve to illustrate the action. In this diagram, which is self-explanatory, E_R, E_{R1}, E_N and E_B are the voltages across R, R_1, N and B of Fig. 2. The slope of the curves and general proportions are exaggerated for the sake of clarity. In an actual test, the neon volts were found to fall from 149 to 148.5 for an increase of current from 5.4 to 8.5μA. The series resistance was 0.25MΩ.

If the grid battery be replaced by automatic bias (see Fig. 4), the voltage E_B (Fig. 3) will not longer be constant, but will follow the variations of AC input. This does not detract in any way from the correct working of the apparatus. In practice, the neon current assumes a value which produces a stable condition in the circuit, and this stable condition can be

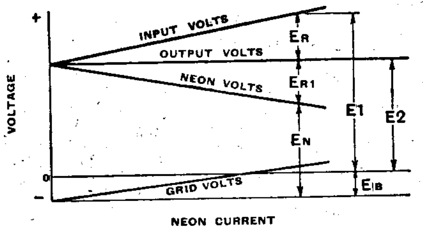


Fig. 3. Illustrating the operation of the stabilising circuit of Fig. 2.

made to correspond to either a level output characteristic or to one which slightly rises or falls. The resistance R_G is required for stability and to prevent a comparatively large current passing through N via the grid in the event of the grid becoming positive.

The voltage output from the circuit of Fig. 2 would be approximately 140 volts—allowing 10 volts for grid bias—but this may be increased to any desired value (limited, of course, by the available voltage at E_1). All that is needed is a potentiometer connected across E_2 with N connected to a tapping. This is shown at R_P in Fig. 4, which is a diagram of the complete circuit, including the usual rectifier and smoothing circuit. The partial AC stabilisation has also been added. The grid battery of Fig. 2 has been replaced by automatic bias obtained by means of a small half-wave metal rectifier M connected as shown. The smoothing of this grid-bias circuit must be effective, as any ripple would be superimposed on the output voltage.

As the valve V carries what might be termed the "surplus" current at any time—the total DC current for any particular AC input voltage being constant, irrespective of external load—it is clear that if the control is to be effective from no load to full load, the valve must be capable of carrying at least the full output current. It is also clear that if, when the input voltage is low and there is no external load, the valve carries a current equal to normal full load, then when the input voltage is high the valve must take a current, under no-load conditions, which is higher than normal full load. Another point with regard to suitable valves is the effect of the negative bias voltage on the operation of the neon tube. The negative bias voltage is included in the voltage applied to the neon lamp circuit, but not in the output voltage, so that a high negative bias voltage will limit the effective range of the stabiliser circuit.

Choice of Valve

Heavy-current, steep-slope valves are, therefore, indicated, and the "Harries" tetrode type has been found to be the most satisfactory. For the present purpose these tetrodes may be connected as triodes or in the manner shown in the diagram (Fig. 4), which is rather better.

Two such valves (Hivac AC/Z) are shown in parallel in Fig. 4, and, with the component values shown, this circuit gives a sensibly constant output voltage of 200 from no load to 60 mA when the AC input is varied from 190 to 270 volts. This easily covers the range of 200 to 260 volts originally aimed at. Alternative valves of the tetrode type are the Osram KT41 or

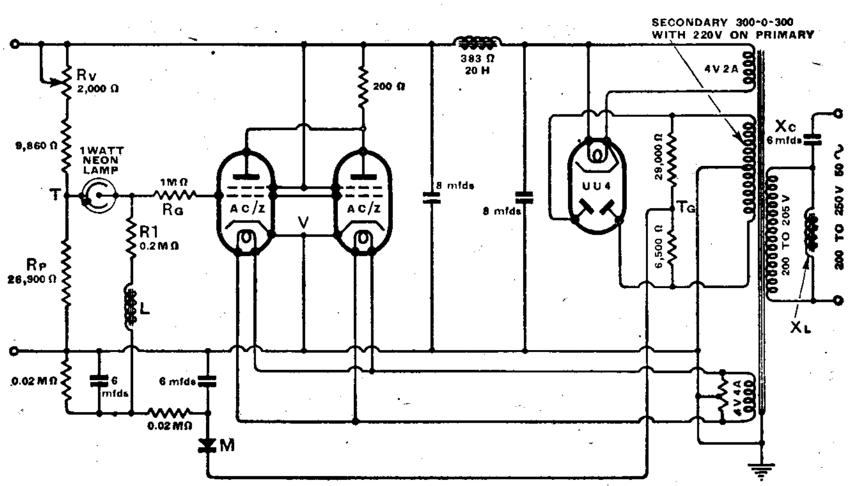


Fig. 4. Complete power supply unit, with both AC and DC stabilisation.

Constant Voltage Supply—
the Cossor 42 OT. These valves have not been tried in this circuit, but should be quite satisfactory without alteration of component values. Another valve that should give good results, but would require some alterations in resistance values, is the Brimar PA1, a high-slope output triode. It is suggested that if this latter valve be tried, the potentiometer tap T on the neon potentiometer RP should be variable. Also, the tap TG on the AC potentiometer for grid-bias rectifier supply should be variable. These two taps could then be adjusted on test to give best results. R1 might also need some adjustment.

The neon tube is of the 1-watt indicator type, and the resistance has been removed from the cap. It will be noticed that there is no special series resistance in this circuit to take the place of R in Fig. 2, as the resistance of the smoothing choke is sufficient for the purpose. With a mains input variation of 200 to 260 volts, the transformer input only varies from 205 to 225 volts owing to the partial AC stabilisation. It will thus be seen that the valve filaments are never overrun.

Avoiding Parasitic Oscillations

The choke L prevents oscillations in the neon circuit which are otherwise liable to occur and would appear as a ripple on the output voltage.

The curves in Fig. 5 (a) show the performance with 4 mA and 60 mA loads. It will be noticed that a slight fall of output occurs with rise of input volts on light load. Both curves were taken with the voltage adjustment set for 200 volts on full load. Fig. 5 (b) shows the control exercised by the partial AC stabilisation. The tests were made after the apparatus had been left in circuit for half an hour, although a few minutes warming-up suffices for ordinary use.

The 2,000Ω variable resistance Rv allows an exact setting of the output voltage under any conditions. The total adjustment provided by this means is $\pm 2\frac{1}{2}$ per cent. If a large voltage adjustment is required, the tapping T on the potentiometer should be variable.

Turning now to the partial stabilisation of the AC input, the reduced voltage-change is effected by connecting a condenser Xc (Fig. 4) in series with a choke XL and connecting the transformer primary across the choke. As XL has an iron core that is operated near saturation point, its reactance varies considerably with variation of current. As the choke is in parallel with the transformer primary, the two can be considered as a single inductive impedance varying with current value and in series with the condenser Xc. The whole forms a series resonant circuit which, if the supply frequency be fixed, will resonate at a particular current value.

The actual resonance condition is not required for the present purpose, but with a resonant circuit of this kind it is possible to obtain across either the choke or condenser separately a voltage that is higher than the applied voltage across the two in series. Thus, with 200 volts input, the voltage applied to the transformer primary is 205 in the present case. If the input voltage be increased, thereby increasing the current through the choke and reducing its impedance, the output voltage across the choke will obviously not increase at the same rate as the input voltage, a point being reached where the output voltage becomes less than the input—see Fig. 5 (b).

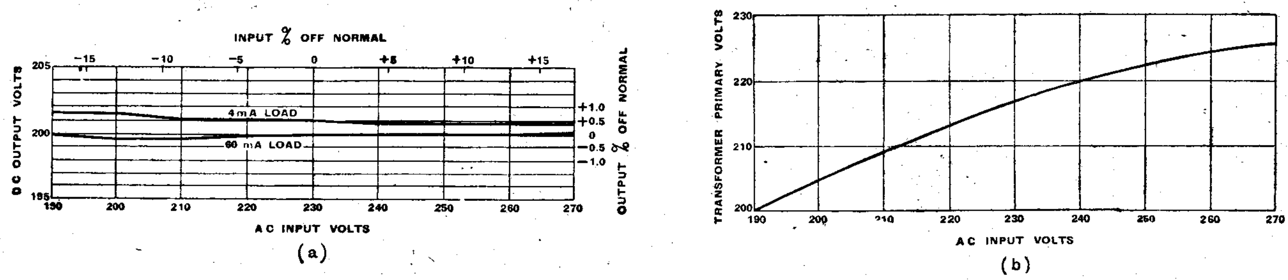


Fig. 5. Curves showing performance for DC and AC stabilisation.

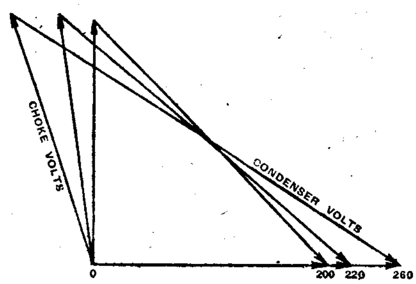


Fig. 6. Vector triangles to illustrate operation of the AC stabiliser.

In Fig. 6 vector triangles have been drawn for three different input voltages in order to indicate more clearly what happens in a circuit of this kind. It would be of little use to give details of the choke as this must be made to suit the particular transformer employed. Incidentally, it should be possible to design the transformer itself to have the necessary variable impedance characteristic and so dispense with the choke. The addition of the choke, however, allows the main equipment to be of standard form.

Choice of Components

Most of the components in the apparatus described may vary in value within fairly wide limits without much affecting the satisfactory performance, and the changing of valves and neon tubes for new ones of the same type will not usually necessitate adjustments in other parts of the circuit. There is one resistance assembly, however, that must not be subject to appreciable resistance variations due to changes of temperature, etc., and that is the potentiometer assembly which provides a voltage tap for the neon tube. This must be wire-wound and of good quality.

A precaution should be noted with regard to valve connections: a short bridge-wire should join the two screen grids, from which a single wire should be taken to the positive supply. The reason for this may seem rather obscure, but it entirely prevents self-oscillation at ultra-high frequency which can occur with certain other arrangements of connections. If such oscillation is permitted it will interfere with the stability of the output voltage.

It is an advantage, although not essential, to screen the neon tube. This has been done in the present apparatus by means of a coating of "Aquadag" (colloidal graphite) applied to the glass bulb and connected to the negative output terminal, which is earthed.

UNBIASED

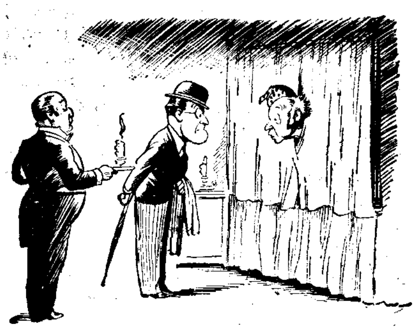
By FREE GRID

1066 and All That

I HAD rather a shock a few days ago when I was invited by a member of *The Wireless World* editorial staff to accompany him to a meeting of the I.E.E. Wireless Section. I was very greatly irritated by the behaviour of my companion, who, during the discussion period, was fidgetting uncomfortably in his seat and betraying every symptom of uneasiness, so much so that I began to wonder whether I had not, at last, hit on the real reason why it is that editors and their puppets invariably use the archaic "we" when referring to themselves in their respective journals.

It was not until we got outside after the show was over that I learned the cause of my companion's extraordinary behaviour. It appeared that he had been irritated because he had wanted to take down, there and then, certain observations made during the discussion period without waiting for the official report. Thinking that he must have inadvertently left his portable steel-wire recorder in the taxi in which we had arrived, I expressed my sympathy, only to be told that he possessed no such article, and that what was annoying him was that he had no knowledge of shorthand.

For a moment I could only stare stupidly at him, as I could scarcely credit that any member of the staff of a wireless journal which, apart from "covering every wireless interest," counts electrical recording as being also among its lawful prey, should rely on so archaic a method of recording the human voice as shorthand.



Bedtime story.

In fact, the whole affair made such a very deep impression on my mind that I began to wonder dimly whether the Editor of the *Wireless World* himself still arrived at the office each morning in his own horseless carriage and was gently wafted upstairs in an old hand-cranked lift to a quiet and peaceful office which knew not women with their ceaseless chatter and their noisy typewriters, but was served by staid middle-aged clerks who plied their quill pens gently under the flickering light of the gas jets, breaking off from time to time as they were summoned to the Editor's presence by a restful tinkling from the row of old Victorian pull-bells over their heads.

Probably, I mused, in this haven of old-world peace, the raucous voice of the loud-speaker was never heard, but the news bulletins (bringing tardy tidings of the relief of Mafeking) came in on the morse inker to the gentle accompaniment of the de-coherer tapping softly on the coherer while the imperious and shrill-voiced summons of the telephone never disturbed the peaceful drowsiness of a summer afternoon, its place being taken by the gentle warbling of the speaking-tube.

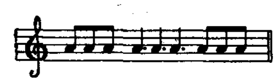
I was so lost in my musings that I nearly got run over by a very horseless carriage in the Strand, which had the effect of bringing me back to harsh reality, and I jumped hastily into a taxi with the determination that, late as the hour was, I was going to see the Editor in person about the matter, even if it meant rousing him from his old four-poster and interviewing him in nightcap and nightshirt by the light of a guttering candle.

Morse Mucked-up

IT is astonishing what a large number of morse-learning books there are now upon the market, under various fancy titles such as "Telegraphy without Tears." Although I have carefully studied all of them I must confess that, much as it goes against the grain to admit it after my recent difference of opinion with the Editor, in which I found it necessary to return my *Wireless World* tie to him, none of them makes me regret the sixpence I spent on the original edition of the *Wireless World* morse booklet.

Yet when all is said and done, even the *Wireless World* book is far from perfect, as in spite of the fact that at the outset it warns me to memorise rhythmic sounds rather than graphical symbols, it tells me later on that the letter A is represented by • —, the letter B by — • • •, and so on. Now this just isn't true in any system of telegraphy, nowadays. It disappeared, in the case of wireless communication, about the year 1902, when we threw our coherers and morse inkers overboard and started to use headphones and a magnetic detector.

There seems to be as much muddy thinking about this matter as there is about economics, judging from the recent unseemly wrangle in the columns of *Wireless World* between the Editor and one of his correspondents about "immutable economic laws." A man who ought to know better has tried to tell me that the writing down of the morse code as a series of dots and dashes on paper is analagous to a musical score, which a skilled musician can "read" as easily and quickly as we more earthly folk can read the betting news. It is nothing of the kind, of course, as you



Try this on your piano.

can easily prove by asking a skilled wireless operator to read a message written down in dots and dashes and watching the hopelessly halting hash he makes of it.

To my mind the only way of teaching morse to the budding wireless operator is to eschew all mention of dots and dashes and let him learn the rhythmic sounds straight away. In the case of the lone learner with nobody to help him, this obviously means gramophone records, but unfortunately gramophone records are clumsy things and cannot be included in a sixpenny booklet.

Therefore, we must find some system of representing rhythmic sounds by means of printers' ink, and we do not need to look very far, for what else is a musical score than a method of representing rhythmic sounds by means of printers' ink. It may be argued that only a very small percentage of people understand even the simplest musical score. This is so, of course, but still fewer people know anything about dots and dashes. Therefore, as they have got to learn one or the other, they might as well learn the simple musical score method which, once they have learned it, will always conjure up rhythmic sounds in their minds, which is more than can be said for dots and dashes. To my mind, the dot-and-dash system is just morse mucked-up. No doubt, however, the *Wireless World* booklet will serve as an efficient stopgap until I can find time to produce something better myself.

THE WORLD OF WIRELESS

STANDARDISING AMATEUR GEAR

U.S. National Defence Plan

STANDARDISATION of ultra-high-frequency radio equipment for amateur civil defence radio networks, is proposed by the American Radio Relay League.

It is planned to make the separate units of 112-Mc/s emergency stations, as constructed by individual amateurs, universally interchangeable through use of a standard system of plug and socket cable connection and the adoption of standard voltages and currents.

Because of the probable failure of power supplies, it is essential that the apparatus should be self-contained. Since, however, there is a shortage of dry batteries because of military requirements, a widely available vibrator-type of power supply equipment, delivering approximately 30 watts from a 6-volt accumulator, has been selected as the source of power.

PRICE REGULATIONS

THE continued shortage of new receivers has encouraged a certain class of undesirable retailer to increase the price of sets. Whilst *The Wireless World* is frequently receiving complaints from indignant purchasers, few of them seem to realise that machinery has been set up by the Government to deal with such cases, but that only when the cases are notified can they be investigated.

The Price Regulation Committee in each area, the address of which should be available at Town Halls and Borough Offices, are very anxious to be informed of such irregularities, and readers will be doing the industry and the general public a service by doing so. The address of the Price Regulation Committee for the London area is Belgravia Chambers, 72, Victoria Street, S.W.1.

AERIAL DESIGN

IN a paper on "Aerial Characteristics," read before the Institution of Electrical Engineers on January 7th, Mr. N. Wells made a valuable contribution to the study of aerial design for broadcasting on medium and long waves. Starting from basic physical formulæ for radiation from vertical antennæ, the author considered the modifications introduced by current retardation and showed the basic principles in the design of anti-fading aerials of the straight vertical and folded-top types.

FUEL ECONOMY

Broadcasting Stations and Receivers

SIR ALLAN POWELL, chairman of the Board of Governors of the B.B.C., when asked recently if the Corporation intended acting upon the recommendation of the Government Select Committee that the B.B.C. should close down at 10 p.m., thereby saving the fuel required for the transmitters and for the millions of receivers, pointed out that if that were done the enemy would very soon take the opportunity to use the unoccupied wavelengths for propaganda purposes.

The question of the fuel consumed by receivers has been the subject of correspondence in *The Times*, where one writer stated that they used 1,000,000,000 units a year, equivalent to a million tons of coal, which, according to the 1938 figures, represents a fourteenth of the coal used by the generating stations. This figure, however, appears to be very wide of the mark. On the assumption that 7,000,000 of the 9,000,000-odd receivers are mains-operated, that each one consumes 50 watts and that it is used for four hours a day, the total current consumption is 511,000,000 units a year. Even this figure is considerable, for it is probably 3 per cent. of the electricity generated.

NEW YEAR HONOURS

Services of the Wireless Fraternity Rewarded

AMONG the many members of the wireless fraternity who received honours in the New Year list was Sir Frank E. Smith, Controller of Telecommunications Equipment, who was awarded the Grand Cross of the Order of the Bath for services to the Ministry of Aircraft Production and Ministry of Supply. Mr. A. P. Rowe, Superintendent, Telecommunication Experimental Establishment of the Ministry of Aircraft Production was created a Commander of the Order of the British Empire. Air Commodore H. Leedham, who is Director of Radio Production in the Ministry of Aircraft Production and chairman of the Inter-Service (Communications) Components Committee, was made a Companion of the Order of the Bath.

Among the many appointments and awards for "outstanding zeal, patience and cheerfulness, and for setting an example of wholehearted devotion to duty, without which the high tradition of the Royal Navy could not have been upheld," was the Distinguished Service Medal to P.O. Telegraphist L. H. Flanagan and A.P.O. Telegraphist R. E. R. Richards. Telegraphist Lt. S. H. Hewison, R.N.,

WOMAN'S INVASION of the hitherto predominantly masculine field of wireless continues, and an A.T.S. Wireless Training Battalion has been formed in the Southern Command. Here the girls are seen at morse practice with the help of a Creed Teacher, while our cover illustration shows them doing practical work with a field set.

The World of Wireless— was made a Member of the Order of the British Empire.

Two First Radio Officers in the Merchant Navy, W. S. Cardwell and J. Clarkson, were made M.B.E.s. A civilian wireless operator in the R.A.F. Coastal Command, C. F. Wheeler, was awarded the British Empire Medal.

Five Chief P.O. Telegraphists were awarded the British Empire Medal.

Two B.B.C. officials were honoured. Val Gielgud, Director of Features and Drama, and Miss M. H. Wace (Mrs. O. Wilson), Empire Talks Director, were created Officers of the Order of the British Empire.

VACATION APPRENTICESHIP SCHEME

Practical Experience for Students

FOR some years a scheme has been working whereby students at the Imperial College of Science and Technology have been enabled during the long summer vacation to obtain practical experience with manufacturers.

There is a large number of students studying electrical communication at the College, many enjoying State Bursaries, and some will be desirous of obtaining the practical experience that this scheme affords. During this year's summer vacation more than 300 students will be available for varying periods of from 6 to 8 weeks. This number constitutes a record. Although there are more than a dozen firms in the wireless industry co-operating in the scheme, the organiser, Mr. J. Newby, wants to extend this list, and asks us to draw manufacturers' attention to the scheme. He will gladly give information to interested manufacturers if they will communicate with him at the Imperial College, Prince Consort Road, London, S.W.7.

Last year's 181 students worked for a total of 981 weeks with 124 firms and received a total payment of £1,466.

WCRC ON THE AIR

THE new 50-kW short-wave station of the Columbia Broadcasting System, WCRC, which has been erected at Brentwood, Long Island, New York, is scheduled to begin a regular service on January 25th. The station has been granted permission to operate on the following frequencies: 6.06, 6.12 6.17, 9.65, 11.83, 15.27, 17.83, 21.52 and 21.57 Mc/s. It will operate in conjunction with WCBX, which was recently moved from Wayne to Brentwood. Eight of the thirteen aerial arrays will be directed towards Latin America.

"AUTOMATIC" AIRCRAFT NAVIGATION

Dual Direction Finders

ACCORDING to a report in *Flying* (U.S.A.) it would appear that the Civil Aeronautics Administration of America is using a dual automatic direction finder, of which the possibilities were foreshadowed by J. A. McGillivray in *Wireless World* for January 26th, 1938. The apparatus is installed on board a twin-engined "laboratory plane" which has just been put into commission by the C.A.A. with the object of keeping its inspectors abreast of technical developments.

The automatic navigator comprises two interconnected direction finders, with their pointers operating on the same azimuth scale. Different stations are tuned in on the two sets; if, to take a very simple example, the stations chosen are at the aerodromes of departure and destination, all the pilot has to do is to manœuvre his aircraft so as to keep the pointers in a straight line.

BRITISH SPONSORED PROGRAMMES?

MR. W. E. GLADSTONE MURRAY, general manager of the Canadian Broadcasting Corporation, is reported as having told the Washington, D.C., journal, *Broadcasting*, on his return from England, that the British Government has under consideration the erection after the war of a number of commercial broadcasting stations in the Crown Colonies.

The proposed stations, which would operate on the medium and short wavebands, would not be connected with the B.B.C., but would be under official Government control. Mr. Murray stated that the stations would operate individually, and in networks between various colonies.

U.S. RADIOLOCATION

A NEW radio device to locate ships and aircraft hidden from the human eye has been announced by the U.S. Navy Department. According to *Broadcasting* it is thought to be similar to our radiolocators. Skilled personnel to maintain the "Radars," as the apparatus is called, must have had experience in the design, construction and operation of UHF transmitting and receiving equipment, or experience with television and cathode-ray equipment. Accepted applicants will be enlisted in the Naval Reserve.

Mr. R. A. Watson Watt, whose name is so closely linked with radiolocation, has, incidentally, been on a visit to the U.S.A. during the past month.

VALVE PRODUCTION

Statement by Board of Trade

"THE President of the Board of Trade appreciates the importance of keeping the maximum number of wireless sets in commission, subject to the overriding claims of the Services, and hopes to ensure that a sufficient supply of suitable valves will be available. The present production of most types of British valves should shortly be sufficient to meet the home maintenance demand, and the possibility of importing any necessary balance of valves of American types is under consideration."

This statement was made in reply to a question recently raised in the House of Commons asking whether the President of the Board of Trade was aware that a number of radio sets in the country were unusable owing to the shortage of valves.

RADIO OFFICERS REWARDED

FIRST RADIO OFFICER F. W. T. McGOWAN, of a merchant vessel which was set on fire and later sunk as a result of enemy action, has been awarded the George Medal. After transmitting the distress call he was trapped in his cabin with three others, but forced his way out and returned three times to release the others, two of whom were seriously injured.

Another first radio officer to be honoured is B. H. Smith, who is created an M.B.E. His ship was torpedoed and so badly damaged that she had to be abandoned, but before doing so he sent out signals on the emergency transmitter.

In the latest list of awards of Lloyd's War Medal for Bravery at Sea is the name of Chief Radio Officer N. W. Campbell.

TELEVISION IN FRANCE

ACCORDING to French newspapers which have recently reached London, television in France is by no means dead.

A demonstration recently given at Lyons to the press, by M. Henri de France, President of Radio-Industrie, showed a new system of large-screen television followed by reproduction on a convex home screen about 14 by 12 inches. Definition was 567 lines.

It is proposed to recondition the Eiffel Tower television station and to build two other stations, one at Lyons and the other at Marseilles. Two to three years are indicated as the time which will elapse before television will become general in France. Individual receiving sets will, the writer says, cost 12,000 francs each, which at pre-war exchange would represent a little over £68.

FROM ALL QUARTERS

FM Link

A FUNDAMENTAL application of frequency modulation has been introduced by the National Broadcasting Company. As an additional safety factor against interruption in the transmission due to line failures, the key stations of the two N.B.C. networks WEAF and WJZ, have been equipped with FM receivers. These will be kept tuned to the N.B.C.'s experimental FM station W2XWG, in the Empire State Building, which would be employed to transmit the programme if the lines broke down.

R.M.A. Council

THE number of members on the Council of the Radio Manufacturers' Association has this year been increased from 12 to 18. This number includes 12 set and/or valve manufacturers and six component and/or accessory makers. After its election at the annual general meeting on December 12th, the Council elected Mr. M. M. Macqueen (G.E.C.) as chairman and Mr. E. J. Power (Murphy) as vice-chairman. The Rt. Hon. Lord Hirst of Witton was unanimously re-elected president of the Association.

Marconi-Ekco

AT the annual general meeting of E. K. Cole, Mr. W. S. Verrells, the chairman, announced that the company had sold the whole of its share interest in Marconi-Ekco Instruments. The accounts for E. K. Cole for the eighteen months to September 30th shows a net profit of £70,076.

B.B.C. News

THE transmission of news in English in the B.B.C.'s European and World Services are tabulated below. Times are given in BST.

0200: 49.10, 31.32, 30.53, 25.53.
0300: 49.10, 31.32, 30.53, 25.53.
0530: 49.10, 31.32, 25.53.
0715: 49.10, 42.46, 31.55, 31.25, 25.53, 19.60.
0900: 49.59*, 41.49*, 42.46, 40.98*, 31.55, 30.96*, 25.53, 25.29*, 19.82, 19.66, 19.60, 16.86, 16.84.
1200: 31.86, 25.53, 19.82, 16.84, 16.77, 16.64, 13.97.
1400: 25.53, 19.82, 16.84, 16.77, 16.64, 13.97.
1700: 19.82, 19.66, 16.84, 16.77.
1900: 49.10, 48.54, 31.86, 19.82, 19.66, 16.84.
2145: 49.10, 31.25, 25.68, 25.53, 19.82.
2215: 49.10, 31.32, 30.53, 25.53.
2300: 49.59*, 41.96*, 41.49*.
2345: 49.10, 31.32, 30.53, 25.53.

Wavelengths marked with an asterisk are used in the European Service only.

New Stokowski Recordings

IT is reported from America that for Leopold Stokowski's latest gramophone recording session, when one hundred recordings were made in ten days, a new technique was employed. All the music was first recorded on film sound-tracks and then "dubbed" on to discs. This method enabled Stokowski, in the re-recording process, to manipulate the dynamic range to suit his wishes.

FM Receivers

A TOTAL of more than 120,000 frequency-modulation receivers are now in use in American homes, according to a report recently issued by FM Broadcasters Inc. At the beginning of 1941 there was approximately only 15,000 FM sets in use. It is estimated that manufacturers were turning out 1,500 receivers a day at the outbreak of the war in the Pacific.

I.E.E.

FREQUENCY modulation will be the subject discussed at the informal meeting of the I.E.E. Wireless Section on Tuesday, January 27th, at 5.0, when Mr. D. A. Bell will open the discussion. For the second half of the 1941-42 session, which begins in February, the Council has decided to alter the time of meetings to 6 o'clock. The first meeting of the Wireless Section in February will be held on Wednesday, 4th, when Mr. O. S. Puckle will give his paper on time bases.

Brit. I.R.E.

DESCRIBING the radio profession as the practice of the youngest branch of engineering, Mr. Leslie McMichael, recently elected vice-president of the British Institution of Radio Engineers, stated that "the necessity for the existence of a professional body devoted solely to radio and allied engineering cannot be disputed in this age of specialisation."

Transmitting valves is the subject of the paper to be given by Mr. L. Grinstead at the meeting of the Brit. I.R.E. at 21, Tothill Street, Westminster, S.W.1, on Saturday, February 7th, at 3 p.m. The next Midlands Section meeting will be held on February 27th at the James Watt Memorial Institute, Birmingham, when Mr. G. Bernard Baker will read a paper on thermionic frequency control.

Obituary

WE regret to record the death at the age of 63 of the Right Hon. H. B. Lees-Smith, who was Postmaster-General from 1929-1931 in the second Labour Government.

NEWS IN ENGLISH FROM ABROAD

REGULAR SHORT-WAVE TRANSMISSIONS

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
America			
WNBI (Bound Brook)	15.130	19.83	2.15, 3.0‡, 4.0‡, 6.0†.
WRCA (Bound Brook)	17.780	16.87	2.15, 3.0‡, 4.0‡, 6.0†.
WGEO (Schenectady)	9.530	31.48	9.45 a.m., 9.0†, 10.55§‡.
WGEA (Schenectady)	15.330	19.57	7.45§‡, 9.55§‡.
WGEA	9 55	31.41	9.45 a.m.
WBOS (Hull)	11.870	25.27	2.0, 3.0, 5.0, 9.0, 12.0 midt.
WCAB (Philadelphia)	6.060	49.50	2.55 a.m., 6.0 a.m.
WCBX (Wayne) ..	11.830	25.36	7.30‡, 8.15†, 8.45§‡, 11.30.
WCBX	15.270	19.65	2.0, 5.0§‡.
WRUL (Boston) ..	9.70	30.93	12.15 a.m.‡.
WRUL	11.730	25.58	12.15 a.m.‡.
WRUL	11.790	25.45	9.30‡, 11.15§‡.
WRUL	15.350	19.54	5.0*, 9.30‡, 11.15§‡.
WRUL	17.750	16.90	5.0*.
WLWO (Cincinnati) ..	15.250	19.67	5.0‡, 8.0†.
Australia			
VLR7 (Lyndhurst) ..	11.840	25.34	5.20.
Egypt			
SUX (Cairo)	7.865	38.14	6.50, 10.10.
French Equatorial Africa			
FZI (Brazzaville) ..	11.970	25.06	8.45.
India			
VUD4 (Delhi)	9.590	31.28	9.0 a.m., 1.30, 4.50, 6.15.
VUD3	11.830	25.36	1.30.
VUD3	15.290	19.62	9.0 a.m.
Sweden			
SBO (Motala)	6.065	49.46	10.20.
Turkey			
TAP (Ankara).. ..	9.465	31.70	8.15.
TAQ	15.195	19.74	1.15.
U.S.S.R. (Moscow)			
31-metre band ..	—	—	7.0, 8.0, 9.0, 10.15.
Vatican City			
HVJ	6.190	48.47	8.15.

MEDIUM-WAVE TRANSMISSIONS

Country : Station	kc/s	Metres	Daily Bulletins (BST)
Ireland			
Radio Eireann.. ..	565	531	1.40‡, 6.45‡, 6.50†, 10.0.

It should be noted that the times are BST—**one hour** ahead of GMT—and are p.m. unless otherwise stated. The times of the transmission of news in English in the B.B.C. Short-wave Service are given at the top of the page.

The American stations are now transmitting bulletins in addition to those tabulated as and when the necessity arises.

* Saturdays only. § Saturdays excepted. ‡ Sundays only. † Sundays excepted.

In-phase Amplifier

By R. C. WHITEHEAD

Designing a Non-phase-reversing Stage

THE ordinary resistance-capacity amplifying stage has an output voltage which is 180 degrees out of phase with respect to the input voltage. In the design of vision-frequency amplifiers, pulse-generators, multi-valve oscillators, etc., it is sometimes found that, while sufficient gain can be obtained with a given number of valves, this combination produces the wrong number of phase reversals. To avoid adding a valve, the gain of which is not required, one of the stages can be made into a non-phase-reversing stage.

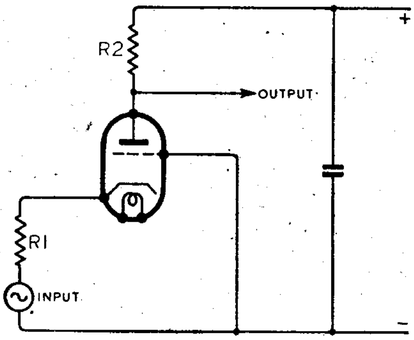


Fig. 1. Basic circuit arrangement : normal connections to grid and cathode are reversed.

Fig. 1 shows the fundamental circuit of a non-phase-reversing stage. Instead of the cathode being connected to earth and the input being applied between grid and earth, the *grid* is earthed and the input is applied between *cathode* and earth.

In Fig. 2 is shown the circuit of a practical non-phase-reversing stage. Because the input and output voltages are in phase, and because the grid acts as an earthed screen between input and output,[1] a triode valve can generally be used in cases where otherwise it would be necessary to use a pentode.

The condenser C1 and the resistance R3 have been introduced in order to avoid passing the DC component of anode current through the source resistance R1. If R1 is high in value and a wide frequency band is to be covered, then C1 and R3 cause design difficulties, and they should not be included unless absolutely necessary. If R3 is made high then the voltage available for operation of the valve is reduced. If R3 is made low, then C1 must have a low reactance at the lowest working frequency, and if this frequency is in the neighbourhood of 50 cycles, then, as *both* sides of C1 are at high signal potential, the *stray* capacity between it and earth will influence the design and performance at very high frequencies (e.g., 3 megacycles).

[1] "Journal of the Institution of Electrical Engineers," September 1939. Description of Series Amplifier in the Standard Telephones transmitter.

Design Considerations

Since the cathode has been taken up above earth potential (as regards DC), so also must the grid be taken up above earth potential by the same amount, less the amount of grid bias required for normal operation. This is most conveniently done by connecting the lower end of the grid leak to a tapping on R3. The grid condenser C2 and the grid leak R4 can have normal values.

In this circuit the anode decoupling condenser C3 is shown connected to the cathode. The alternating component of anode current does not therefore pass through the source resistance R1, and negative feed-back and consequent reduction of gain are avoided.

When selecting a condenser for the C3 position an electrolytic type should only be chosen if the normal leakage current will not upset the performance of the circuit.

Examination of Fig. 2 reveals that both R3 and R5 are effectively in parallel with R1. Normally R5 should be equal to R3.

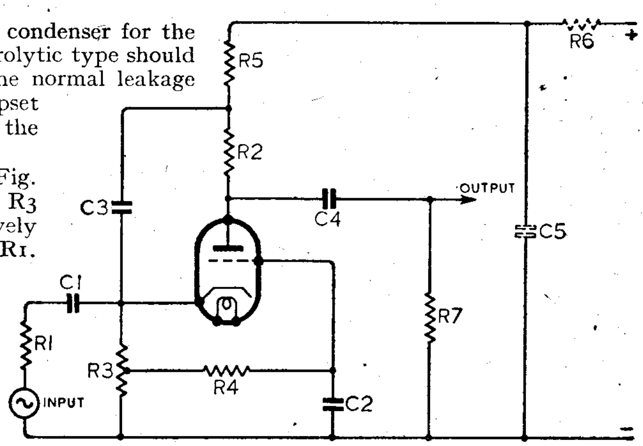


Fig. 2. Circuit diagram of a practical non-phase-reversing amplifier.

The load resistance R2 and the decoupling resistance R5 should be made as high as is consistent with other requirements in order that the capacity of C3 may be kept to a minimum, because the *stray* capacity of C3 to earth is effectively across R1.

Supposing that the HT supply voltage contains some residual hum, and for the moment ignore the components shown dotted in Fig. 2. In an *ordinary* amplifier the decoupling circuit acts also as a smoothing circuit. However, in the circuit of Fig. 2 this is not so. If the reactance of C3 at the hum frequency is small compared with R1 plus R5, then the hum volts present in the HT system are only reduced in the proportion R1/(R1+R5) and these hum volts are applied to the cathode or *input* of the stage and are thereby subject to its full amplification. The remedy is to ensure that the hum voltage is small at the top end of R5. This is done by adding C5 and R6.

Variations in HT voltage occurring at very low frequencies (a few cycles per second) may also find their way to the cathode and these are not entirely removed by C5 and R6. If these are troublesome they may be reduced by reducing C3 or C2. Reduction of the former will increase the bass response, reduction of the latter will decrease the bass response.

The grid leak of the succeeding stage (R7) should have a value which is high compared with R1 multiplied by the stage gain.

If the cathode-earth volts exceed about 30, the valve should normally have its own heater winding. A compromise may, however, be effected by connecting a common heater winding to a potentiometer across the HT supply, and arranging for the potential of the heaters to be midway between the extreme values of cathode-earth potentials of the various valves.

The input capacity of the stage comprises the following:—(a) Cathode-heater capacity. (b) Cathode-grid capacity. (c) C1 and C3 stray capacities to earth. (d) Stray wiring capacities.[2]

It will be seen that the input capacity of this stage is higher than that of a normal stage.

Finally a successful design can be best achieved by arranging the circuit as follows. These notes apply particularly when covering a very wide frequency band. (a) Insert the non-phase-reversing stage at a point where the output impedance R1 and the output voltage of the previous stage are both low. (b) Avoid the use of C1 if possible. This can be done if the previous stage is a cathode-follower. (c) Make R2 as high as possible without encountering loss at the highest operating frequency. (d) Make R3 and R5 as high as possible without allowing the valve to be overloaded. (e) Make C1 and C3 as low as possible without encountering loss at the lowest operating frequency.

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[2] Examples of "strays" are as follows: (a) For AC2/HL class of valve, about 18 $\mu\mu$F. (b) For same valve, 8.5 $\mu\mu$F. (c) A 1 μF metal-cased upright condenser having a base area of 2 square inches had stray capacity to earth of 22 $\mu\mu$F when stood directly on a metal panel and 4 $\mu\mu$F when stood up on ½-inch insulators. (d) Allow about 10 $\mu\mu$F.

"Foundations of Wireless"

Third Revised Edition

THIS well-known *vade mecum* of the wireless student has just made its appearance in completely revised form; the revision has been carried out by M. G. Scroggie. Certain portions of it, more especially the part dealing with the all-important subject of detection, have been largely re-written, and two entirely new chapters have been added. The first of these deals with the question of wave propagation and of aerial design, including specialised types such as dipoles, DF and anti-interference aerials, to mention three among many.

The second new chapter forms a very necessary corollary of the first, and treats of transmission lines of various types. In revising the book opportunity has been taken to substitute completely modern terminology where necessary.

One of the goals which the reviser aimed at when setting about his task was to make the book appeal to the very large number of men who are now entering, or waiting to enter, the wireless branches of the three Services, although the book has not thereby lost one iota of its usefulness to the ordinary stay-at-home wireless man, who desires to get a sound grasp of fundamental wireless principles. Simple algebraic formulæ are freely used, but these need frighten nobody, the book being definitely in the non-mathematical class. As its name suggests, it commences from the beginning and assumes no previous knowledge of wireless, nor indeed of electricity and magnetism.

This book, which is issued from the offices of *Wireless World*, can be obtained through any bookseller at a cost of 6s., or 6s. 6d. by post direct from our publishers, Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

Sentiment and the War

IN spite of the strenuous efforts which have undoubtedly been made, there is plenty of evidence available to show that many people have not yet done as much about waste-paper salvaging as they could do. Even we, in this office, in spite of the large contribution already made, feel somewhat guilty when we survey the well-stocked shelves of the *Wireless World* Library, and we are now setting about the by-no-means enviable task of thinning it out in the best Mr. Middleton style. There are, we fear, many old books, periodicals, and newspapers dealing with wireless matters, some dating back to the last century, which we have hitherto kept solely for sentimental reasons, and these will undoubtedly have to go. We are probably not the only ones who have been hoarding a lot of old literature, wireless and otherwise, for purely sentimental reasons, and we hope that these few words will catch the eye of our fellow-sinners in this respect. So, to work.

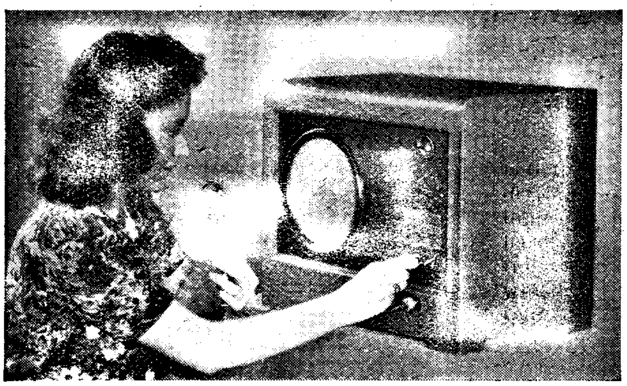
Rendering a Service

WERE it not for such a service as that rendered by the Radio Research Board in compiling the Abstracts and References section of *The Wireless Engineer* month by month, the wireless engineer might well feel cut off so far as the advances in wireless are concerned, for the majority of journals from oversea are now going to the Government libraries. In the January issue of our sister journal, which is published on the first of the month, some 350 articles recently appearing in the world's technical Press are abstracted or referred to.

Articles on transit time phenomena in electronic tubes and recent developments in air-cored inductances, together with a three-page summary of recently accepted wireless patent specifications, are also included in this issue. *The Wireless Engineer* is obtainable to order through newsagents, or direct from our publishers at Dorset House, Stamford Street, London, S.E.1, at 2s. 8d., including postage.

The Mirrophone

Compact Magnetic Recorder and Play-back Unit



AS most readers will know, there are three main methods of recording sound: mechanically on wax, photographically on film, and magnetically on steel wire or tape. The last, though widely used by the B.B.C. and other organisations, has not achieved the wide popularity of the other methods, in spite of the advantage that it offers, as compared with most other systems, of immediate play-back. Unlike the film or the commercial wax recording, the steel tape requires no processing and retains its impressions almost indefinitely.

Thanks mainly to this feature of immediate play-back, a suitably designed magnetic recorder would appear to have especial advantages for certain specialised uses, and it is not surprising to learn that a compact unit, combining provision for recording and immediate play-back has recently been produced in the United States by Western Electric. The Mirrophone, as it is called, employs the normal principles of magnetic recording, and uses a steel tape, which, as compared with a wire, can easily be prevented from twisting, and permits of transverse recording.

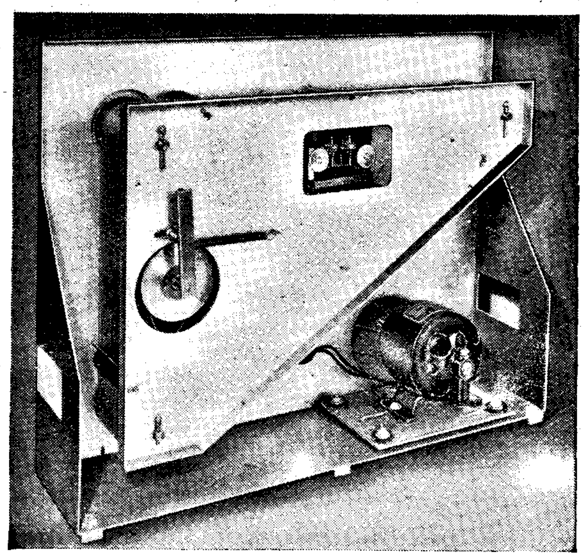
Housed in a small cabinet is the recording-reproducing unit, an amplifier and a loud speaker. Associated with this unit there is a high-fidelity crystal microphone. The thin narrow tape on which the recordings are made is mounted on drums which rotate to draw the tape between the poles of the recording magnet. To allow the tape to repeat without rewinding, its ends are welded together to form an endless belt. The material of the tape is a special magnetic alloy recently developed by the Bell Telephone Laboratories.

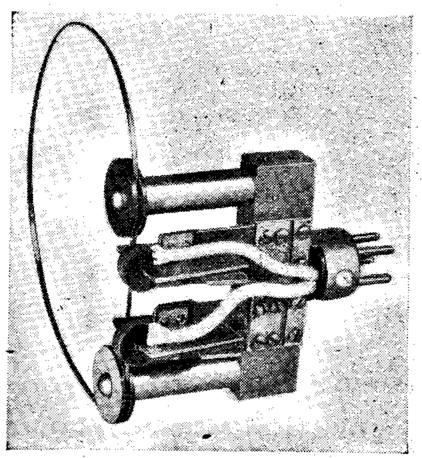
In reproduction the recording magnet serves as the pick-up device. An accompanying illustration shows the recording and polarising magnets; a short loop of tape illustrates the method of threading. These magnets are a removable unit with plug connections. The dynamic loud speaker is supplied by a two-stage amplifier, which develops exceptionally high gain. An acoustic chamber encloses the back of the speaker. Its field coil also serves as a smoothing choke for the amplifier anode current supply.

Alternating current from any 110- to 120-volt lighting circuit operates the Mirrophone. A volume control regulates the intensity of the recording or the reproducing currents; and an electronic volume indicator shows when the level is correct for recording. To indicate the length of the recording there is a moving pointer which makes one complete revolution per minute and can be reset at any time.

A record once made can be reproduced as often as desired and kept indefinitely or until the switch is again thrown to the recording position. Doing so automatically clears the tape as it passes the polarising magnet and prepares it for a new record. The switch also has a stand-by position which leaves the tape running but disconnects the erasing, recording and reproducing units. An output jack permits connection to an external loud speaker or another recording machine when permanent records are wanted.

Best quality recordings are obtained when the speaker is close to the microphone, but the results are entirely satisfactory from greater distances. Group conversation can be picked up when the speakers are several feet away. Intelligible recordings have been made in large auditoriums with the sound source many feet from the microphone. On the other hand, whispered words can be reproduced





Below is shown the magnet assembly of the Mirrophone. The upper magnet is used for polarising the tape and the lower one for recording and reproduction. The right-hand picture shows the position of the magnets in the chassis; also the drums by means of which the tape is passed between the pole-pieces of the magnets. The tape is endless, so rewinding is not required.

loud enough to be heard by all present in a large auditorium with the sound source many feet from the microphone.

In the Mirrophone, instructors in voice training have an effective new tool. Public-speaking classes and music schools should find it helpful in developing good diction and correcting faulty technique in the rendition of vocal and instrumental music, for it has the great advantage of permitting a student to hear his own efforts as others hear them and to listen critically to the faults which his teacher wishes to correct. An experimental model in use at the Juilliard School of Music in New York City is shown in an accompanying photograph.

As a lecture demonstration for talks and at expositions and conferences it has the advantage of being able to reproduce recorded speech immediately and of preparing itself automatically for a new record. The Mirrophone is also an effective aid in teaching the correct pronunciation of foreign languages. Large commercial organisations and retail establishments can use it to train their personnel in correct diction for contacts both face to face and over the telephone. For the first time those interested in cultivating the voice and studying instrumental music have in the Mirrophone the opportunity of critically reviewing and surveying their own performances without any appreciable time-lag; at last they can share in a privilege long enjoyed by those who follow the literary and graphic arts.

The Wireless Industry

THE introduction of a rectifier (type 1D6) on American UX base as a direct replacement for types 25Z5, 25Y5, etc., is announced by Standard Telephones and Cables, Ltd. Allocations are shortly being made to BVA wholesalers.

◇ ◇ ◇

We have received from British Insulated Cables, Ltd., Prescot, Lancs, a leaflet on B.I. Flux Solder, which is in the form of wire with a core of activated resin. Stocks are available in 13 or 16 SWG with 50/50 or 60/40 tin-lead alloy.

◇ ◇ ◇

The emergency catalogue just issued by Gardners Radio, Ltd., Somerford, Christchurch, Hants, indicates that in spite of rationalisation in some directions, the firm is still able to supply most of the transformers and other replacement components required for receiver servicing and to undertake rewinding and repairs to standard types of mains transformers and loudspeakers.

◇ ◇ ◇

Hammans Industries, Ltd., have sent us copies of their engineering bulletin (H101) in which the physical and electrical properties of aluminium and other non-ferrous metals are compared with those of laminated synthetic materials. Also a leaflet dealing with the name-plates and dials made by their associated firm the Universal Engraving Co., Ltd.

◇ ◇ ◇

Rimington, Van Wyck, Ltd., suppliers of high-quality gramophone recordings, of 42/3, Cranbourn Street, London, W.C.2, issue each month "Rimington's Review," in which the latest records are described. The price of the publication is 4d.; the December number deals with the firm's own issue of recordings of French pianoforte music played by Phyllis Sellick.

RANDOM RADIATIONS

By "DIALLIST"

Television "In the Round"

YOU'VE probably been thinking about the possibilities of the new development in television, of which something has appeared in the papers. I mean, of course, Mr. Baird's demonstrations of three-dimensional images on the viewing screen. So far, I've not seen any technical account of the method used, but from what I can gather it consists at the transmitter end in scanning the image by split beams subtending angles about the same as those at the human right and left eyes respectively. Then at the receiver the images are projected alternately. It's not quite so simple as that, for red, blue and green filters are used, and the picture appears in colour. It is still in the experimental stages, of course, and so far the picture can be seen as a stereoscopic picture by one viewer only at a time, and he must be seated bang opposite the receiver. Still, it is a good step forward, and I don't doubt that developments will follow. I'm not saying that we'll have full colour television perfected by the end of the war; but I wouldn't be a bit surprised if it came along pretty soon after the service gets going again.

Sound, Too

A recent article in *The Wireless World* showed what has been done in the matter of reproducing sound by loudspeakers in such a way that it gives a true "two-eared" impression. Just as we see things in the round because we use two eyes some inches apart in the process, so speech, music and other sound don't seem quite natural unless the "two-eared" effect can be reproduced to some extent. Our ears are, I suppose, direction finders of a kind! There must be a slight phase difference in the sound waves that strike their drums unless we are directly facing the source of the sound, so that the two paths from it to the brain, *via* air, ears and nerves are exactly equal. Anyhow, very definite progress has been made in the matter of stereophonic reproduction, and I'm sure that there will be much bigger developments in the future. The movie people have taken it up, as you know; they have plenty of money to spend on research and they're egged on by that spirit of competition which is so excellent a spur.

In Continuation

Think what it will mean when we are able to receive television with the images appearing solid instead of flat and the accompanying sounds coming through as if the microphone were binaural like our noble selves. When that has happened we shall look with astonishment at the flat images that we are used to now, and listen to the one-eared sounds with which we are satisfied at present with astonishment that anyone could ever have found them sufficiently real to be worth bothering about. Such is our make-up that we accept new developments in reproduction, no matter how far from the real thing they may be, and enjoy their results thoroughly until a further step is made. Then we wonder that we could ever have been entertained by the old methods. When I was very young, people used to revel in the music of the phonograph, with its cylindrical records and its little tin horn.

Much was lacking in its performance; but we hadn't missed it because we didn't realise that it ought to have been there.

Stepping Stones

Then came electrical recording—1925, wasn't it?—and the radiogram. Heavens! Could we ever have listened with any pleasure to the mechanically made record mechanically reproduced? Try the combination now, if you can rake up an old record and an old gramophone and you'll be surprised. And whilst you are about it, turn up any old wireless book that is on your shelves and look at the circuits and the valves of the four- and five-valve receivers in whose performances people once took such delight. High-impedance triodes throughout, all (even the output) of the general-purpose type. Yet enthusiasts used to write to the papers boasting that their sets gave such volume that "every word and every note of music could be heard to perfection (!) at 100 yards or more." And grid bias! No negative bias on the AF grids in the early days; what bias there was you'll find on the RF side of the set, and it was *positive*, its job being to hold down unruly, unstabilised stages that were prone to burst into oscillation at the slightest provocation.

Unintentional Broadcasting

REFERRING to my recent note on the music that could be heard—coming apparently from its aerial masts—when passing near one of our high-powered B.B.C. stations, a reader sends me some interesting particulars. He's soldiering now, like me, but at one time he was on the staff at Droitwich. There they didn't get music from the masts, but they got it "very loud and clear" in both the feeder huts. The explanation accepted was that it was due to movements of the air heated up in the immediate neighbourhood of the feeder lines. He asks how the necessary rectification could take place if the masts were responsible. I think it could at any electrically bad joints—under bolt-heads and so on—as the masts swayed slightly in the wind. Do you remember an article in *Wireless World* some years ago on Parasitic Rectification? It gave instances of trouble caused in houses near high-powered stations by rectification between the joints in gutter spouting, lead roofs and other metal bits and pieces. Re-radiation gave rise to some mysterious cases of local interference, which were subsequently cured by bonding together the offending joints, thus short-circuiting the rectifying contacts.

Saying It with Sparks

This kind reader sends me also an account of a very funny incident that occurred at the station. During a thunderstorm a local lightning flash caused the horn gaps on the masts to flash over. The transmitter went on working, but, once struck, the arcs persisted for some time. While they lasted a terrific burst of music was broadcast from them to an astonished countryside. One labourer rushed in, all of a dither, crying that the middle of the field was full of flames and music! A singing arc with a vengeance.

GOODS FOR EXPORT

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

LETTERS to the EDITOR

The Editor Does Not Necessarily Endorse the Opinions of His Correspondents

Scale Distortion

BEING, I believe, the originator of the term "scale distortion," I feel I must be involved in A. S. Evans' criticism of it in the January issue. I am not prepared to answer for all the "many articles" to which he refers, but if my own are included among them they must have been misinterpreted.

Mr. Evans' argument is that, as the effect described as scale distortion occurs when listening to the original performance at varying distances, (1) it is not peculiar to loudspeaker reproduction, and (2) is not distortion, and (3) that the real distortion is due to the falling bass of the loudspeaker, knowledge of which has hitherto been confined to himself and P. G. A. H. Voigt.

(1) I am sorry if I have made the impression of holding that scale distortion is something to do only with reproduced sound. Actually I agree entirely with Mr. Evans that it exists equally in direct listening to a performance or speech; but I was writing in a journal devoted more to loudspeaker reproduction than to concert-going. Moreover, listening at really abnormal levels is in practice confined almost entirely to loudspeaker reproduction.

(2) "The farther from the orchestra, generally speaking, the worse the distortion, but does one worry about it, or complain . . . ? No!" This I disagree with, and so would Mr. Evans if he paid for a seat in the dress circle and was given an equally well-upholstered one in the foyer. If he were so unfortunate he might be quite glad of some sort of tone correction for making the best of a bad situation. The variations in loudness in different positions *within* a normal concert hall are found by actual measurement (see *The Wireless World*, March 10th, 1938, p. 210) to be far less than those due to typical volume control settings. For various reasons (such as a desire not to disturb other people) an orchestral programme is often turned down to much less than the original loudness in any part of the hall, and sometimes studio speech is magnified. The fact I have tried to bring out is that in such cases one does not get a perfectly proportioned reduction or enlargement; the actual balance of tone is affected, chiefly in the bass, which is deficient in the former but excessive in the latter (so a "compensated" volume control does not help, for the same setting may give an enlargement of one programme and a reduction of another, depending on adjustments at the broadcasting end). If the unpleasant effect of reproduction at a different level is due purely to insufficient loudspeaker bass, how does Mr. Evans account for the growing boominess of quiet speech when it is magnified?

If one is obliged by circumstances to listen to an orchestra at much less loudness than one would hear it in the most expensive seats, is it better to hear it, as it were, at a great distance in the open air, with a false balance of tone, or is it better to attempt to create an illusion of the real thing by restoring at least the balance of tone heard at the best distance?

(3) I feel sure that P. G. A. H. Voigt would disclaim any monopoly in realising the general badness of loudspeakers in the bass or of striving hard to improve them. Loudspeaker characteristic curves have been published in *The Wireless World* and elsewhere for many years, and far more has been written about their faulty bass response and methods of counteracting it than on scale distortion. If I have not emphasised that unbalanced reproduction is obtained if the loudspeaker is deficient in bass, it is because it is surely self-evident.

And now a counter-attack. When he says, "To give full orchestral volume a baffle-mounted loudspeaker must be fed with something like 600 watts," Mr. Evans may be quite correct, but he is running a great risk of being misunderstood to mean *loudness* where he says *volume*. Actual measurement showed (see again the article referred to above) that a 1½-watt output was enough to reproduce the same loudness in a living room as was being heard in the stalls of the now lamented Queen's Hall during the playing of very loud music indeed. At the same time, I called attention to the imperfection which would remain even if all recognised reproducer distortion could be eliminated. The listener is very sensitive to the subtle

Letters to the Editor—

effects of sound *distribution* (e.g., "Acoustics of Cinema Auditoria," Mason and Moir, *Proc. I.E.E. (Pt. III), Sept.*, 1941). If Mr. Evans insists on renting a full-size concert hall and a 600-watt amplifier and loudspeakers to match, he must be warned that the orchestra must play in an entirely "dead" studio, for it wouldn't do to have the reverberation of *two* concert halls superimposed. And then there would still be the need for multiple-channel technique *à la* Disney to give a semblance of source distribution. "CATHODE RAY."

IN the days immediately preceding the war you were good enough, on occasions, to give me space to join, with "Cathode Ray," and many others, in the perennial controversy on scale distortion. Now, in your January issue, this controversy has been revived in the article, "Scale Distortion," by A. S. Evans. I should like, if I may, to return to this subject.

The article in question was really divided into two parts. In the first Mr. Evans showed to his own satisfaction that scale distortion is, in effect, a fallacy, whilst in the second he discussed frequency distortion in loud speakers, and its correction. In my view the first part of the article was unsound; it was based on wrong premises and reached completely wrong conclusions. With the second part I was in full agreement—but the question of frequency distortion in loud speakers has but little bearing on the subject of the article. There is not any disagreement, so far as I am aware, with the view that loud speakers in general (and, maybe, baffle-mounted speakers in particular) do introduce frequency distortion to an extent which is detectable if real high-quality reproduction is required. Nor, again, so far as I am aware, is there disagreement with the view that frequency distortion in one link of a reproducing system may (and, indeed, should) be corrected by an inverse distortion deliberately introduced elsewhere in the system. But what has this got to do with scale distortion?

Scale distortion, so called, is the result of the ear's frequency characteristic being dependent upon sound intensity. Thus, if a programme which one would hear in the original at one level is reproduced at another, then its "balance" will be changed, and scale distortion will be occurring. It is true that if, in addition to being reproduced at the wrong level, it is also being subjected to frequency distortion, then it will sound even worse than it would if scale distortion alone were occurring. This, though true, is irrelevant.

It may be conceded that scale distortion occurs as one moves from one part of a concert hall to another, but to say, as Mr. Evans says, that "the balance is automatically corrected by that very peculiarity of the ear over which we have worried unduly" is completely incorrect.

The balance is not corrected; it is overlooked, by the uncritical, in just the same manner as the inaccurate reproduction of the vast majority of radio equipments is overlooked by their owners. If Mr. Evans' statement is true, why do many of us prefer a particular distance from the orchestra in a given concert hall? The reason is that in that position we get what we consider (and all this is essentially a subjective decision) to be the best "balance."

An ideal reproducing system will reproduce the sound of the orchestra (free from frequency distortion, of course) at that level at which it would be heard if the particular listener were in *his* favourite seat in the concert hall. It follows that there is no *one* correct reproducing level—it is always that level at which the individual would most like to hear the original. This suggests a very large range of variation, but, in practice, this is not so since a good concert hall is inherently one in which the sound intensity does not vary very greatly from one position to another.

It is, in general, a risky thing to endeavour to analyse matters of art in terms of scientific precision. So it is in this case. It is not true that the only factor in scale distortion is the variation of the ear's frequency characteristic with intensity. There is, in addition, the question of the formation of subjective harmonics (i.e., harmonics formed in the ear itself as a result of its non-linear mechanism) which depend upon intensity. Most important of all, there are the subjective or artistic factors.

The charm of a sunset, the majesty of the snow-clad Alps, the perfection of a Beethoven symphony; these things are not definable in terms of colours, of shapes, or of frequency characteristics. Scale, size or loudness—these are inherent factors. A miserable, puny, undersized reproduction of a great symphony is no more capable of exciting the deepest emotions than is a vest-pocket photograph of the Matterhorn.

Finally, may I say that Mr. Evans' figure of the 600 watts required to produce "full orchestral volume" may very easily mislead. It may be true that the acoustic output of an orchestra is 600 watts, but it is of more general interest that an amplifier rated at some 10 to 20 watts is fully capable, with a baffle-mounted speaker in an ordinary room, of producing at the listener's ear an intensity equal to that which would exist at his ear in the concert hall.

Batley, Yorks. J. R. HUGHES.

Wire versus *Wireless*

AS one who has devoted considerable thought and time to convincing people of the advantages of wired broadcasting, I was very pleased to see that in your Editorial last month no attempt was made to confound Mr. Eckersley on technical grounds. Instead, the argument offered was merely a clever exposition of the elementary objection always raised against wired wireless before the matter has been the subject of serious thought or experience. It so happens that the idea, at first sight, appears to be in opposition to the independence of thought and action upon which we, as a nation, pride ourselves. The objection is usually stated as "having to have what they give you instead of what you want."

The significance of this *cliché* lies surely in the personality behind the word "they." If by "they" we mean a democratic authority working for the best possible use of such entertainment and enlightenment as can be conveyed to man through the ear alone, "what they give" immediately becomes synonymous with "what you want," and the objection breaks down.

The use of the expression, "Properly applied international broadcasting" in your Editorial suggests that you are prepared to believe that some such authority as I have assumed may come into being in the post-war world. For those, however, who are not prepared to accept this assumption, and consider free listening as a necessary brake on dictatorial tendencies of the governments of the future, I would point out that the taxing of all receivers out of existence, except a standard low-range, pre-tuned model, would give all the advantages of the wired system to any government so inclined.

It might be argued that the war has brought in foreign listening to stay. There are no grounds for this belief; world news will once again resume its third place to local gossip and sports results. News bulletins in foreign languages will disappear because, while it is of interest to-day to tune in Lisbon and check up statements made by our own news service, no one will wish to tune in, say, Breslau, to hear the result of the Wigan by-election or the latest purchaser of some eminent footballer.

The part which international broadcasting has to play in the post-war world is, therefore, based on this reasoning, rather limited. It is obvious that this small part will be played more efficiently if one central authority is responsible, which automatically presupposes the use of the very best receiving equipment, to say nothing of recording the material for dissemination at a suitable time.

F. ALWYN.

Rotherham, Yorks.

Technical Training

IN your January issue W. M. Dalton makes a number of curious and almost incredible assertions on the subject of training of radio engineers. I do not know exactly what he means by "three years' simple electrical engineering," but obviously his students do not spend much time in the classroom; all the electricity needed by a radio engineer can be taught in forty hours, at the outside, to people with matriculation physics and mathematics. No one with qualifications less than this will ever learn much about radio. "Three years' thermionics" is equally absurd. My students acquire all that is necessary in six hours, or less.

Your correspondent goes on to suggest that the nine-year course he outlines should be supplemented by acoustics, astronomy, chemistry, heat, mathematics, and optics, to a standard higher than that of the B.Sc. (London). Mathematics is useful to the really expert student, and acoustics to the loud-speaker specialist, but advanced astronomy, chemistry, heat, and optics have no connection whatever with radio.

These and other points, as, for example, his statement that "the radio man could eat the electrical engineer's subject and then carry on with his own," lead one to suppose that Mr. Dalton's letter is to be taken as a jest. If it is seriously intended, then he presents a misleading and wholly ridiculous picture of the knowledge needed by a radio engineer.

SUBALTERN.

I THINK Mr. W. M. Dalton (in his letter in your January issue) has omitted a vital step in the training of radio engineers: between the three years' simple electrical engineering and "at least three years on thermionics" there should be at least ten years on atomic physics, to include quantum theory, relativity, wave-mechanics and whatever new developments in fundamental physics there may be in the next ten to fifteen years, without which the student cannot possibly understand the emission of an electron from a complex surface.

Seriously, though, a trained engineer is not an encyclopædia, but a man who has some knowledge and knows how to use it, and knows where and how to look for further information. With all due respect to the regular contributors to *The Wireless World* (whom your correspondent suggests as suitable teachers for his extensive syllabus), I should hesitate to ask any one of them to hold forth on all of the following subjects: theory of electrical machines (e.g., the use of inter-poles), atomic physics of the type outlined above, optics of the standard required for the design of wide-aperture lenses, astro-physics and meteorology as required for investigation of propagation conditions, filter theory, mathematical treatment of radiation from aerials, high-efficiency modulation systems for broadcasting stations, and the design of oscillators of extremely high frequency stability. If there is no teacher who can cover the whole field envisaged by Mr. Dalton, is it reasonable to expect the student to learn it all during his "training" period?

A training course should be devoted to the study of fundamental principles, not specific pieces of apparatus; but departure from this ideal is forced in practice by the need for the student to acquire the practical technique of some particular sub-section of radio by the age at which he requires to earn a living. I suggest that the only hope for a practicable scheme of part-time training is a three-year course in mathematics and the relevant sections of physics, followed by a two-year course of radio in which the time is divided equally between general radio theory and a specialised course in one section of radio technique. (Possible subjects for specialisation might be: acoustics and AF amplifiers, aerials and propagation, high-power RF amplifiers and modulators, etc.) Having got a footing in the industry on the strength of his one specialisation, the engineer may then (if he has the time and inclination) study other branches of the art.

D. A. BELL.

London, N.21.

Curing Instability

Causes of Unwanted Oscillation in Broadcast Receivers

By JAMES GIBBONS

AMONG the many faults which a wireless receiver can develop, and one of the hardest to locate, is that of instability. Like many other defects, it may be just perceptible, or immediately obvious, and ranges from hardly audible "motor-boating" at full volume to a violent succession of whistles as the tuning condenser is rotated. Again, the cause of such instability may be a change of circuit conditions in either the AF, RF, or IF circuits. It is widely known that this effect is always caused by unwanted reaction, and is the result of spurious coupling between two or more circuits in cascade, or to self-oscillation of any particular stage.

Whistles in superhets need not be regarded with grave concern in every case. All receivers of the low-IF type (100-130 kc/s) and particularly those without any signal-frequency amplification have self-generated whistles on the LW band at least, usually on that part of the band which coincides with a wavelength equal to the 2nd harmonic of the intermediate frequency. (Assuming an IF of 117 kc/s, the second harmonic would be 234 kc/s, equivalent to a wavelength of about 1,277 metres.) This is, of course, due to a beat effect between the output of the second detector and a received signal. It is one of those self-generated whistles which have to be considered when the receiver is designed, because very little can be done about it afterwards.

Typical Causes

The cause of instability in a wireless receiver may be fairly simple, such as wrong operating voltages on IF or FC valves, or more elusive, perhaps being due to SG by-pass condensers having become open-circuited, or to the screening of coils, or leads, become disconnected from, or developed high resistance contact to, earth. Metallised valves, too, develop queer tricks. The connection between the metal coating and the cathode sometimes works a little loose, and often provokes acute instability. Anything, therefore, which tends to reduce the efficiency of inter-circuit screening, and decoupling, or introduces unwanted coupling by high-resistance contacts, must be suspected when normal stability is affected.

A systematic check of all the possible causes, starting with the simplest, is the best procedure. First of all it should be noted what type of instability has developed. Is it present all the time, or only on the weaker stations? Does it occur only at certain positions of the wave scale? Does the set seem lively, etc.? A careful test will often give a clue to the whereabouts of the trouble; for instance, unstable conditions which show up only at certain positions on the tuning scale are quite often caused by poor contact to the different rotor sections of the gang tuning condenser. If this is suspected, and, for that matter, at any time a set is being given a "surface" overhaul, these contacts should be removed, and their surfaces cleaned with petrol and fine glass paper. On replacing, the contact tension should be increased, and a smear of vaseline applied to the bearing surfaces. It is also advisable to examine carefully the continuity of the earth wire, and earthing device. There are many commercial superhets that are not at all happy when worked without an earth, while nearly all high-gain TRF sets develop self-oscillation at the high-frequency end of the MW band without its stabilising influence.

Visual Indications

Keen visual observation has always been a necessary asset to rapid fault-tracing in radio receivers. Quick perception will often reveal in a fraction of the time faults which could only be found in a general way by much tiresome routine testing. It is therefore good practice to make a careful examination for obvious defects. Be always on the look-out for traces of electrolyte round the bases of tubular electrolytic condensers. This sometimes dries and makes detection difficult, but it always impairs good contact, and increases the apparent power factor of the condenser, causing reduced general performance, abnormal hum level and reduced HT voltage in the case of reservoir condensers, and low volume, thin reproduction, and instability in the case of smoothing condensers. Press all coil cans, valve screens, etc., firmly down on their bases, giving them at the same time a screwing motion to make sure of a good biting contact. Be suspicious of all earthing tags, making sure of their electrical connection to the chassis; remember that high-resistance contact to earth of screening and decoupling components has been productive of more cases of instability than any other single cause. Check carefully all soldered connections to valve-holders and decoupling components. It takes very little time to re-solder many joints, while a poor one which goes undetected is probably the most difficult of all faults.

Many rough, but informative, tests can be made before the chassis is removed from the cabinet. If the main smoothing condenser is suspected of being open-circuited, a substitute can be tried between the HT side of the output transformer and chassis, or between the SG of an output pentode and chassis. Sometimes, too, stability can be restored by touching the metal coating of one of the valves. The implication here is obvious, and that particular valve and stage should be checked without delay. SG decoupling condensers can likewise be temporarily connected between the appropriate contact on the valve-holder and chassis, if the mechanical design and layout will allow. If not, remove the chassis right at the start and work in comfort. Always rearrange as before any inter-circuit wiring disturbed during tests. This is important, as neglect to do it may provoke further instability, and even AF circuits are sometimes quite critical.

Stray Couplings

Volume control wiring should always be treated with respect. The controlling potentiometer in many sets is used as, or part of, the signal diode load resistance; it is therefore in circuit with the high-gain end of the IF amplifier and second detector. Any careless derangement of its attendant wiring may cause unwanted self-generated whistles by reaction between nearby leads carrying RF currents. The writer knows of at least one commercial superhet which was cured of a nasty whistle on Luxembourg by altering the run of wiring to the volume control, thereby eliminating acute 2nd-IF harmonic feedback. It is so often the small things which make the big differences.

Open - circuited secondaries are another certain cause of greatly reduced performance, together with lively "chirps" all over the scale. A voltage and current test will, however, always give a clue to this defect, as it removes the bias from the succeeding valve, which then shows reduced anode volts and high anode current.

A flat, unchanging howl and/or "motor-boating" are manifestations of instability which are peculiar to AF circuits. Again the most likely causes are O-C anode de-coupling components, or cathode resistor by-pass condensers, and/or a partially O-C smoothing condenser. This latter component, if its capacity has become low, can cause most puzzling faults, ranging from an 80 per cent. reduction in general performance, or perhaps whistles on all but the strongest signals, to barely perceptible "motor-boating." Further, there is never any rise in hum level, as might be expected. As a potential destroyer of performance this component is nothing if not versatile, as many service-men will ruefully testify. Accordingly, it should be checked at an early stage.

Finally, the writer would like to repeat an axiom that is well known wherever successful radio servicing is performed. It is this: "Never take anything for granted, test it and be sure, or surprised."

"Wireless World" Index

THE index to Volume 47, January to December, 1941, of *Wireless World* is in course of preparation and will be published shortly at 7½d., post free, or, with cloth binding case, 4s. 5d., post free. Arrangements can be made for readers' copies to be bound with an index in the publishers' case at a cost of 10s., plus 9d. for the return postage.

Aircraft Identification

TWENTY-SIX leading types of aircraft are included in the revised edition of the identification chart of British aircraft issued by our associated journal *Flight*. Grouped according to type, the perspective illustrations present a general air aspect of each aircraft. Copies of the chart may be obtained from Dorset House, Stamford Street, London, S.E.1, price 1s. 3d. each, plus 6d. postage on single copies, or 7d. up to three copies.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

A RADIO INCLINOMETER

A HORIZONTAL aerial, subjected to a vertically polarised field, is connected to a counterpoise so that there is no signal pick-up. The counterpoise may be an aeroplane in flight, and the point of zero pick-up is determined empirically. Under these circumstances, any change in the fore-and-aft trim of the aeroplane will be indicated on a zero-centre indicator.

In order to remove any doubt as to whether the variation in level is in the upward or downward direction, the horizontal aerial is coupled through a reversing switch to the output from a second aerial which is arranged vertically. The combined signals are then fed to a receiver, and a reversing switch, synchronised with the first switch, is connected between the receiver and a pair of rectifiers feeding the indicator. The initial setting of the aerial to give zero pick-up is approximately horizontal when the aerial is connected to the electrical centre of the counterpoise. If it is not practicable to connect it to the electric centre, then it may be connected at any other convenient point, provided it is given a corresponding slight "tilt" upwards or downwards.

Marconi's Wireless Telegraph Co., Ltd., and J. Stewart. Application date, November 3rd, 1939. *No.* 536259.

PHOTO-SENSITIVE RELAYS

RELATES to relays of the kind which give a visual or audible indication either when light falls on a photo-electric cell or when the normal illumination increases in intensity. One drawback of the usual arrangement is that no positive indication is given should the supply current fail, and so render the device ineffective.

According to the invention, a photo-electric cell in the grid circuit of a thermionic amplifier is arranged so that any increase of the normal incident light causes an increase in anode current. Two relays are included in the anode circuit, one of which responds when the current rises and the other when the current falls below a predetermined value. During normal conditions the second relay is energised, but the alarm circuit is open and ready to be operated should the photo-electric cell be stimulated by extra light. In the latter event, the first relay responds and is locked to give a continuous warning, even when the exciting stimulus has ceased. Should the supply current to the device fail or be cut off, the second relay is de-energised, but its alarm is activated to draw attention to the failure.

Baird Television and L. C. Bentley. Application date, January 5th, 1940. *No.* 537832.

DIRECTION-FINDERS

A RADIO compass indicates the bearing of a ship or aeroplane with respect to a radio transmitter, and it is possible to utilise a self-orientating aerial system which will show continuously the radio bearings of the craft as it changes course. The object of the invention is to combine a radio-compass reading with that given by a magnetic compass so that an indication of the craft's true bearing (with reference to a meridian) can be constantly shown at various observation points on the craft in the same way as an ordinary repeater compass.

This is done by applying voltages derived from the radio compass to one pair of the deflecting plates of a cathode-ray tube, and voltages derived from the earth compass to the other pair of deflecting plates. At the same time a rotary arm sweeps over a potentiometer, which takes the form of a double figure-of-eight and applies to both pairs of deflecting plates voltages which are proportional to the instantaneous angular position of both bearing indicators. The cathode-ray tube will then show two traces simultaneously, one corresponding to the radio bearing and the other to the magnetic compass bearing. By applying a further potentiometer control, the arrangement can be used to give a point position of the craft on a chart.

Marconi's Wireless Telegraph Co., Ltd. (assignees of D. G. C. Luck). Convention date (U.S.A.), January 31st, 1939. *No.* 537089.

PREVENTING FADING

FADING is usually localised, and it is known that it can be largely offset by feeding a single receiver with the combined effective pick-up from a number of separate aerials distributed over a fairly limited area. This method of diversity reception is not, however, a practical proposition to the ordinary broadcast listener.

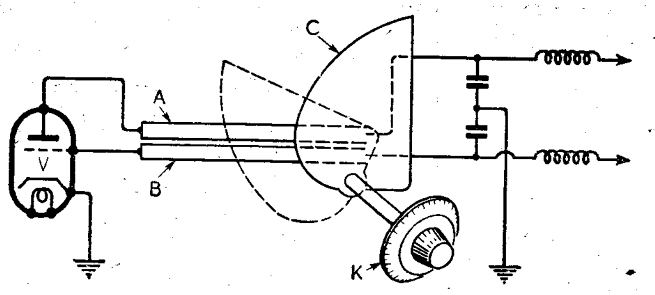
As a more convenient alternative it is proposed to make use of, say, two aerials which are in close proximity to each other and to the receiver, but possess different directional characteristics. When fading sets in on the aerial to which the set is for the moment coupled, a switch is automatically brought into operation and changes that aerial for the alternative one. Fading may be general, or it may be selective in the sense that the carrier is attenuated more than the sidebands. The latter type produces the same kind of distortion as over-modulation. In either case a voltage derived from the AVC circuit is applied to control the condition of a pair of gas-filled discharge tubes which are inter-coupled to form a "flip-flop" relay between the receiver and one or other of the alternative aerials.

Marconi's Wireless Telegraph Co. (assignees of H. O. Peterson). Convention date (U.S.A.), March 15th, 1939. *No.* 537937.

LECHER-WIRE CIRCUITS

THE usual way of tuning a pair of Lecher wires is to slide a short-circuiting bar or condenser along the length to fix the voltage node. The object of the invention is to replace this method by one in which tuning control can be effected by means of a rotating dial or knob.

The arrangement is shown as applied to the tuning of a receiving set for centimetre waves. The grid and anode of the valve V are coupled by a quarter-wave Lecher circuit consisting of two strips A, B set parallel to each other with their wide surfaces in the same plane. The tuning element is a thin metallic disc C, of the contour shown, and mounted eccentrically on the spindle of a rotary control knob K. The disc moves close to and parallel with the plane of the deeper strips, so that the series capacities between the disc and the strips form a low impedance shunt, the position of which is determined by the leading edge of the disc. The rotation of the disc increases or decreases the effective electrical length of the Lecher circuit, and therefore its tuning by an amount which is linearly related to the angular rotation of the control knob K.



Rotary Lecher-wire tuning.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of J. R. Schick). Convention date (U.S.A.) March 22nd, 1939. *No.* 538921.

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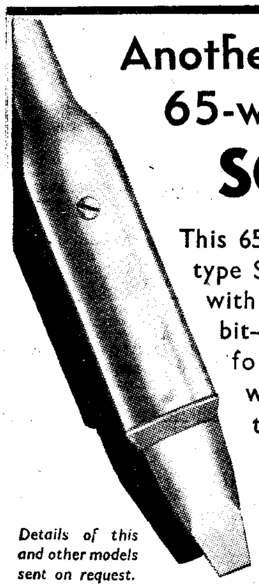

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