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# Wire ess World

Radio and Electronics

37th YEAR OF PUBLICATION

## JULY 1947

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

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VALVES AND THEIR APPLICATIONS

By M. G. SCROGGIE, B.Sc., M.I.E.E.

No. 7: Mullard TWIN TRIODE ECC32

There are quite a number of special circuits, such as multivibrators and push-pull drivers, that use a pair of similar triodes; for these purposes twin triodes usually save cost and space.

Each triode in the ECC32 is a normal type with a μ of 32 and r_s of 14,000Ω. Used with a 0.1 MΩ coupling, the voltage gain is nearly 30, and varies little with the supply voltage, which chiefly affects the signal output obtainable. For low distortion (2-3%) the output at 200 volts is 45 V peak, and at 400 V is 115 V peak. The ECC32 is not restricted to designs with common cathodes; and the capacitance between anodes is less than 1 pF. In a 2-stage amplifier, the grid pin farther from the heater pins should be used for input.

For driving push-pull amplifiers or providing symmetrical c.r.t. deflecting voltages, there are several well-known phase-inverter circuits. The gain obtainable from most of them, using a pair of similar valves, is approximately equal to that of one ordinary stage. In the cathode-coupled or Schmitt circuit it is only about half as much, and a negative voltage has to be provided; but it is a very versatile sort of circuit, and especially suitable for c.r.t. deflection.

Ideally, the signal anode currents would be equal and opposite, so would cancel out in R_e. In practice they must be sufficiently unequal for their difference to give enough voltage drop in R_e to drive V2 oppositely to V1. To minimize this inequality, R_e should be large—of the same order as R_a and R_v—and the voltage gain per stage also large. With the ECC32, for example, the difference in outputs need be only about 5%; and this, if not negligible, can be corrected by making R_a < R_v.

A feature of this circuit is that if one wants to mix another signal in the balanced output, without coupling the two signal sources, the grid of V2 is available for doing so.

It is obvious, too, that by coupling the anode of V2 to the grid of V1 it can be made to generate sustained oscillations, of a type depending on the couplings. If a 2-phase output is not needed, R_a can be short-circuited. A very stable constant-frequency oscillator, using an untapped inductor, may be based on this arrangement, which is easily seen to be an earthed-grid triode driven by a cathode follower. Used as an amplifier, it is capable of covering a very wide frequency band.

The following are a few references to details of the foregoing schemes:


"Cathode - Coupled Oscillators," F. Butler; Wireless Engineer, 1944.


This is the seventh of a series written by M. G. Scroggie, B.Sc., M.I.E.E., the well-known Consulting Radio Engineer. Reprints for schools and technical colleges may be obtained free of charge from:

THE MULLARD WIRELESS SERVICE CO. LTD.,
TECHNICAL PUBLICATIONS DEPARTMENT,
CENTURY HOUSE, SHAFTESBURY AVE., W.C.2

Advertisement of The Mullard Wireless Service Co. Ltd.
ARRANGEMENTS are already well advanced for the first post-war National Radio Exhibition, to be held at Olympia, London, from 1st—11th October. Naturally, at this early stage there are many details of the show to be finally settled, but it is already clear that the organizers, the Radio Industry Council, have brought in some radically new ideas.

In our opinion the Olympia shows of the years immediately before the war contributed much less than they might have done towards the growth of radio. They were essentially planned to "sell" broadcasting to the public—and that was already "sold." Although we welcome co-operation between those who conduct broadcasting and those who make the equipment with which it is received, it seems no function of the industry to act as unpaid publicity agents for the B.B.C. The shows were devoted almost exclusively to broadcasting, and dealt hardly at all with other branches. Emphasis on severely technical developments was considered as being out of keeping with the spirit of the exhibition, and no great effort to cater for those interested in such things was made. There were as a rule few exhibits of even a mildly educational nature; little, in fact, to encourage members of the public to take an intelligent interest in the technical means by which broadcasting was brought to them and little to help them to obtain the best possible results from their equipment.

There are, as we have said, signs that all this is to be changed at the 1947 show. A large number of manufacturers of non-broadcast apparatus—transmitters, electronic equipment, etc.—are expected to be represented, as will Government departments and other non-commercial users of wireless. If, as we understand, the show is to be of a more informative nature than in the 1930s, that is strictly in harmony with changes brought about by the war, when untold thousands of men and women became familiar with wireless. A large number of them attained a high technical standard and of these a good proportion retain their interest in radio. Suitably encouraged, they will exert an important influence on public appreciation of the finer points of broadcast receiver design and performance.

It is to be hoped especially that means will be sought to instruct and inform visitors of the potentialities of modern equipment and how to use it to best advantage. Of course, bearing in mind the diverse nature of the attendance at a public exhibition, it will be all to the good if the pill of instruction can be coated with the gift of entertainment, but we think that there is plenty of scope for serious educational exhibits.

As an example of something on which the public needs information, the broadcast receiving aerial comes to mind. This matter was forcibly brought out by a contributor to the correspondence section of our May issue. He contended that ten million odd listeners have been encouraged for so long to use their sets with no aerial, or with a miserable apology for an aerial, that few of them realise the possibilities of the modern broadcast receiver. Here is an opportunity to devise a convincing exhibit to demonstrate the benefits conferred by a proper aerial system used with a sensitive set.

**Thoughts for the Future**

*Wireless World* does not decry the idea of a "popular" annual radio exhibition, with a wide appeal, but we hope that it will eventually become a great deal more than that. The various branches of wireless tended to drift apart as a result of the vast expansion brought about by the invention of broadcasting. Then, as an outcome of war, these branches again found common ground in many fields, and have tended to come together again. This convergence is all to the good, and we should like to see in the near future an annual radio exhibition that would be regarded as the focal point of the year in the whole world of wireless.
Wire or Wireless?

By THOMAS RODDAM

There is a rather snobbish feeling that line work is just an old-fashioned poor relation of radio. Even the professional radio engineer has this feeling, although he always keeps a sharp eye open, for the line engineers have been very prolific in ideas. Obvious examples of our debt to them are wave-filters, negative feedback and wide-band amplifier techniques. The interchange of ideas, with the radio engineer often getting more than he gave, was always at the level of circuit methods. It was felt that the field of usefulness of radio barely overlapped that of line working, so that common techniques were used with a different fundamental aim. Radio was for broadcasting, or for very long-distance communication by telephone or telegraph, with telegraph as the normal method: lines were principally for short- and medium-distance communication, chiefly by telephony, and usually within the area of a town or county, although anywhere within a continent was possible. Of course, there was the transatlantic cable, but most radio engineers thought this was an out-of-date standby for use during "Dellinger's."

This view is now in urgent need of revision: radio's future is in active competition with the cable and the overhead wire. Some readers will remember the struggles which took place in the early days of radio between the wireless organizations and the cable companies. Like the affair of the Kilkenny cats, mutual cannibalism was the final outcome. The new battle between radio and wire may never come out into the open as public competition: it may be waged in the conference rooms of technical administrators between staffs of engineers and economists. Yet battle there is bound to be. Some people do not believe this. At a recent I.E.E. meeting, at which colonial telecommunications were discussed, some speakers expressed the view that a radio link was a rather temporary affair, to be used only until there was time to put up poles, hang wires from them and hack a path through the jungle to enable the maintenance engineer to bicycle on his fault-finding errands. Native gentlemen who are skilled at constructing bracelets from copper wire are believed to support this outlook: in America, where a more sophisticated approach is adopted, Western Union are setting up radio links to do the work now done by overhead wires.

Readers of Alice Through the Looking Glass will remember the train of which "the smoke is worth a thousand pounds a puff" with a guard whose "time is worth a thousand pounds a minute." The cost of the London-Birmingham coaxial cable was quoted as a thousand pounds a mile: apart from television relaying, what is this extremely expensive piece of wire used for? The answer is that with only a megacycle bandwidth in the amplifiers 240 carrier telephone channels can be superimposed on a single cable. With improved amplifiers wider bands still can be obtained, so that many hundreds of speech channels can be connected using only a single coaxial cable in each direction. This is simply an extension of a principle already in common use, in which carrier frequencies between 12 kc/s and 60 kc/s are used to convey twelve channels on a pair of overhead wires.

Later in this article we shall discuss the circuit methods adopted by the line engineers.

The Future of Trunk Communications

Fig. 1. Level diagram of New York-Philadelphia carrier telephone system.

Fig. 2. Auxiliary repeater station on New York-Philadelphia route.
Meanwhile, where does the radio engineer come in? The answer is that he, too, knows how to transmit a wide band of frequencies from one point to another. Assuming that the bandwidth corresponds to modulation frequencies of up to 2 Mc/s, which we shall see later is what we want, this is just the same problem as we have in television. Even at 7 metres this bandwidth is not hard to get: at higher frequencies, around 500 Mc/s (60 cm), for example, it is difficult not to provide the required bandwidth. Highly directional aerials can be used to concentrate all the energy from the transmitter in the direction of the receiver, and to collect the energy at the receiving end, so that only small power is required for rather more than optical range. One system* installed during the war in British Columbia, worked on frequencies between 42 Mc/s and 50 Mc/s, using 250 watt transmitters. The longest circuit was from Prince Rupert to Langan Island, a distance of 108 miles, and the average input to the receiver was 100μV, which was well above the receiver’s requirement of 20μV.

This circuit carried only one telephone channel, but the 98-mile path from Prince Rupert to Alliford Bay carried two telephone channels and four teleprinter channels. Other links in the British Columbia network were shorter, but distances of about 40 to 50 miles may be regarded as normal for V.H.F. radio links. We can therefore imagine a chain of receiver-transmitter repeater stations, spaced 50 miles apart, passing our radio signals across country.

What do the line people do? Fig. 1 shows what happens between New York and Philadelphia, and is based on information given in Bell System Technical Journal, Vol. XVIII, No. 4. By the time the signals on the coaxial cable have travelled 15 miles they have been attenuated about 30db. To avoid cross-talk the input level is restricted, so that it is then necessary to amplify the signals before they fall too near noise level. The sort of installation needed for this is shown in Figs. 2 and 3, also reproduced from the above paper. Obviously quite a lot of money must be spent on these repeater stations. To make it more difficult, "twist" regulation must be provided; as the temperature of the cable changes with the weather and the season, the frequency characteristic of the attenuation alters, so that the gain regulating circuits must allow not only for overall changes of attenuation, but also for change of attenuation at different frequencies.

Here the radio engineer is on a very good wicket. His transmission path is, at V.H.F., pretty stable, and the variations of attenuation are not frequency selective. Of course, if he gets more than one transmission path he will run into selective fading, but this can be avoided. Furthermore, if he uses frequency modulation, he can provide a link of absolutely constant overall equivalent, and, again assuming that no multipath distortion is present, the 50 miles of radio link should be a very solid and quiet transmission path. Of course, even at 500 Mc/s it is quite hard work designing a frequency modulation system to take modulation frequencies up to 2 Mc/s, but before the war one experimental system at least had been set up as a means for providing television relaying, and we have had quite a lot of experience with wide bands and short wavelengths since then. It is very much easier in some ways than the radar and broadcasting prob-

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Wire or Wireless?—

lems, because, unlike broadcasting, we can concentrate all the power in a narrow beam, and, unlike radar, we do not receive only a small amount which has been scattered back. The powers used in this sort of work are measured in watts, not in kilowatts and megawatts, and the valves used are almost conventional in design.

It seems very likely that we shall soon see some experimental links working on this basis. Certainly there seems to be no reason why we should not. All the techniques are known and understood; only the application is needed. What do we need at the transmitter and the receiver? Obviously, we need the basic elements of the normal transmitter and receiver, the modulator, amplifier and oscillator at the transmitter, the frequency changer, amplifiers and detector at the receiver. In addition, we must take a very close interest in the way in which our 240 telephone circuits are all connected to the same radio modulator at the transmitter end and to the output circuits at the receiver. In the New York-Philadelphia link the speech frequencies in the band 200kc/s to 3,400 kc/s are used to modulate a carrier of frequency 60 kc/s to 108 kc/s. Twelve such carriers, spaced at 4 kc/s intervals, are obtained in this band. One sideband only is selected, so that the channel now occupies the band 60.2 kc/s to 63.4 kc/s, 64.2 kc/s to 67.4 kc/s, and so on up to the twelfth channel in the band 104.2 kc/s. There is a difference between British and American practice according to whether lower or upper sideband is selected, but this does not make any fundamental change in the principle of the system. The whole group of twelve channels is then shifted bodily by a second "group modulator" to the desired frequency band. Thus, by modulating the group with a carrier frequency of 912 kc/s, it can be moved to occupy the band 972-1,020 kc/s, the upper sideband being again selected. In this way the whole frequency spectrum between 60 kc/s and 1,020 kc/s is occupied by 20 groups, each made up of 12 channels. The equipment which does this is shown in Fig. 4. This is the heart of the whole system, and, comparing it with the size of a receiver or a 50-watt transmitter, the reader will see that if the radio man insists that he is not interested in what happens before they pipe the signal into his modulator, he is in for a pretty thin time, because the engineer on the line side will take the running of the transmitter and receiver in their stride.

The urgent problem for the radio engineer has therefore two aspects. First of all, he must understand the methods and techniques which have been adopted for multichannel telephony on lines. The fact that elaborate systems have been evolved does not mean that they are necessarily final in form, although they are now so well established that it will not be easy to make any changes unless some considerable improvement can be made. Secondly, he must study the problems of wide-band radio links at very high frequencies. These are urgently needed both for telephone purposes and for television. In many countries television can only be run economically by the simultaneous broadcasting of one programme in several large towns. Radio links from the studio to the satellite towns are essential. Furthermore, few countries are willing to start up a new television service on British pre-war standards; they have heard so much about 1,000-line stereoscopic colour television with sound on a common carrier that they will not invest their money in a system they believe to be out of date. The radio links must therefore be designed to accommodate the very wide bandwidths which the future television systems will require. The reader will appreciate that to provide a frequency modulation system handling signal frequencies up to, say, 20 Mc/s means that a deviation of ±30 Mc/s must be used. This is still rather a nightmare for the engineers, but when bandwidths of this sort are available, and there is no doubt that they will be in a few years' time, we shall be able to be thoroughly extravagant in using them for communications purposes. Telegrams will be sent by high-speed facsimile processes, for example, and we may have 400-line television thrown in as an extra on trunk telephone calls. There is, in fact, no limit to what can be envisaged once the V.H.F. radio link comes into its own.


Principles of Radio for Operators, by Ralph Atherton, M.S. The material contained in this book is used in the American Navy for the 16-week course of training for radio operators. Each of its sixteen chapters covers a week's training. A set of problems is given at the end of each chapter of the book which covers basic electrical principles and explains the function of each section of a receiver. There are also chapters on transmitters and circuits. 341 + iv pages. Macmillan and Co., Ltd., St. Martin's Street, London, W.C.2. Price 7s.

Short-Wave Listeners' Annual, 1947. The eight chapters of the annual, include sections on commercial W/T stations as well as broadcasting and amateur stations. Lists of station addresses and slogans are also included. Among the useful miscellaneous data are a wavelength-frequency conversion chart and a list of Standard Times. 254 + vii pages. Amalgamated Short-Wave Press, Ltd., 57, Maida Vale, London, W. Price 2s.

Electrical Developments, by E. G. Britton, D.Phil. An idea of the scope of this book, which gives "simple qualitative accounts of some of the more common electronic devices," will be gathered from the headings to some of its thirteen chapters. They include the Electron, Thermionic Valve, Cathode-ray Tube, Klystron, Positive Grid Oscillator and Magnetron, Cyclotron, Photo-electric Cells, Electron Multiplier, Electron Microscope and Application of Electron Technique to Television. 308 + viii pages with 74 figures. George Newnes, Ltd., Southamton Street, Strand, London, W.C.2. Price 7s 6d.

Microphone Pre-Amplifier

Cathode Follower Circuit Suitable for P.A. Work

By R. SELBY

During the course of modernizing some general-purpose P.A. equipment, it was thought that the existing moving-coil microphones constituted a weak link in the chain of what was intended to be a high-fidelity amplifying system, and consideration was therefore given to the sound cell type of piezo crystal microphone.

The outstanding advantage of this type of microphone is the good frequency response, stated by the makers to extend almost level to about 10,000 c/s. Non-directional pickup, small size and weight, and absence of "blasting" when overloaded, are also useful features. On the other hand, the low voltage output (which cannot be stepped up by a transformer as in the case of moving coil microphones) and the high impedance present problems. The makers give the output as -66 db to a reference level of 1 volt per dyne per sq cm and the impedance as being similar to a capacity of 0.005 µF. In the absence of reliable figures for other types, it is difficult to make any accurate comparison, but in practice it may be said that additional voltage amplification of perhaps 35 to 40 db is required as against a sensitive moving-coil microphone and transformer. The high impedance, predominantly of a capacitive nature, implies that the microphone must work into a load of the order of 5 megohms if loss of bass is to be avoided, and that the self-capacity of the lead, which must be thoroughly screened, will cause a loss of voltage.

A preliminary attempt at incorporating an additional high-gain stage of amplification in an existing A.C. mains amplifier proved, as expected, to be unsatisfactory owing to hum and noise. Attention was therefore turned to the use of a separate pre-amplifier, using D.C. supply for valve heaters, and employing to advantage the characteristics of the cathode follower.

The main amplifying stage, $V_1$, is conventional, employing an R.F. pentode (EF50). This valve is very suitable for the purpose, since it has a very steep slope and is satisfactorily non-microphonic. Strictly speaking, the use of a variable-mu valve is to be deprecated, but in view of the extremely small grid swing to be handled it is not considered that any distortion is introduced. In spite of the use of a 5 megohm grid resistor no grid current can be detected. Bias is derived from a potential divider across the heater supply.

The output stage is a cathode follower, employing another EF50. The high input impedance enables maximum gain to be obtained from $V_1$ without loss of high frequencies, whilst the low output

Fig. 1. Circuit diagram of amplifier. $V_1$ and $V_2$ are EF50's.

Fig. 2. Method of obtaining H.T. supply from main amplifier.
Microphone Pre-amplifier—

impedance permits operation with an unscreened line to the main amplifier. This feature was considered essential, as screened cable, apart from expense, is less durable and much more awkward to handle and joint than ordinary T.R.S. flex.

There is, of course, a considerable loss in the output stage due to the use of the very low load resistance of 100 ohms, but the overall gain of the amplifier is sufficient for all ordinary purposes. If desired, higher values can easily be substituted by a switch, so that when conditions permit the operation of a higher impedance line a higher signal level can be maintained.

H.T. consumption is approximately 2 mA at 100 volts and can, therefore, be supplied easily from a dry battery. Alternatively it may be obtained from the main amplifier, either by a separate line, or by utilizing a species of phantom circuit on the existing signal line, as shown in Fig. 2. The latter method has proved entirely satisfactory. A switch has been fitted to disconnect the circuit for occasions when the main amplifier is being used alone, otherwise its input will be shunted by the comparatively low 22kΩ resistance.

It will be noted that the anode circuits of the pre-amplifier have been rearranged slightly in order to provide the necessary filtering between A.F. and D.C. as simply as possible. This also permits the use of slightly higher H.T. voltage with a consequent substantial increase in gain, and it becomes possible to reduce the load resistance to a figure as low as 50 ohms. The blocking condenser should be as large as possible in order to keep the line impedance low at low frequencies. The writer has used 400 µF but a value of the order of 1000 µF would be preferable, and is not difficult to arrange since the rated working voltage need not be more than about 150 volts.

The H.T. supply must be adequately decoupled and should be taken from a potential divider in preference to a series dropper, in order to prevent excessive rise of voltage on the line and on the electrolytic blocking condenser if the heaters of V₁ and V₂, are cold.

The use of this type of pre-amplifier is not, of course, confined to the sound cell microphone. With suitable alterations to the input constants, any other type of microphone may be used, and a pickup may be fed into the grid of V₁ or the suppressor of V₂. In fact it may easily be developed into a mixing unit of any desired complexity. The writer has incorporated a method of remotely controlling the main amplifier. The main virtue lies in the use of a cathode follower for matching to a low-impedance line, and in the writer's opinion represents a distinct advance on the conventional output stage with step-down line transformer.

Clip-on Test Prod

Made from Easily Obtained Materials

The test prod described here, although it is not quite as simple in construction as the plain pencil type, combines the slender-ness and adequate insulation of that type with a gripping device that enables it to be clipped on to a test point and left hanging there while both hands are free for work. Anyone who has once made and used one of these gadgets will wonder how he ever put up with the non-gripping type. It can be easily made in the most modest workshop.

Fig. 1 (a) shows the general appearance and dimensions. When the cross-bar in the handle is pulled back by the forefinger and thumb, the gripping jaws A and B at the business end are separated. Inside the handle, as shown in Fig. 1 (b), there is a spring that normally presses these jaws together, thus gripping the wire, terminal, etc., that form test points, when this cross-bar (which slides in a slot in the hollow handle) is released. The details will probably be obvious from the diagrams. The author has found it possible to construct these gripping test prods with quite simple and easily obtained materials such as a bicycle spoke for the inner rod, thin metal tubing, Terry springs, and ebonite tube for the handle part.

W. H. C.
Television O.B. Vehicle

New Pye Equipment

DESIGNED to operate in a minimum time after arrival at a site, the Pye television outside-broadcast vehicle is a complete television transmitter from camera to aerial housed in a Hum-ber Utility vehicle. The transmitter has an output of some 50W at 660 Mc/s for a modulation level corresponding to peak white and this is fed through a balanced feeder to a horizontal dipole mounted in a re-flector and carried by a telescopic mast projecting through the roof of the vehicle. The mast is motor-con-trolled and on arrival at a site it is necessary only to switch on the motor; it then looks after itself and switches itself off when the full height of 40ft is reached, so leaving the operators free to attend to the other apparatus. The aerial gives a beam of about ±20° and a gain of some 14 db.

Two camera units on four-wheeled dollies are carried. The wheels are coupled to the camera so that rotating it also turns the wheels and they are thus always set correctly for a direct forwards and backwards movement. A simple view finder only is fitted, both electrical and optical focus being controlled by the operator at the control desk in the vehicle. Optical focus is con-trolled through the agency of a Selsyn system.

One camera on its dolly is shown alongside the vehicle and the other folded up in its carrying position on the drop-back. The backs of the monitor and control racks can also be seen.

The control desk, showing the picture monitor tubes with the waveform monitors above them.

The aerial at its full height on its telescopic mast.

The control desk contains two picture monitor tubes and two waveform monitors. Fading and mixing facilities are provided.

The cameras have Pyton iconscope-type tubes and contain the sound pre-amplifiers as well as the video amplifiers and scanning equipment. E.H.T. is obtained from the line fly-back and there is a safety interlock to remove the supply if the time-base fails. Each camera has 100 yards of cable containing five screened pairs and nine unscreened leads.

Pulse generating equipment in the van produces the synchronizing pulses and mixes them with the V.F. signals, diode clamps being used throughout to maintain the black level.

The Pye Videosonic system is used, in which the sound channel is conveyed by width-modulated pulses inserted in the line sync pulses, thus saving a separate R.F. transmitter and receiver.

The power supply comes from a 3.5-kW generator driven from the vehicle engine, but provision is made for the use of 50 c/s mains when such a supply is available. A separate intercommunication set is provided so that the O.B. crew can work under the immediate direction of the producer at the main television station.

The complete station and vehicle weighs 24 tons and there is room for a crew of three, including the driver. The station was shown at the British Industries Fair at Olympia.

OUR COVER

In the cover picture the folded dipole of the intercommunication channel of the Pye O.B. Equipment can be seen at the side of the reflector of the vision aerial.
Tuned A.F. Filters

1.—General Considerations and Design Formulae

By H. E. Styles, B.Sc.

For purposes such as correction of pick-up response or elimination of heterodyne interference it is often necessary to employ filters which will attenuate a certain specified band of frequencies only. In such cases it is usual to employ either the parallel tuned rejector circuit (1) or the series tuned acceptor circuit (2).

It is a simple matter to design such circuits so as to obtain any desired maximum attenuation at the resonant frequency, but the degree of attenuation at other frequencies depends upon the magnification factor, "Q," of the tuned circuit. Calculation of "off resonance" attenuation is somewhat involved owing to the reactive component of the tuned circuit impedance at such frequencies, the difficulties being accentuated in circuit (2) by the presence of the shunt resistance R normally required for bias and volume control purposes.

It has, however, been found possible to derive a simple relationship between attenuation, frequency and "Q" by means of which the required value of the latter can readily be calculated, thus enabling the circuit constants to be chosen so as to produce any desired maximum attenuation and bandwidth of affected frequencies.

The derivation of this relationship is given in the appendix, final design data being as follows:

Let \( L = \) Coil inductance in henrys.

\[
\begin{align*}
C & = \text{Capacitance in farads.} \\
\gamma & = \text{Resistance in series with} \\
& \text{L (including the coil} \\
& \text{resistance).} \\
R & = \text{Resistance across output} \\
& \text{of filter.} \\
S & = \text{Input series resistance} \\
& \text{in circuit (2).} \\
f_0 & = \text{Frequency of maximum} \\
& \text{attenuation.} \\
f & = \text{Frequency other than} f_0. \\
F_0 & = \text{Desired maximum effective} \\
& \text{attenuation factor at frequency} f_0. \\
F & = \text{Desired effective attenuation} \\
& \text{factor at frequency} f. \\
Q & = \text{Magnification factor of} \\
& \text{the tuned circuit} \\
& \text{comprising L, C and} \gamma.
\end{align*}
\]

From the last equation, knowing \( F_0 \) and \( f_0 \), the value of \( Q \) required to produce any desired attenuation \( F \) at frequency \( f \) can be determined. Usually it is desired to ensure that the attenuation shall become negligible at a given frequency and for practical purposes negligible attenuation can be taken as corresponding, to

\[
F = 0.8 \quad \text{(-2 decibels)}.
\]

Table I gives the value of

\[
Q\left(\frac{f_0}{f} - \frac{f}{f_0}\right)
\]

corresponding to an attenuation of 2 decibels for any maximum attenuation of from 3 to 39 decibels, the first horizontal line giving values of \( Q\left(\frac{f_0}{f} - \frac{f}{f_0}\right) \) for maximum attenuations (at \( f_0 \)) of from 3–9 decibels, the second line from 10–19 decibels and so on. From this table the value of \( Q\left(\frac{f_0}{f} - \frac{f}{f_0}\right) \) corresponding to negligible attenuation for a given maximum attenuation can be read off and hence, knowing the values of \( f_0 \) and \( f \), the required value of \( Q \) can be obtained.

\( R \) is normally determined by considerations other than frequency correction and knowing \( R, Q, F_0 \) and \( f_0 \) the necessary values of \( L, C \) and \( \gamma \) can be obtained from the equations given above.

Design Data for Circuit (1).

\[
\begin{align*}
L & = \frac{R(t - F_0)}{2\pi f_0 QF_0} = \frac{Q\gamma}{2\pi f_0} \\
\gamma & = \frac{R(t - F_0)}{Q^2 F_0} \\
C & = \frac{QF_0}{2\pi f_0 R(t - F_0)} = \frac{1}{2\pi f_0 Q\gamma} \\
Q\left(\frac{f_0}{f} - \frac{f}{f_0}\right) & = \pm \sqrt{\frac{F^2 - F_0^2}{F_0^2(t - F_0^2)}}
\end{align*}
\]

1 Effective attenuation factor is absolute attenuation factor divided by any constant attenuation which may be produced at frequencies outside the affected bandwidth. For circuit (1) absolute and effective attenuations are identical but for circuit (2) effective attenuation equals the absolute attenuation times \( \left(\frac{R + S}{R}\right) \) since the circuit produces a constant attenuation of \( \left(\frac{R}{R + S}\right) \) at frequencies far from resonance.

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www.americanradiohistory.com
Design Data for Circuit (2).

\[ L = \frac{Qr}{2\pi f_0} \]
\[ C = \frac{1}{\pi f_0 Qr} \]
\[ \gamma = \frac{SR_F}{(R + S)(1 - F_0)} \]
\[ = \frac{F_0 S}{1 - F_0} \text{ when } R \text{ is infinitely great.} \]
\[ Q \left( \frac{f_0 - f}{f_0} \right) = \pm \sqrt{\frac{F_0^2 - F_0^2}{1 - F_0^2}} \]

Thus the value of \( Q \left( \frac{f_0 - f}{f_0} \right) \) can again be obtained from Table I, with it is desired only to ensure a given maximum effective attenuation at \( f_0 \) with negligible effective attenuation \((-2 \text{ db})\) at \( f \).

Circuit (2) will of course produce a constant attenuation of \( \frac{R + S}{R} \) at frequencies far from resonance, but this will not affect the frequency correction characteristics of the filter. This constant attenuation can be reduced by increasing the value of \( R \) which in some cases may be omitted, bias being applied by a resistance shunted across the input to the filter. Such a resistance will not affect the attenuation characteristics of the filter, although it will modify its input impedance. In such cases, since \( R = \infty \), circuit (2) will theoretically produce no attenuation at frequencies far from resonance, the impedance of the tuned circuit then becoming infinitely great. In practice, however, stray capacitance across the output of the filter, together with the self-capacity of inductance \( L \), may result in unwanted attenuation of high frequencies and consequently it is usually inadvisable to make \( R \) unduly large.

It will be observed that in the case of circuit (2) the value of \( \gamma \) varies with variations in \( R \) and \( S \) whilst the input impedance of the filter will also depend upon the resistance values chosen. These considerations will decide the most appropriate values for \( R \), \( S \) and \( \gamma \) in any given circumstances.

Input Impedance of the Alternative Filters.

Circuit (1).

The input impedance varies from a minimum value approximating to \( R \) at frequencies far from resonance, up to a maximum value of \( \frac{R}{F_0} \) at the resonant frequency.

This change in impedance may be limited by shunting a resistance \( R' \) across the filter input, the attenuation characteristics of the latter being thereby unchanged. In such a case the minimum attenuation will be approximated to \( \frac{R}{RR'} \) whilst the maximum impedance at resonance will be \( \frac{R}{R + R'} \).

Circuit (2).

In this case the impedance varies from a maximum value of \( R + S \) at frequencies far from resonance down to a minimum value of \( \frac{R}{R + S} \) at resonance. If \( R \) be large compared with \( r \), the minimum impedance will approximate to \( S + r \), whilst if \( R \) be omitted completely the maximum impedance will tend towards infinity. The variation in impedance can therefore be controlled by choice of \( R \).

Factors Influencing Choice of Filter Circuit.

(a) Transmission Loss.

Circuit (1) produces no attenuation at frequencies far from series resistance \( S \), if of large value, tends to isolate the tuned circuit of the filter from the input source. For this reason circuit (2) is often the more suitable for direct coupling to pick-ups, etc., which normally are of reactive character.

(b) Effect of Reactive Input Sources.

If the source feeding the input to the filter is of reactive character the behaviour of circuit (1) may be upset by unwanted resonance effects. This is less likely to occur with circuit (2) as the

<table>
<thead>
<tr>
<th>Maximum Attenuation (db)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tens</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>2</td>
<td>12.9</td>
</tr>
<tr>
<td>3</td>
<td>41.1</td>
</tr>
</tbody>
</table>

(2) Effect of Reactive Input Sources.

If the source feeding the input to the filter is of reactive character the behaviour of circuit (1) may be upset by unwanted resonance effects. This is less likely to occur with circuit (2) as the

(c) Phase Change.

Both circuits may produce considerable changes in phase, particularly at frequencies corresponding to values of \( Q \left( \frac{f_0 - f}{f_0} \right) \) approximating to unity. Whilst such phase changes are normally unimportant, the behaviour of amplifiers employing negative feedback may thereby be adversely affected.

(d) Component Values.

When it is necessary to ensure a specified minimum input impedance it will generally be found that one of the two alternative filter circuits will require more convenient component values than
Tuned A.F. Filters—

the other. Usually it is desirable that the value of the inductance should be as low as possible and it will be noted that for both circuits \( L = \frac{Q_f}{2\pi f} \). Thus the circuit requiring the smaller value for \( f \) will also necessitate the employment of the smallest inductance.

The minimum impedance of circuit (1) is approximately equal to \( R \) whilst, in the case of circuit (2), provided that \( F_0 \) is reasonably small and \( R \) reasonably large, the minimum impedance will not differ greatly from \( S \).

Now for circuit (1) \( r_1 = \frac{R(1 - F_0)}{Q^2F_0} \) and for circuit (2) \( r_2 = \frac{S}{1 - F_0} \) approx.

Hence \( r_1 = \frac{R(1 - F_0)^2}{Q^2F_0^2} \).

Thus, for a given minimum impedance, \( r_1 \) will be greater than \( r_2 \) if \( 1 - F_0 \) is greater than \( QF_0 \).

Therefore, if \( Q \) is less than \( \frac{1 - F_0}{F_0} \) circuit (2) will usually require more convenient circuit components than circuit (1) and vice versa.

Example of the Use of Design Data.

Assume that it is desired to attenuate a heterodyne whistle of 9,000 c/s by 20 db whilst at the same time the attenuation at 6,000 c/s is not to exceed 2 db. Also, the input impedance must not fall below 250,000 ohms, no limit being set to the maximum input impedance.

Then from Table I we find that for a maximum attenuation of 20 db an attenuation of 2 db corresponds to a value of 12.9 for \( Q \) of \( \frac{f_0}{f} \).

Now \( f_0 = 9,000 \) and \( f = 6,000 \).

Hence \( f_0 \) is \( f \) is 0.83.

Thus \( Q = 15.6 \).

Since \( F_0 = 0.1 \) (i.e. -20 db.), \( 1 - F_0 = 0 \).

Hence it is evident that for the purpose in question circuit (1) will demand the more convenient component values. We therefore have for circuit (1):

\[ \begin{align*}
L &= \frac{15.6 \times 9250}{2\pi \times 9000} = 2.56 \text{ H.} \\
C &= \frac{9250}{2\pi \times 9000 \times 15.6 \times 9250} = 0.00012 \mu\text{F}.
\end{align*} \]

**APPENDIX.**

Derivation of the Design Data.

Using the nomenclature employed previously we have:

\[ f_0 = \frac{2\pi \sqrt{LC}}{r} \] (to a first approximation), \[ Q = \frac{2\pi f_0 L}{r} \]

\[ R_D = \frac{L}{C} \] for circuit (1), and \( R_D = r \) for circuit (2).

where \( R_D = \) equivalent resistance of the tuned circuit at \( f_0 \).

If \( Z = \) impedance of the tuned circuit at \( f \) and \( \phi = \) phase angle between current in the external circuit and the applied voltage.

Then \( Z = R_D \cos \phi \) in circuit (1).

\[ \frac{f_0}{f} \cos \phi \] in circuit (2), and \( \tan \phi = \frac{Q}{\frac{f_0}{f}} \).

For Circuit (1).

At a frequency \( f \) this circuit comprises an impedance of \( R_D \cos \phi \) in series with a resistance \( R \), the phase angle \( \phi \). The resultant impedance \( Z_1 \) is given by the expression \( Z_1^2 = R_D^2 \cos^2 \phi + R^2 + 2R_D R \cos \phi \).

Now \( F_0 = R + R_D \), hence \( R_D = \frac{R(1 - F_0)}{F_0} \).

Also, \( F = \frac{R}{Z_1} \), hence \( F_1^2 = \frac{Z_1^2 \cos^2 \phi (R_D^2 + 2R_RD + R^2)}{F_0} \).

\[ \begin{align*}
\cos^2 \phi \left( \frac{(1 - F_0)^2}{F_0} + \frac{2(1 - F_0)}{F_0} \right) + 1 = \cos^2 \phi \left( \frac{1 - F_0^2}{F_0^2} \right) + 1.
\end{align*} \]

Hence \( \cos^2 \phi = \frac{F_0^2}{F^2(1 - F_0^2)} \) but \( \cos^2 \phi = \tan^2 \phi + 1 \).

Hence \( \tan^2 \phi = \frac{F_1^2}{F_0^2} = \frac{F_1^2}{F_0^2} \).

Thus \( Q \left( \frac{f_0}{f} \right) = \frac{F_1^2}{F_0^2} \).

For Circuit (2).

In this case let \( \frac{R}{F} = A \) or \( R = rA \), and \( \frac{S}{F} = B \) or \( S = rB \).

Considering first the circuit comprising \( L, C, r \) and \( R \), we have, at frequency \( f \), an impedance of \( r \) in parallel with resistance \( R \) at a phase angle \( \phi \). If \( Z_1 \) be the resultant impedance \( \frac{Z_1^2}{r^2} = \cos^2 \phi \left( \frac{1}{r^2} \right) + \frac{2 \cos^2 \phi}{r^2A^2} = \cos^2 \phi \left( \frac{1}{rA^2} \right) + \frac{2 \cos^2 \phi}{rA^2} \).

The phase angle \( \alpha \) of this resultant is given by \( \cos \alpha = Z_1 \left( \frac{\cos^2 \phi}{r} + \frac{1}{rA^2} \right) \).

Considering now the complete circuit (2), we now have an impedance \( Z_2 \) in series with a resistance \( S \) at a phase angle \( \alpha \). The resultant impedance \( Z_s \) is therefore given by

\[ Z_s^2 = Z_1^2 + S^2 + 2SZ_1 \cos \alpha = Z_1^2 \left( 1 + \frac{B^2}{Z_1^2} + \frac{2B^2}{Z_1^2} \right) (A \cos^2 \phi + 1) \]

Let \( K = \) absolute attenuation factor at frequency \( f \). Then \( K = \frac{Z_1}{Z_2} \).

Hence \( K^2 = \frac{Z_1^2}{Z_2^2} = \frac{1 + B^2 \left( \cos^2 \phi \left( A^2 + 2A + 1 \right) + \frac{2B}{A^2} \right)}{A^2 + 2B(A \cos^2 \phi + 1) + (A + B)^2} \).

(Continued at foot of opposite page)
Broadcasting in Australia

Review of the Present Position

With her 130 medium-wave broadcasting stations Australia has more transmitters in proportion to her population than America. Australia’s 7,000,000 people are served by 100 commercial stations and 30 Government transmitters—one station to every 56,000—whilst America has one to every 127,000. In this country there is one to every 900,000.

The radio density is 19.69 sets per 100 of the population, which means that nearly every home has a receiver, for the statistician’s population figures show an average of 4.25 people in every home.

The Government transmitters, which vary in power from 1 to 10 kW, are operated by the Australian Broadcasting Commission established in 1923 on similar lines to the B.B.C. The power of commercial stations is limited to 2 kW.

In addition to the medium-wave stations there are five short-wave transmitters operated by the A.B.C. for the benefit of the more remotely situated population. Australia’s 1,500,000 licensed listeners pay £1 a year. An additional licence for a receiver costs £2 a year. There were 72,000 such licences at the end of last year.

Experimental transmissions were recently started from a 2-kW F.M. station working on 90 Mc/s in Melbourne. Some twenty receivers built by the P.M.G.’s Department are being used for the field tests. Over 900 applications for commercial F.M. transmitting licences have been made during the past few years. In a report issued some months ago by the Parliamentary Standing Committee on Broadcasting the conclusion was reached that F.M. service tests should be made by the Post Office in each of the six capital cities and that the Australian Federation of Commercial Broadcasting Stations should be given the opportunity of making similar tests.

Commenting on the possible introduction of television in Australia the Standing Committee in its report points out that it is unfortunate that British and American television equipment is not interchangeable. This means that unless international standardization is introduced within a reasonably short time it will be necessary “to make a fundamental decision involving Empire preference as regards an Australian service.” The committee recommends that tenders be invited for the erection of experimental stations in Sydney and Melbourne.

Turning now to the overseas transmitters, it was not until the end of 1939 that the Australian Department of Information started short-wave broadcasts. The transmitters used were one of 10 kW belonging to Amalgamated Wireless, Australasia, and two 2-kW A.B.C. stations. Radio Australia, as the overseas broadcasting section is called, now operates two 100-kW transmitters (VLA and VLB) and one 50-kW station (VLC) at Shepparton, 110 miles north of Melbourne, and a 20-kW station, VLG, at Lyndhurst, 24 miles south-east of Melbourne.

The Shepparton transmitters employ nineteen aerial arrays for operation on frequencies between 6 and 22 Mc/s.

Australia’s radio industry is now operating nearly 100 factories employing twice as many people as were in the industry before the war. Of the 200,000 sets sold last year about 25 per cent were battery operated. Prices are about 25 per cent above those of 1939.

Tuned A.F. Filters—Appendix (Concluded from previous page)

Now circuit (2) produces a constant attenuation at frequencies far from resonance equal to

\[ R \]

\[ \frac{R}{R + S} \]

or

\[ \frac{A}{A + B} \]

Let \( L \) = absolute maximum attenuation at \( f_0 \).

Then \( L = \frac{R}{Rf + S} \times \frac{A}{A + B + AB} \)

Hence \( F_0 = \frac{A}{A + B} \times \frac{A}{L + A + B} \)

and \( F = \frac{A}{A + B} \times \frac{A}{K} \)

Thus \( F^2 = \frac{(A + B)^2}{A^2} \times \frac{A^2}{\cos^2 \theta (A^2B^2 + 2A^3B + 2A^2B^2 + (A + B)^2)} \)

Hence \( \cos \theta = \frac{1}{F^2} (A + B)^2 \times \frac{2A^3B + 2A^2B + (A + B)^2}{(A + B)^2 (1 - F^2)} \)

therefore \( \tan \theta = \frac{F^2 (A + B + AB)^2 - (A + B)^2 (1 - F^2)}{F^2 (A + B + AB) - (A + B)^2 (1 - F^2)} \)

\[ = \frac{F^2 (A + B + AB)^2 - 1}{F^2 - F_0^2} \]

or \( \frac{F_0^2}{f / f_0} = \sqrt{\frac{F_0^2 - F^2}{F^2 (1 - F^2)}} \) as for circuit (1).
A resonant choke is an inductance which resonates with its own self-capacitance at the radio-frequency concerned. It thus acts as a parallel-resonant circuit at this frequency, and offers a high impedance; because of this the chokes are used to prevent R.F. currents from straying into unwanted paths. In the detector output circuit and in the heater leads of R.F. valves the use of such chokes is not uncommon.

A resonant choke is an inductance which resonates with its own self-capacitance at the radio-frequency concerned. It thus acts as a parallel-resonant circuit at this frequency, and offers a high impedance; because of this the choking action falls off as the frequency departs from resonance. It is, however, effective over a reasonably wide band, and the resonance frequency should be chosen to lie towards the middle of the band to be covered.

Chokes of this kind are not often used at the lower frequencies because the resonance tends to be too sharp in relation to the bandwidth. They could, however, be used in I.F. amplifiers, but they are rarely needed. They find most application at frequencies of 10 Mc/s and over, where it is possible to use a single-layer winding, and then the design of suitable chokes becomes amenable to simple calculation.

When the coil is wound with a large ratio of length to diameter the length of wire required is one-half wavelength. As the ratio is reduced, the length of wire needed is lessened also. This is easily understandable, for shortening a coil increases the coupling and capacitance between turns and so increases the inductance.

Fig. 1 gives a curve showing the value of \( x \) as a function of the ratio of length to diameter of the coil, where \( x \) is the number by which the wavelength must be divided to find the length of wire needed.

As an example, suppose that length/diameter is 4 and that the choke is to resonate at 45 Mc/s. Fig. 1 gives \( x = 2.4 \), and the wavelength corresponding to 45 Mc/s is 6.66 metres. The length of wire is thus \( 6.66 \times 2.4 = 16.00 \) in. If the diameter of the coil is \( \frac{1}{32} \) in the length is \( \frac{1}{4} \) in, and the length of one turn is \( \frac{1}{3} \times 3.14 = 1.18 \) in, so that \( 109/1.18 = 92.5 \) turns are needed. The turns per inch are \( 92.5/1.5 = 61.6 \), and reference to wire tables shows that No. 38 enamelled wire can just be used with careful winding.

Figs. 2 and 3 show curves of winding length as a function of frequency for a number of different winding diameters, and for No. 36 and No. 41 gauges enamelled wire respectively. They are derived from Fig. 1, and are convenient in design, since they enable one to pick the most suitable dimensions very quickly, and it is usually sufficiently accurate to wind the coil to length without bothering about the actual number of turns.

For 13 Mc/s, for instance, with No. 36 wire one could hardly use anything less than \( \frac{1}{32} \) in diameter, since anything smaller would be inconveniently long. Fig. 2 gives the winding length as \( \frac{1}{4} \) in. With No. 41 wire, however, one can well drop to \( \frac{1}{32} \) in diameter and wind to \( \frac{1}{4} \) in. One might not, of course, be able to stand for the higher D.C. resistance of No. 41 wire; one certainly could not in a heater circuit and, in fact, one would try not to drop below about No. 26 gauge for this purpose. Such chokes are not usually needed below about 30 Mc/s, and the dimensions are then so reduced that larger wire is not impracticable.
50L6s — hard to get

*BRIMARIZE! it's a better bet

Substitute a 35L6GT for that hard-to-get 50L6GT. Both are Beam Tetrodes and both International Octals. Their characteristics are similar, except for a small difference in heater voltage. An increase in line cord resistance is all that is required to make this substitution.

<table>
<thead>
<tr>
<th>RATED CHARACTERISTICS</th>
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<tbody>
<tr>
<td>50L6GT</td>
</tr>
<tr>
<td>Heater Volts</td>
</tr>
<tr>
<td>Heater Current</td>
</tr>
<tr>
<td>Anode Volts</td>
</tr>
<tr>
<td>Anode Current</td>
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<tr>
<td>Screen Volts</td>
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<tr>
<td>Screen Current</td>
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<tr>
<td>Grid Bias</td>
</tr>
<tr>
<td>Power Output</td>
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<table>
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<tr>
<th>TYPE</th>
<th>CHANGE SOCKET</th>
<th>CHANGE CONNECTIONS</th>
<th>OTHER WORK NECESSARY</th>
<th>PERFORMANCE CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>35L6GT</td>
<td>INT/OCTAL NO CHANGE</td>
<td>NO CHANGE</td>
<td>Increase line cord resistance by 100 ohms (110 volt receivers) or 80 ohms (230 volt receivers)</td>
<td>NEGLIGIBLE</td>
</tr>
</tbody>
</table>

BRIMAR
RADIO VALVES

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP, KENT.

WATCH THIS SERIES FOR THE BEST ADVICE.
Have you thought of Morganite for the problem?

Of course there are Morganite Potentiometers and Resistors for Radio but do you know that Morganite Resistors are available in ratings up to 500 watts in sizes from 0.05 to 100 cubic inches in rods, tubes and special shapes? In addition to light electrical applications such as clocks, automobile regulators and fluorescent lamps, Morganite Resistors are doing heavy duty, for instance, in electrical power switchgear.

Surge protective Resistors obeying the law R = KV have now been developed and are creating a revolution in the design of surge protective apparatus and interference elimination.

MORGANITE

THE MORGAN CRUCIBLE COMPANY, LIMITED, LONDON, S.W.11
World of Wireless

NEWS OF OLYMPIA

Owing to the number of applications for space in the fifteenth National Radio Exhibition, being organized by the R.I.C. for October 1st to 11th in Olympia, the layout of the stands had to be rearranged. The ballot for stands was held at the beginning of June and the latest list includes the names of 175 firms.

In the section devoted to electronics and communications twenty-three manufacturers will be exhibiting.

"Non-commercial" users of radio equipment who will be exhibiting include the B.B.C., Board of Trade (Export), Cable and Wireless, G.P.O., Scotland Yard and the Ministries of Civil Aviation and Supply.

A feature of the exhibition—the motto of which is "Britain Builds Radio for the World"—is an Export Centre where overseas visitors will find every facility.

INSTRUMENTATION

A BULLETIN of information on technical matters relating to communications, methods of measurement and electro-medical science is to be issued bi-monthly by Marconi Instruments, St. Albans, Herts, under the title "Marconi Instrumentation." It is written essentially for the industry and professionals and deals with trends of development, new applications and experiences in the use of measuring equipment rather than with descriptions of individual instruments.

The first issue contains articles as diverse as the relationship between power factor, loss angle and magnification, clinical aspects of electro-surgery, and monitoring systems for signal generators.

"EXPERIMENTAL SCIENCE"

The above is the title of a booklet issued by the Institute of Physics to explain the purpose, scope and value of the courses leading to the award of National Certificates in Applied Physics. They are awarded by a joint committee of the Ministry of Education and the Institute.

The prescribed training, which is in applied physics rather than in electrical and mechanical engineering, provides for part-time study for three years for the Ordinary National Certificate, and for a further two years for the Higher National Certificate. A student entering for the course should have had full-time continuous education up to the age of 16 or have completed satisfactorily a junior two-year part-time course after leaving an elementary school.

Candidates for the Higher National Certificate who succeed in reaching a sufficiently high standard in the final examination will be granted exemption from the academic requirements for membership of the Institute of Physics.

Copies of the booklet, which has been widely distributed to colleges and in the industry, may be obtained from the secretary of the Institute, 47, Belgrave Square, London, S.W.1.

TELEVISION PROGRESS

The announcement within a day or two of each other that contracts had been placed by the G.P.O. and the B.B.C. for the erection of both the Birmingham television transmitter and the radio-relay link stations between London and Birmingham has created considerable interest. That long-term plans have been made is also evidenced by the receipt of a contract with Marconi's for sound and vision equipment for a subsequent transmitting station, the site for which has not yet been decided upon.

The vision transmitter for the Birmingham station, the site for which is still uncertain, has been ordered from Electric and Musical Industries, whilst the sound equipment will be supplied by Marconi's. It will be recalled that the London station was supplied by the same companies.

Whilst the G.P.O. specification for the London-Birmingham television radio-relay link calls for duplex working, the G.E.C. link will provisionally provide reversible single-channel working in order to expedite its introduction.

Two intermediate stations will be used to relay the signals between the terminal stations which will be near London and Birmingham, respectively. It is uncertain whether the terminals will be linked to the transmitters by radio or cable. Owing to the nature of the terrain one of the paths between stations will be about two miles long and the other two about 40 miles each.

Each station will be equipped with an 80ft lattice steel tower on the top of which will be a 9ft square cabin containing the R.F. and signal channel equipment. The transmitting and receiving paraboloids, each

MOBILE FIELD UNIT used by the G.E.C. during the winter trials to determine the best route for the London-Birmingham television radio-relay link. 12ft in diameter, will be mounted on the cabin. They will incorporate a de-icing system. A small building at the foot of the tower will house the supervisory control equipment and the power supply units.

Four transmitter frequencies of the order of 1,000 Mc/s will be employed and these may be used over and over again if the link should be extended to other centres. It is hoped to give details in a future issue of the system of modulation used by the G.E.C. in the supervhet receivers, whereby the video-frequency signals do not appear except at the terminals.

Duplicate equipment (except aerials) is provided at each station and will automatically come into operation in the event of a failure. The aerials will be automatically
by a ship, entering the range of a Decca chain without accurate knowledge of its position, may instantaneously determine it.

It is understood no case was made by the U.K. delegation for Gee as it is considered to be of no use as a marine aid. This is the opposite view to that taken by civil aviation. In view of this it is interesting to note that one of the recommendations calls for the co-ordination of air and marine interests in each country so that delegates to international meetings on aids for either may speak with the interests of both in mind.

Regarding long-range navigational aids it was agreed that the requirements of aviation are more pressing than those of shipping, but in determining the most appropriate aeronautical aid it is suggested that due consideration be given to the needs of both. It was agreed by the delegates that "Standard Loran gives higher accuracy within its effective coverage area than does Consol within its larger effective coverage area." It was suggested that the Loran system should be expanded wherever it can jointly serve both marine and aviation.

Whilst it is not contemplated that early action will be taken to make the fitting of radar compulsory it is recommended that as a pre-requisite "a universal performance specification of shipborne radar" should be prepared.

No recommendations were made regarding frequency allocations nor restricting shipborne radar to one frequency band.

**BRIT. I.R.E. CONVENTION**

The first post-war convention of the British Institution of Radio Engineers U.N. held in Bournemouth from May 26th to 29th. Members and visitors were officially welcomed at an inaugural luncheon on the Tuesday and attended a convention banquet on the Thursday.

In addition to the presentation of technical papers— covering such diverse subjects as waveguide for microwave, multi-channel communications, radio navigational aids, F.M. transmitter design, high-fidelity recording and reproduction, railway radio, H.F. and V.H.F. valves, television and broadcast aerial design—facilities were available for visits to technical establishments in the vicinity of Bournemouth. These included the B.O.A.C. Airport at Hurn, a demonstration of the Decca Navigator on board the motor yacht "Navigator" and H.M.S. "Collingwood" the Admiralty's main technical training school for radio, electrical and the various radio-location devices.

**AMATEURS AID U.N.**

Plans are being made for the enlistment of amateurs to transmit weekly bulletins on behalf of the United Nations Organization. The offer of amateur help in disseminating U.N. information was made by the president of the International Amateur Radio Union and an agreement has been signed providing for co-operation for one year. The bulletins will be issued to two or three key operators in New York who will transmit them at scheduled times. These transmissions will in turn be rebroadcast by amateurs who will form a world-wide network.

**PERSONALITIES**

Sir Clifford Paterson, F.R.S., has received the James Alfred Ewing Medal for 1946 from the I.E.E. on the joint recommendation of the Royal Society and the Institute of Civil Engineers. Sir Clifford, who received the medal for specially meritorious contributions to the science of engineering in the field of research, is Director of the G.E.C. Research Laboratory.

Professor Willis Jackson, of the Imperial College of Science and Technology, London, has been appointed by the Minister of Supply to the Ministry's Advisory Council on Scientific Research and Technical Development.

O. F. Brown, assistant secretary of the Department of Scientific and Industrial Research, was appointed a C.B.E. in the Birthday Honours. He joined the D.S.I.R. as secretary of the Radio Research Board in 1918 and
served on the first Television Advisory Committee. Early during World War II he went to the M.A.P. and in 1943 was appointed Director, Telecommunications Division. Returning to the D.S.I.R. in 1944, he took charge of the new Headquarters Information Division and was appointed to the present Television Advisory Committee. Mr. Brown was general secretary of the British Commonwealth Scientific Conference held last July and is secretary of the standing committee formed to carry on the work of the conference.

H. L. Kirke, head of the B.B.C. Research Department, was also appointed a C.B.E. Within a year of joining the B.B.C. in 1924 he was appointed to his operation between British and French laboratories in England, he cooperated enthusiastically, opening his own establishment for their equal use.

IN BRIEF

Dearer Replacement Valves.—The British Radio Valve Manufacturers' Association has issued a list of price revisions for types which they regard as obsolete or obsolescent, but for which there is still a demand for the maintenance of existing sets. Nearly sixty types, and their equivalents in different makes, are affected, and price increases in the majority of cases are between 20 and 60 per cent.

On the Map.—It was agreed at the fifth International Hydrographic Conference, recently concluded at Monaco, that the symbol for radar on marine charts should be “RR” to differentiate from “R” which is used for radio. The radar symbol has been used by the Admiralty for some time.

Amateur Transmitters.—The number of licensed amateur transmitters in Great Britain and Northern Ireland on June 9th was 5,161.

British Wireless Dinner Club.—The 24th dinner of the British Wireless Dinner Club was held in London on June 6th with the president, Major-General Sir Leslie G. Phillips, in the chair. The guest of the evening was Sir Edward Appleton, F.R.S. During the evening the election of president and officers for the ensuing year took place, A. J. Gill being elected president and Vice-Admiral J. W. S. Dorling vice-president.

Licence Figures.—A further increase in the number of broadcast receiving licences in force in Great Britain and Northern Ireland was recorded at the end of April, when the total was 10,810,550 (approx.). Of this total 16,600 were television licences. The corresponding figures for March were 10,783,400 and 14,550.

Broadcasting Stations.—The second edition of the Wireless World booklet, giving details of frequency, wavelength and power of 1,200 broadcasting stations in the long, medium- and short-wave bands is now available. To minimize errors entries have been checked against the frequency measurements made at the B.B.C.'s receiving station at Tatsfield. To meet the criticism that there are no details of medium-wave stations outside the European zone, the title of the booklet has been changed to "Guide to Broadcasting Stations." It is available from booksellers, price 15, or by post from our Publisher, 15 st.

London-Kabul Radio Link.—Cable and Wireless, in co-operation with the Afghan Administration, opened a direct 3,500-mile wireless-telegraph beam service between London and Kabul on June 1st.

For "m" read "µ".—The signal strength quoted in the caption to the illustration of the C.B.C. aerials on page 216 of the June issue should, of course, have been given in microvolts.

R.C.A. Index.—The Radio Corporation of America has issued new indices to R.C.A. technical articles and papers that have appeared in various publications.

LOUD HAILER ON THE ROAD. A Hampshire Constabulary police car, fitted with an Ardent re-entrant horn loudspeaker of a type similar to that used as a marine "loud hailer" during the war. The speaker is stated to have a reliable range of 20-25 yards for talking to fast-moving cars; for pedestrian control the range is 100 yards.

H. L. KIRKE, C.B.E.

Marconi's. A member of the I.E.E., he was chairman of the Radio Section in 1944-45. He is chairman of the Acoustics Group of the Physical Society.

Professor G. W. O. Howe, D.Sc., who retired from the James-Watt Chair of Electrical Engineering, Glasgow University, a few months ago, has been given the honorary degree of Doctor of Laws of the University. Dr. Howe is technical editor of our sister journal Wireless Engineer.

The American Medal for Merit was awarded to a number of British scientists a few months ago "for exceptionally meritorious conduct in the performance of outstanding services to the United Nations." The U.S. Embassy has recently given details of the citations, some of which are quoted below:

Sir Edward Appleton "was outstanding in the effectiveness of his work for co-operation between British and American scientists, and was responsible for important phases of the early research leading to the development in the United States of modern radar."

Dr. Robert Cockburn, head of the Counter-measures Group of T.R.E., "was instrumental in devising new electronic techniques to counter the enemy's use of fire control methods, navigation aids and bombing devices. . . . In the field of radio and radar counter-measures, Dr. Cockburn won the British scientific staff, above all others, had the most comprehensive grasp of the scientific and operational problems involved."

Albert P. Rowe, head of T.R.E., "exercised a dominant role in the development of radar and countermeasures in the United Kingdom. When American scientists working in these fields proposed to establish advanced laboratories in England, he cooperated enthusiastically, opening his own establishment for their equal use."

Sir Robert Watson Watt's "years of work, in a field little frequented, largely formed the basis of the extraordinary early success of British radar when the onset of the war engulfed England in a wave of bombing. . . . The success attained in the military employment of these new scientific devices and methods inspired and stimulated the great radar programme in the United States. . . . In the development and effective combat employment of superior types of radar, radar counter-measures and communications equipment, his services were of enormous value."
World of Wireless—

The World of Wireless—

INDUSTRIAL NEWS

Anglo-Belgian Exhibition.—Particulars of an exhibition of British products for European markets, which is to be held in the Salle de la Madeleine, Rue Duquesnoy, Brussels, from September 24th to 29th, are obtainable from the organizers, H. & H. Trading (London), Ltd., 5, Copthall Buildings, Copthall Avenue, E.C.3.

Anglo-Danish Exhibition.—Arrangements are being made by the British Import Union of Copenhagen, in collaboration with the Federation of British Industries, to set up an all-British Exhibition in Copenhagen in September, 1948. A further announcement will be made by the Board of Trade as soon as plans are completed.

H.M.V. public address equipment has been installed in the Savoy Hotel, London. H.M.V. equipment was also used at Olympia for the recent “Ideal Home” exhibition and the B.I.F., for which 390 loudspeakers were used.

Masteradio, Ltd., has a new head office at 10-20, Fitzroy Place, London, N.W.1. (Tel.: Euston 2628) The sales and service depot is at 310-321, Euston Road, N.W.1. A new factory at Tre- forest, Glamorgan, is starting production and the company’s works will eventually be centred there instead of at Watford.

Chloride.—The London sales depot of the Chloride Electrical Storage Co., evacuated from Shaftesbury Avenue to the latter early in the war, is now at 60, Whitefield Street, Tottenham Court Road, W.I. (Tel.: Museum 1616.)

Watson Watt.—The address of Sir Robert Watson Watt and Partners, Ltd., the recently formed company of technical consultants, is 27, Chancery Lane, London, W.C.2. (Tel.: Holborn 3721.)

Multitone Advertisement—Correction.

—In the Multitone advertisement which appeared in the June issue, it was stated “The amplifier incorporates volume compression circuit and two channel output; one channel provides level modification, the other a high pass.” The word in italics should, of course, read “amplification.”

Relay Services Exhibition.—The latest equipment developed for wireless broadcasting relay systems was shown at an exhibition held recently in London by the Relay Services Association of Great Britain. Among the exhibits were high-power audio amplifiers and test apparatus made by Associated Electronic Engineers and W. Bryan Savage; small parts and accessories by Belling-Lee, British E. G. Frye (Relay) and Relay Electric; loudspeakers by C. French, Whiteley Electrical and Wharfedale; cables and overhead wires by Callender’s, G.E.C., and T.C.M.C.; valves by G.R.T.S. and test apparatus by G.E.C. and Mullard.

English Electric Valve Co., Ltd., Queen’s House, Kingsway, London, W.C.2, has been formed to manufacture radio and electrical apparatus.

Lelant Instruments, Ltd., exhibited at the fifty-third International Fair at Barcelona, which was open from June 20th-25th.

CLUBS

Birmingham.—Meetings of the Birmingham and District Short-Wave Society are still held monthly, on the first Monday at 8.00 at the “Hope and Anchor,” Edmund Street, but it is hoped to hold them fortnightly. Sec.: N. Shirley, 14, Manor Road, Stetchford, Birmingham, 9.


I.S.W.C.—A special programme is to be broadcast from HCJB, Quito, Ecuador, for members of the International Short-Wave Club, on June 27th at 05.30 (D.B.S.T.) Transmission will be on 72,445, 6,958 and 15,115 Mc/s (24,68, 30,12 and 19,55 metres). Reception reports should be sent to Radio Station HCJB, Casilla 691, Quito, Ecuador, S. America. I.S.W.C. Sec.: A. E. Bear, 100, Adams Gardens Estate, London, S.E.12.

West Bromwich and District Radio Society meets on Mondays at 7.30 alternately at the “Gough Arms,” Jowett’s Lane, and Uddal Engineering, Mill Street. Practical work is done at the latter address, where the club transmitters, G3BWW, is located. Eight of the members are licensed amateurs. Sec.: R. G. Cousins (G3BCS), 38 Collins Road, West Bromwich, Staffs.

Wigan.—Reception reports of transmissions in the 40-metre band from the station of the Wigan and District Amateur Radio Club (G3BPW) will be welcomed. Sec.: H. King, 2, Derby Street, Spring View, Wigan.

Worcester now has a radio society—the Worcester and District Amateur Radio Club. Meetings are held on the first Thursday in the month at the Victoria Institute. Sec.: D. Higley, 1, York Place, Worcester.

MEETINGS

Institute of Physics


Physical Society

Acoustics Group. A symposium on sound absorption and reverberation at June 26th, at 10 a.m., at the Royal Institute of British Architects. Speakers: include Prof. P. V. Bruel, of Gothen- burg University, and J. Moir, of B.T.H.

Television - Signal Generator

All Power Transformers, Ltd., of 8a, Gladstone Road, Wimbledon, S.W.19, have produced a television-signal generator, Model 200, which is designed to suit the needs of research and development laboratories. It produces a 45-Mc/s modulated R.F. output, the modulation comprising the standard sync pulses and any of the following picture signals: all-black, all-white, 9 horizontal white bars, 9 vertical white bars, chess-board pattern of 64 black rectangles.

Side view with covers removed of All Power Transformers television-signal generator.

All signals are derived from a 101,250-c/s master oscillator by counting down, and stabilizing means are included to keep the phase of the signals constant with respect to the 50-c/s mains. The equipment is rack-built.
The essentials of the line time-base are a saw-tooth voltage generator with a recurrence frequency of 10,125 c/s and an amplifier. It is possible, and in fact, common practice, to use a blocking oscillator and a pentode power amplifier in a circuit very similar to that of the frame time-base described in Part 4. As compared with the frame circuit, however, both linearity and synchronizing are less easily secured.

Linearity is more difficult because there is an additional factor involved—the oscillatory nature of the deflection circuit. Synchronizing is more difficult because the line-scan blocking oscillator transformer must have fewer turns than the frame and it becomes rather hard to develop enough synchronizing voltage across it. In addition, the blocking oscillator develops a large amplitude pulse of opposite sense to the sync pulse and immediately following it. This upsets the interlace if it is allowed to reach the frame circuits and consequently a buffer stage between the line and frame circuits is desirable.

As an alternative the Transistor-Miller integrator saw-tooth generator has many advantages for the line scan. It requires a very small synchronizing voltage and the "backwash" from it is small enough not to affect the interlacing even if a buffer is not used. The saw-tooth output is remarkably linear but is negative-going.

The output pentode must be supplied with a positive-going saw-tooth. This can be obtained from a resistor in the cathode circuit of the Transistor, but it is

Fig. 1. The complete circuit diagram of the line time-base and E.H.T. supply. A Transistor-Miller integrator is used for the saw-tooth generator with a two-stage amplifier having heavy negative feedback.
Television Receiver Construction—more satisfactory to take the normal negative-going output and use an intermediate stage, because this permits the use of heavy negative feedback in the amplifier and this makes it extremely easy to obtain a linear deflector-coil current.

The circuit diagram of the complete line time-base unit is given in Fig. 1. The saw-tooth generator is $V_1$, a valve of the EF50 type. A detailed explanation of the action of the Triatron-Miller integrator has already been given and it is, therefore, sufficient to deal with it rather briefly.

Starting with $C_5$ charged to the full H.T. voltage which, in this instance, is the voltage across the decoupling capacitor $C_9$, the conditions are that the suppressor grid $G_5$ is at about cathode potential and that both the screen grid $G_3$ and the anode are drawing current so that the potentials of these electrodes are below H.T. Because of the voltage drop across $R_5$, the control grid $G_1$ is negative with respect to cathode by this amount, and there is no grid current.

The capacitor $C_6$ then discharges through $R_9$, $R_6$, and $R_7$ and the voltage across it falls and so the $G_1$—cathode voltage changes in a positive direction causing both anode and screen $G_3$ currents to rise and the electrode potentials to fall. The rising voltage across $R_5$ is very nearly equal to the falling voltage across $C_5$, so that the voltage across $R_4$ and $R_7$ is nearly constant. This is the condition for a linear change of voltage across $C_5$ and as the voltage across $R_5$ is changing similarly this also is nearly linear and is the voltage used for the scan.

When the anode voltage falls beyond a certain point the field of the anode becomes insufficient to attract to itself the normal proportion of the electrons passing $G_3$. As a result, the anode current drops and the screen current rises. The latter causes $G_2$ to change negatively in potential because of the increased drop in $R_4$ and the potential of $G_2$ also changes negatively since $G_3$ and $G_4$ are connected through $C_4$. This turns still more electrons back to $G_3$, further increasing the screen current. The action is cumulative and the valve is very rapidly driven to the condition of anode current cut-off, a heavy screen current, a very low screen potential and a highly negative $G_2$ voltage.

In normal operation the action is initiated by a negative-going sync pulse applied to $G_3$. This reduces anode and increases $G_3$ current.

The above conditions hold while $C_5$ discharges through $R_2$ and during this time $C_6$ charges through $R_5$ and the grid-cathode path of the valve from H.T. It does this because with the anode current cut off, the control grid becomes positive to cathode.

When the charge on $C_6$ has leaked away sufficiently, $G_3$ becomes lower in potential and once more permits anode current to flow. This reduces the screen current and causes the screen and $G_3$ potentials to rise further. The action is again cumulative and there is a rapid change-over to the assumed initial conditions.

The time for which anode current is cut off is governed largely by the time constant $C_6(R_5 + R_9)$ and by the grid base of $G_3$. With the EF50 rather a small time constant is required and with 100 pF for $C_6$ a resistance value of around 50 kΩ is suitable. The sync input needed is small and so it is applied to a tapping on the grid leak formed by using 47 kΩ for $R_5$ and 4.7 kΩ for $R_9$. It is applied through a 10-pF capacitor which together with $R_9$ acts as a differentiator.

The cathode resistor $R_4$ and its by-pass capacitor $C_4$ are included to make the generator self starting. Without them, it would sometimes fail to start in the absence of sync pulses.

The saw-tooth output is taken from the slider of $R_6$, which forms the "Picture Width" control, to the input of the amplifier. The first valve $V_2$ is an EF37 (or EF36, 6J7, 6J7G, GT, etc.) strapped as a triode and RC-coupled with $R_{11}$, $C_9$, and $R_{13}$ to the EL38 output valve $V_3$. A grid stopper $R_{18}$ is included to inhibit parasitic oscillation and a screen stopper $R_{14}$ is also used. The screen is fed from the $+$ H.T. line at about 250 V.

The value is self-biased by $R_{18}$ and feeds the deflector coils through the transformer $T_1$. A resistance $R_{18}$ is included in series with the deflector coil and the voltage developed across it by the passage of the deflector-coil current through it is applied to the cathode of $V_2$ as negative
current feedback. With the high degree of feedback provided, the whole amplifier, from its input voltage to the deflector coil, is extremely linear and it is consequently easy to obtain a linear scan. However, this is not sufficient to ensure a linear scan at the extreme left-hand side of the picture, for with the most economical operation the output is accordingly provided to control the linearity at this point. It is provided by C9 in conjunction with R19, R20, R21, R22, R23.

The E.H.T. supply for the tube is taken from the line fly-back. A voltage-doubler rectifier circuit is used and fed through the anti-parasitic oscillation resistor R15 from a tapping on T1; this is done since rather less than the full voltage on T1 is needed. Three capacitors, two rectifiers W1 and W2, and a resistor R17 form the rectifier which provides an output of some 5 kV.

The form of construction

Details of the layout of components are clearly shown in these photographs of the underside of the chassis. C1 is joined to a single insulator tag to which a lead is run from the Line Sync Output tag on the frame time-base.
Television Receiver Construction—adopted is clearly shown in the photographs and is similar to that of the frame time-base. The chassis measures 9\(\text{in}\) by 9\(\text{in}\) high end of the main chassis. A shelf mounted 3\(\frac{1}{8}\)in below the top carries the rectifiers and is cut away near the rectifier terminals.

On account of their length the protective cover to prevent accidental contact.

The power supplies at 6.3 V, 250 V and 480 V are taken by flexible leads to a tag-board on

by 3\(\text{in}\) deep and has a shelf mounted 5\(\text{in}\) from the top to support the valveholders. The shelf is carried by strips of 3\(\text{in}\) by 3\(\frac{1}{8}\)in brass screwed to the chassis and which also act as stiffening members. On account of the great height of the EL38 its valveholder is carried by a small sub-panel standing 3\(\frac{1}{8}\)in below the main valve shelf and secured to it by two pillars.

The E.H.T. components are carried in a sub-chassis measuring 3\(\text{in}\) x 3\(\text{in}\) x 3\(\frac{1}{8}\)in screwed to the rectifiers are not easy components to dispose of, particularly as they must be kept away from hot parts. They are held in place by a simple clamp and lie across the C.R. tube. As the connections are all at high voltage to earth ignition-cable is used for the leads and a protecting box cut from fibre sheet is used to cover the ends remote from the chassis. Similarly a fibre plate is used as a cover for the sub-chassis. The fibre does not provide any normal insulation; it is used purely as a which there are also two tags for the deflector coil leads. A single tag near the input circuit is used for the sync input and is connected by a flexible lead to the "line sync" terminal on the frame time-base unit.

The 1.88-MΩ resistor \(R_{17}\) in the E.H.T. circuit comprises four 0.47-MΩ resistors connected in series and this arrangement is adopted to reduce the voltage existing across any individual resistor. The feedback resistor \(R_{16}\) is two 33-Ω resistors connected
in parallel, because the required 16.5 Ω is not a standard value. Similarly, \( R_{18} \) comprises two 300-Ω resistors in parallel.

The waveforms at various points in the circuit are shown in Fig. 2 and it is a great help in adjustment if an oscilloscope can be used and connected across \( R_{18} \). In order to obtain the full scan, the linearity resistance \( R_{19} \) and \( R_{22} \) must be carefully adjusted in conjunction with the picture width. Several fixed resistors, connected to sockets and a wander-plug are used in conjunction with the variable \( R_{22} \) merely because variable resistors of sufficiently high power rating are too difficult to obtain at present for it to be practicable to use a single component.

Set the wander plug to include \( R_{19} \) and \( R_{22} \) in circuit at first and with \( R_{8} \) set for a small output examine the waveform across \( R_{18} \). It should have one of the forms sketched in Fig. 3 (a) in which A is the correct one. By adjusting \( R_{22} \) in conjunction with the wander plug to bring in or cut out additional resistance if necessary, there should be no difficulty in bringing it to this correct form A.

Now increase the amplifier input by \( R_{8} \). There will at first be little or no change of output waveform except for its magnitude. At length, however, it will start to change to the form B. This occurs when the input is sufficient to cut off \( V_{3} \) at the end of the fly-back.

As soon as this point is reached, readjust \( R_{22} \) to bring the waveform back to A and continue the process of increasing the input and readjusting \( R_{22} \) to keep the waveform like A. The adjustment should be carried out with the saw-tooth generator synchronized to the television signal, because there is a change of both amplitude and frequency in \( V_{1} \) between the synchronized and unsynchronized conditions. If the correct sync pulse is fed to the line sync terminal, it is necessary only to adjust \( R_{8} \) to synchronize the generator and the setting is not critical.

The process of adjusting \( R_{8} \) and \( R_{22} \) should, of course, cease when the correct picture width (7½ in with a 9-in tube) is obtained. There should be no difficulty in obtaining this, but it is as well to indicate what happens when one tries to obtain too much output. Beyond a certain point a kink appears in the wave as shown in Fig. 3 (b), at first small A, and then very large B.

Fig. 3. The waveforms appearing across \( R_{18} \) shown at (a) are with correct A and with incorrect damping B and C. The effect of excessive drive on \( V_{3} \) is indicated by the waves of (b).

This appears because \( V_{3} \) is cut off for too long. The overshoot starts the flyback correctly but the valve does not start to drive early enough and a flat in the wave appears. On the picture the effect is a vertical bright line about one inch from the left-hand side.

If an oscilloscope is not used, the adjustments must be carried out by observing the picture and this is not so easy. Waveforms like B of Fig. 3 (a) are characterized by a bright line on the extreme left-hand edge and in an extreme case, by a folding over of the left-hand edge. Waveforms like C, however, result in an extension of the left-hand side and if one observes an object in the picture on a panning shot it will be seen to increase in width as it comes to the left-hand side. On the test pattern the black rectangles in the border will be
Television Receiver Construction—

wider on the left than on the right.

There is a considerable difference in the current taken by the EL38 with and without drive. With 480 V for H.T., and 250 V for H.T., the anode and screen currents are 72 mA and 8 mA with no drive and rise to 94 mA and 14 mA with drive for normal output. The screen dissipation rises from 2 W to 3.5 W and is well within the rating of 6 W. The anode dissipation with no drive is about 34 watts, which is considerably in excess of the rating. Care must be taken not to run the valve for any lengthy period without drive. With full drive the stage draws 45 watts from the H.T. supply, but this is not anode dissipation, for the major part of it is dissipated in the load and not in the valve. The exact dissipation at the anode is not known, but is of the order of 10-15 W only.

The E.H.T. voltage can be checked roughly by inserting a meter in series with a string of resistors totalling some 40 Ω as a minimum. The voltage is the current multiplied by the resistance. It will be lower than the actual voltage, however, because of the load of even 40-Ω resistance. With 40 Ω series resistance, the voltage is 4 kV per 0.1 mA and an indication of some 4.5-5 kV should be obtained. The actual voltage without the meter will then be some 5-5.5 kV.

Although the current requirements of the output stage are

COMPONENTS

The parts in this list are the ones employed in the original model. Any components of the same electrical specification and suitable physical dimensions can be used.

**Capacitors**

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>10 pF, 250 V working</td>
<td>T.C.C. Type CM22</td>
</tr>
<tr>
<td>C2</td>
<td>100 pF, 250 V working</td>
<td>T.C.C. Type CM23</td>
</tr>
<tr>
<td>C3</td>
<td>8 μF, 500 V working</td>
<td>Dubilier Drilitic</td>
</tr>
<tr>
<td>C4</td>
<td>0.1 μF, 350 V working</td>
<td>T.C.C. Type CP41</td>
</tr>
<tr>
<td>C5</td>
<td>200 pF, 250 V working</td>
<td>T.C.C. Type CM24</td>
</tr>
<tr>
<td>C6</td>
<td>0.001 μF 350 V working</td>
<td>T.C.C. Type T.M</td>
</tr>
<tr>
<td>C7</td>
<td>0.01 μF 1,000 V working</td>
<td>T.C.C. Type CP41</td>
</tr>
<tr>
<td>C8</td>
<td>0.002 μF 5,000 V test</td>
<td>Dubilier Type 680</td>
</tr>
<tr>
<td>C9, C10, C11</td>
<td>0.001 μF 5,000 V test</td>
<td>Dubilier Type 680</td>
</tr>
</tbody>
</table>

**Resistors**

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, R2</td>
<td>47 kΩ 1/2 W</td>
<td>Erie</td>
</tr>
<tr>
<td>R3, R10</td>
<td>4.7 kΩ 1/2 W</td>
<td>Erie</td>
</tr>
<tr>
<td>R5</td>
<td>10 kΩ 3 W, variable, linear law</td>
<td>Reliance Type TW</td>
</tr>
<tr>
<td>R6</td>
<td>2 MΩ, variable, linear law</td>
<td>Reliance Type SG</td>
</tr>
<tr>
<td>R7, R9</td>
<td>2.2 MΩ 1/2 W</td>
<td>Erie</td>
</tr>
<tr>
<td>R8</td>
<td>33 kΩ 1/2 W</td>
<td>Erie</td>
</tr>
<tr>
<td>R10</td>
<td>100 kΩ 1/2 W</td>
<td>Erie</td>
</tr>
<tr>
<td>R11, R10</td>
<td>0.47 MΩ, 1/2 W</td>
<td>Erie</td>
</tr>
<tr>
<td>R12, R13</td>
<td>2.2 kΩ 1/2 W</td>
<td>Erie</td>
</tr>
<tr>
<td>R14</td>
<td>47 Ω 1/2 W</td>
<td>Erie</td>
</tr>
<tr>
<td>R15</td>
<td>2 x 300 Ω 1 W, in parallel</td>
<td>Welwyn</td>
</tr>
<tr>
<td>R16</td>
<td>4 x 0.47 MΩ 1/2 W, in series</td>
<td>Erie</td>
</tr>
<tr>
<td>R17</td>
<td>2 x 33 Ω 1/2 W, in parallel</td>
<td>Erie</td>
</tr>
<tr>
<td>R18, R20, R21, R22</td>
<td>1 kΩ 3 W, variable, linear law</td>
<td>Welwyn</td>
</tr>
<tr>
<td>R23</td>
<td>1 kΩ 3 W, variable, linear law</td>
<td>Reliance Type TW</td>
</tr>
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</table>

**Valves**

<table>
<thead>
<tr>
<th>Valves</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>EF50</td>
</tr>
<tr>
<td>V2</td>
<td>EF37</td>
</tr>
<tr>
<td>V3</td>
<td>EF38</td>
</tr>
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</table>

**Rectifiers**

<table>
<thead>
<tr>
<th>Rectifiers</th>
<th>Output rating (based on R.M.S. input), 2 kV, 3 mA</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1, W2</td>
<td></td>
<td>Siemens Type H4/200</td>
</tr>
</tbody>
</table>

**Transformer**

T₁  See text.

Note.—In Part 4, the type number of the 2-MΩ variable resistor was inadvertently given as Reliance Type TW instead of Type SG.

The bobbins, end cheeks and spacing rings are shown on the right and the parts partially assembled above.
Windings are carried by three concentric bobbins each having
slots in which the windings are laid with paper
interleaving.

Experience has shown that
surface leakage is the biggest
trouble and the slots are not
symmetrically placed in the bob-
bin but are to one side to increase
the leakage path at the high-
voltage end. If bakelized paper
or ebonite tubing of the right
size is available the bobbins can be
turned from this. However, such
materials are not easy to obtain
and the writer has successfully
used ordinary gummed-paper
strip.

A mandrel should be turned of
the diameter of the inside of the
former and wrapped with a layer
of thin waxed paper to prevent
the former from sticking. The
strip is then wound on slowly
wetting it thoroughly as it is done
and giving time for the paper to
stretch. The paper should be
pulled tight as it is wound and the
former should be built up some-
what oversize. It should be put
on one side for two days or so to
dry thoroughly, and with a little
care it will be found to turn on
a lathe quite well if a sharp tool is
used. Of course, as with any
laminated material one must turn
in the right direction, otherwise
the tool just digs in and starts
unwinding the paper.

The turned bobbin should be
baked, if a dry oven is available.
The oven of an electric cooker
is quite suitable, but the ordinary
gas cooker is hardly advisable
since the combustion of gas
produces quite a lot of water
vapour amongst other things.
When quite dry give the bobbins
two or three coats of shellac
varnish.

The end cheeks are cut from
laminated bakelized sheet and
have rectangular holes to take
the core; grooves are turned on
the inner faces to centre the bob-
bin. As the leading-out wires
from the inner and middle bobbins
pass through holes in the cheeks
it is necessary to prevent them
from turning, since if they did, the
leads would be sheared off. This
is done by drilling a small hole
through one end cheek and a
little way into the edge of the

(Continued at foot of next column)

<table>
<thead>
<tr>
<th>TABLE</th>
<th>radiogramophone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>516TG has been introduced by Sobell Industries, Langley Park, nr. Slough, Bucks.</td>
</tr>
</tbody>
</table>

The receiver is a
superhet (4 valves
+ rectifier) with a
4-watt output stage
and covers the usual
short, medium and long
waveranges. A

“Sobell” Model
516 T.G. table
radiogramophone.

price of the Model 717 is £34 13s
plus £7 9s purchase tax. A
radiogramophone incorporating
the same chassis with a 12-inch

turntable. The price is £40 19s
plus £8 16s rd purchase tax. A
model with two short-wave ranges
covering 12-100 metres and a
medium-wave range is available
for export.

The “Sobell” Model 717 is a
seven-valve receiver with an
8-watt push-pull output stage
covering long, medium and two
short-wave ranges. The rounded
top front edge of the walnut
veneered cabinet contains a rotating
drum scale connected to the
wave-change switch and shows
only one scale at a time. The

loudspeaker, Garrard automatic
record changer, costs £143 17s
plus £30 18s 7d purchase tax. A
tilting panel brings into view the
radio receiver dial, and the record
changer is housed in a drawer
which is normally closed while
playing.

Restoring Bass

If the bass response of a set several
years old has gradually failed,
and if everything possible to restore
it electrically has been done, it may
be worth while to take more drastic
measures.

Like most other things, loud-
speakers deteriorate with age. One
part most likely to suffer from old
age is the cone suspension. If it is
made of some composition fibre, it
will slowly harden with age until it
feels quite stiff when you try to
move the cone by hand. If and
when that happens, bass response
will disappear, because the cone can
no longer move freely to pump an
air column.

To rectify the trouble, set the
speaker down somewhere with the
cone upward. Take a tin of very
light machine oil, and run some oil
round the two corrugated grooves
in the cone suspension. Let it stand
until no more oil soaks in, then
remove the surplus with a piece of
cotton wool. Don’t let oil run down
the cone, or get anywhere else but
in the suspension grooves.

Results may not be immediately
apparent, but within twelve hours
the loudspeaker should be producing
bass as robustly as in its pristine
youth.—A. D.
LETTERS TO THE EDITOR

H. J. Round on the Origin of "Squegger" +
Causes of Night-time Ionization +
Amateurs Losing Frequency Band?

"Squegger"

Occasionally one still comes across the term "squegger" as a description for various forms of blocking oscillators. I have not seen any credit given to the originator of the "squegger" circuit and, incidentally, the inventor of the name.

Some time during the first World War (about 1916, I should say) Major C. E. Prince, who was then working on aircraft telephony, showed me a transmitting wavemeter which he had made. It was built on conventional lines, with a tuned anode circuit and grid reaction coil.

Some time before that date I had introduced the grid leak and condenser into transmitter circuits, giving the class C type of oscillator. Prince spotted that if the grid leak was greatly increased in value automatic modulation of the transmitted signal occurred.

He roughly described the process to me as a "squeezing" operation and there and then decided to call the circuit a "squegger".

New Barnet. H. J. ROUND.

"Whistling Meteors"

The author of this article (your April issue) omits mention of two important factors: cosmic rays and "afterglow." The latter is very strong during summer nights and can be equally recognized in semi-darkness. Would meteoric ionization account for the rise in night-time ionization during summer months?

Cosmic rays are powerfully active all times, the only force which is capable of modulating them being a "severe" ionosphere storm. The force of cosmic rays extends to many millions of electron volts and results in charging the atmosphere with positive, negative and neutral particles according to latitude, longitude and height. Furthermore, cosmic rays as measured at the earth's surface follow the geomagnetic contours faithfully. Indeed, there is a North-South, East-West anomaly which is so marked in the world critical frequency contours. Here, then, is some definite correlation. One other correlation is that cosmic rays, too, have a peak at the earth's leading face—a matter of about one per cent.

I am only too conscious of the ionization that must be produced by meteors to question its validity, but can we attribute the whole of the night-time ionization in the ionosphere to them?

I would suggest, therefore, that night-time ionization is due to (1) Residual or afterglow, (2) Cosmic rays, (3) Meteors and (4) other causes, such as terrestrial radiations, etc.

ALBERT PARSONS.

Portsmouth.

Amateurs on E.H.F.

In the May issue of Wireless World R. Naismith, of the N.P.L., discussing the reception of six-metre transatlantic signals, expressed hope that the number of people interested in 50-Mc/s work had increased by the large number of British amateurs who have been taking practical steps to this end, both by transmission and reception on frequencies of this order. But these amateurs have been rudely shaken within the last few weeks by the discovery that there is a great possibility of these frequencies being taken from them. This act of ingratitude towards a loyal body of men and women is one which should not be allowed to pass without comment in your pages.

The war work performed by amateurs may not be known to the persons responsible for the proposal to withdraw from amateur use the frequencies in question. But surely there is someone who can put a brake on the hasty action and ensure that at least a portion of the band is retained for the "hams" who, to quote an official citation, "gave freely of their time and skill" during England's hour of need.

E. R. WESTLAKE, G6KR.

Shrewsbury.

Domestic Recordings

There is one essential point which "Diallist" in his "Random Radiations" and pre-
R.S.G.B. D.F. Contest

On Sunday, May 18th, six-seventeen competitors and friends participated in a hunt for a hidden radio transmitter, the only information vouchsafed being that it was within 10 miles of High Barnet, Herts., was operating on 4,765 kc/s and using the call sign G6CT/P.

Despite showers in the afternoon enthusiasm ran high, yet only five teams actually located the transmitter within the stipulated period. The first to reach the transmitter, which, incidentally, was cunningly

hidden in a dense thicket just off a by-lane near Radlett, was F. Holdaway, of the Romford Radio Society. He was followed about an hour later by S. T. Smith’s team and soon after R. A. Davis’s party, also of the Romford Society, joined them. The winner used a miniature five-valve superhet, screened frame and a short vertical aerial for “sense” determination.

(Above) Taking preliminary bearings at the starting point.

(Left) D.F. Superhet used by the winner, F. Holdaway.

S. T. Smith was the second competitor to locate the transmitter. He is a member of the R.S.G.B. and Southend Radio Society.

Locating a Hidden Radio Transmitter With Amateur-built Direction Finders

Frequency Bands

Wireless World rightly objects to the use of such vague terms as “very,” “ultra” and “super” for defining precisely delimited frequency bands. But are you not yourselves similarly open to criticism for accepting with open arms the equally vague words “long,” “medium” and “short” as designations of wavebands?

W. E. WEBBER.
London, N.W.

[Probably, but we can plead long-established usage, expediency and wide acceptance of these terms. They designate wavebands which fortunately fall roughly into natural classifications by virtue of their propagation characteristics. More fortunately still, the waveband limits (in metres) correspond to such beautifully round numbers that they can be easily memorized. “Very,” “ultra” and “super,” as used officially for frequency classification, lack these advantages, and the significance arbitrarily attached to these words is not generally known. —Ed.]

“Electronics”

CATHODE RAY” told us (in your February issue) that “electronics is a useful word, but—” May I underline the “but” or, rather, go so far as to suggest that the term as used is a thoroughly bad one? By the usage of language it should have a vastly wider application than to “the conduction of electricity through gases or in vacuo.” This arbitrary restriction of the meaning of the word seems to me to be unwarranted and undesirable. By analogy “electronic” should be the adjectival form of “electron.”

L. WAFER.
ELECTRONS really exist. J. J. Thomson and others showed by experiment that electrons really do “shoot off” from hot bodies. Furthermore, it has been shown that if the carbon rod of a battery is connected to a plate and the zinc to a heated cathode, both being contained in an evacuated envelope, the electrons are “encouraged” to cross the space between. Then in any circuit including a valve it is an easy matter to draw an arrow showing the direction of electron flow from cathode to anode. The direction of flow through any other component follows.

As an example consider the rectifier supply unit of Fig. 1. First draw an arrow between cathode and anode of the rectifier valve, then as many more arrows as you like round the circuit, all the same way. Thus, in the resistance shown to represent the rest of the receiver electrons must flow from A to B.

In this way the direction of flow in any part of any circuit containing a valve can be found. If a battery is part of the circuit it must be remembered that the red end—the carbon of a dry battery—“sucks” electrons and the black end “pushes” them out. Hence it is as easy to find the direction in a circuit containing a battery as in one with a valve.

Gremlins have a language of their own. A gremlin riding round a circuit on the back of an electron calls all the joys to come “positive” and all those already passed “negative.” These words are borrowed from the mathematicians who use “negative” to mean the opposite way to the direction it has been agreed to call “positive,” or a quantity of opposite kind to that called positive. If a plug is called “positive” in Gremlin it is certain that its socket is called “negative.”

Some parts of the tour on electron-back are specially important and are to be remembered. The coil of a moving-coil meter is such a part. The terminal to which electrons go, as seen from inside the meter coil, is marked +. Of course, it is not + from the point of view of an electron that has already passed through it, but as it is those now in it that make the pointer move (or burn out the coil!) it is their point of view that labels the terminals. A battery’s job is to cause an electronic commotion outside itself, so it gets labelled from the point of view of electrons outside it.

Now consider the circuit of Fig. 2. The arrows show the direction of flow; there can be no argument about that. As seen from “ground level” the cathode is labelled + because electrons are going towards it. The grid is connected to ground level, so is entitled to no label. However, the electrons just leaving the cathode find the grid is trying to push them back, so from their point of view it is negative. If the labels + and – are permanently left on the diagram it must be obvious from what point of view each one was put in.

If something makes the grid go a little negative (as seen from the earth line) fewer electrons flow to the anode, but since the suck of the battery is unchanged electrons must be drawn from the upper plate of C towards the battery. More electrons then flow to the lower plate in an effort to fill the void. As a result there is an increase in potential difference between the plates; that is, the upper plate becomes more positive.

Fig. 2. The electron flow in an RC amplifier stage.

BOOK REVIEW

There are fifteen chapters devoted to the history and theory of frequency modulation. Chapter 2, Theory of Frequency Modulation, is the important one and consists of a very good elementary explanation of F.M. and of the circuits peculiar to it.

Many of the other chapters, such as those on Audio Distortion, High Fidelity, Antennas and so on, might well be considered out of place. The matters dealt with are quite independent of the form of modulation used and apply equally to A.M. They contain much useful information, but of a kind for which one would not turn to a book entitled F.M.
Q.24. If a "Skyrod" or Television Aerial is erected on a building, is there any added risk of being struck by lightning?

A.24. Since the number of T.V. and Skyrod aerial installations has become considerable and following a period of thundery weather with lightning, the service department has been inundated with enquiries as to what users can do to protect themselves and their property against damage by lightning. These enquiries come in from members of the public, wireless dealers and wholesalers.

First of all, the nomenclature is unfortunate, in so far that a lightning conductor does not conduct or attract lightning, and a lightning arrester cannot arrest lightning.

One would expect interested people to realise that architects do not fit "lightning conductors" to chimneys, factories or other buildings to increase their chances of being struck, therefore why should those who fit a T.V. or Skyrod aerial, presumably with some visual resemblance to a "lightning conductor," expect increased danger?

Readers who have visited Switzerland (and presumably other alpine countries where isolated wooden buildings are commonplace) will have noticed two or three spikes several feet high on roofs of isolated hillside dwellings, these are not aerials but "lightning conductors" to minimise the risk of a strike which inevitably would result in fire.

Questions referring to lightning and thundery weather are becoming very numerous and below we repeat questions 24 and 27, which deal with these subjects.

of the rooms en route. If the unfortunate house is on the 'phone the wires are generally fused, in spite of the proven "r" lightning arrester" fitted by the G.P.O. All this happens whether or not there is an aerial lashed to the chimney.

When you take into account the many millions of houses, and the odd one or two that are damaged by lightning, you realise that the risk is negligible. As tangible proof of this, damage by lightning is generally included in every householder's comprehensive insurance policy, and no increased risk is recognised by the addition of an aerial, T.V., Skyrod, or horizontal.

As an additional "vote of confidence" every Belling-Lee aerial system is insured by us for a period of twelve months, up to a sum not exceeding one hundred pounds, against damage to the aerial system or radio or television receiver due to lightning. Following normal procedure, this comes into operation only in the event of there being no collateral insurance or after any existing insurance cover has been exhausted.

Q.27. Precipitation Static—what is it?

A.27. This is not a very good name, but it has become accepted as applying to any form of static caused by electric charges building up on an aerial quicker than they can leak away: the result is a form of corona. Aerial corona usually extends only a microscopic distance from the conductor, is usually invisible even in the dark, but is often audible near the conductor as a faint hissing sound. The condition is not common except in certain districts. We have reports from high locations round Sheffield, in parts of Yorkshire, on cliff top locations by the sea, etc. It may occur without rain when it is generally heard as a particularly violent hissing noise in the loudspeaker. Thundery weather is not essential. It is generally accompanied by rain or hail, and is sometimes known as "rain static." This type is heard as a series of pops, the frequency of which varies, rising to a roar as the centre of the rain storm approaches. Temporarily earthing the aerial stops the noise, but it builds up again in a few seconds. The charges may be induced from clouds, or by charged raindrops. In dry locations the charge may be built up by the friction of sand or other particles being impelled upon the aerial. The trouble is serious on aircraft, and may result in the air services over vast areas being grounded while the condition persists. The condition came to the notice of some home listeners only after the advent of the more efficient Skyrod aerial. It is now becoming an occasional nuisance to television enthusiasts. You must use an efficient aerial; fortunately it is not frequent in London. So far our technical staff have only seen rain static flashes obliterating an unmodulated raster, and we anxiously await reports of the effect when a transmission is on.

We are not taking all this "sitting down." We have already done a lot of research, including the interrogation of German scientists, and of course a very thorough survey of all that has been written in other countries. The problem of the "ground aerial" is quite different from that on air-borne aerials. We are quite hopeful of success. We would welcome co-operation from our readers. Will those of you who are troubled in this way help us by keeping us advised as to conditions when the nuisance is observed. If you will undertake to help, please write for a questionnaire. It doesn't matter whether or not you use a Belling-Lee aerial.

TO BE CONTINUED.

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Channels of Communication

2. Are They Being Used to Capacity, and, If Not, How Can They Be?

LAST month we noted that channels of communication, like bottles of milk were scarce, not because there were fewer of them than before, but because the demand was rising all the time. And that whether they were radio or line channels, their width (in frequency) was a measure of the rate at which information could be passed along them. Put another way, if a given quantity of information was sent in a short time, \( \Delta t \), it occupied a wide frequency band, \( \Delta f \), and vice versa.

Constant D.C. or A.C. (occupying no frequency width) could not convey signals until it was modulated, and the faster it was modulated the wider the spread of side-bands. Nobody had found (or was likely to) any escape from this conclusion. But in the endeavour to find more channels a possible line of attack was to see whether they were really running full, or if the information could be squeezed tighter without damaging any of it. Was there a definite minimum "quantum" of frequency band \( x \) time, \( \Delta f \Delta t \), needed to convey one unit of information?

Now read on.

One approach is Fourier analysis. This must be familiar to most readers, for example, in the well-known fact that if a sine wave is distorted, say by amplifying it by a valve, the distorted wave can be analysed into a fundamental—a sine wave of the same frequency as the original—plus harmonics, sine waves of higher frequency. The more angular a wave-form, the more harmonics are needed to build it up. That can easily be shown by drawing the waves and adding them together. Some interesting examples—square and peaky curves—appeared in Wireless World Dec., 1945, p. 358.

Next, it should be fairly easy to see that the more exact and comprehensive the information to be signalled in a given time, the more angular and complex the signal must be, and therefore the wider the frequency band it covers. Fig. 1a is a word in morse, clear-cut and perfect to read. To make all the sharp corners, occurring at varying intervals, a very wide range of sine wave frequencies is needed. In Fig. 1b the corners have been rounded off by passing the signal through a channel-narrowing filter, but the morse is still readable. The \( a \) version was wasteful signalling. But if channel economy is pressed too far, as at \( c \), so that only the lowest frequency sine waves are left, the morse becomes unreadable. (Again, is there a definite limit to this paring-down of the signal before one loses the information?)

Radar is one extreme example. In it one wants to mark a time as exactly as possible. To do so one sends a sharp pulse. For perfect accuracy in signalling the time, the front (or back) of the pulse must be quite vertical, or it must be infinitely sharp-pointed. Any of these requirements necessitates an infinite number of harmonics. So although a time or other single item of information could be signalled in an infinitely small period of time by an infinitely short pulse, an infinitely wide channel would be needed.

This elementary signal is all width (of frequency) and no length. It is represented on a frequency/time diagram as an endless horizontal line (of time)—Fig. 2a. In practice, of course, radar has to be content with a finite (though very large) \( \Delta f \), and as a result the pulse is slightly rounded off and occupies a finite (though very small) \( \Delta t \). It is represented in Fig. 2a by a narrow horizontal strip.

The Decca Navigator is at the opposite extreme. It is the frequency that must be exact. Only a single frequency per station is used, but theoretically it takes an

![Fig. 1. The wide channel needed to send the square-cut morse (a) can be narrowed (b) without any reduction in the information. (c) is the result of attempting to send (a) through a still narrower channel; the information is lost. Is there a definite minimum channel for a given rate of information?](image)

![Fig. 2. A signal conveying a single item of information can be represented as a small area \( \Delta f \Delta t \) on a frequency/time diagram. One theoretical extreme is the infinitely brief pulse (a); the other is the unmodulated wave train (b).](image)
Channels of Communication—
It doesn't take an infinitely long time, or anything like it, to get a continuous train of pure sine waves going! Practically true, but if a succession of sine waves ever has a beginning and ending, that is modulation (admittedly it may be at a very low frequency, such as 1 cycle per month), and brings in sidebands accordingly. So a perfectly pure sine wave is an impossibility! Practical Decca is therefore a long narrow strip in the diagram.

Fig. 3. Unvarying D.C. or A.C. can be represented either as at (a) or (b) (or as in Fig. 2b). If the Time and Frequency scales in (a) and (b) are interchanged, the diagrams represent an infinitely brief pulse (as does Fig. 2a).

Zero x infinity being both mathematically indeterminate and practically impossible, what about middling values? How small can a little circular or square area, representing one elementary signal, be? At first it might seem that it could be as small as one liked, subject to the receiver being able to pick it out from the inevitable background of noise that tends to swamp signals if the amplification is increased too far. But it isn't like that at all, for the frequency/time diagram says nothing about the strength of the signal, which can be enormous even if the spot representing it is small. But if, in order to avoid spreading out the sidebands, you modulate very gradually, it takes a long time, $\Delta t$; while if you try to shorten the time, out spreads $\Delta f$. It is not easy to see how one would set about finding the minimum value, if any, of $\Delta f/\Delta t$; but Dr. Gabor has done it, and arrives at the figure $\frac{1}{2}$. That is to say, if you have a channel 500 c/s wide you can send one element of signal in $1/1,000$th of a second. Anything less than that won't register at all. This is where the analogy with quantum mechanics comes in; a quantum of energy is the least amount that will produce any effect.

You may be wondering what shape, intermediate between an endless constant signal and an infinitely brief pulse, a unit signal has to have in order to occupy this minimum area on a frequency/time diagram. The strength-variation of any signal can, of course, be plotted either on a time base or a frequency base, as we saw last month. Thanks to Fourier, it is only necessary to have one of these to be able to draw the other. (By the way, each of them is called a Fourier transform of the other.) The unending D.C. or A.C. of Fig. 2b is shown on an amplitude/time diagram by a line at a constant height, Fig. 3a, or on an amplitude/frequency diagram as a single vertical line, $b$. (If D.C., it stands at zero on the frequency scale.) The interesting thing is that if the frequency and time scales in Fig. 3 are interchanged, the results represent the opposite extreme, an infinitely brief pulse. Does it surprise you that this interchangeability holds for all its larger number of logons, than Fig. 3b. But if, in addition, it is desired to entrance the good for all shapes of signals? For example, a finite pulse with sloping sides, Fig. 4a, occupies frequencies as shown in Fig. 4b. And the wavy pulse shown in Fig. 4b (if the frequency scale were altered to time) occupies frequencies shown in Fig. 4a (if the time scale were altered to frequency).

So there is a sort of poetic symmetry in Dr. Gabor's finding that the "smallest" signal (on a frequency/time diagram) has the same shape on both time and frequency diagrams. He names it a logon. It is the smooth curve shown in Fig. 5, known to mathematicians as a probability, or error, or Gaussian curve. A logon can be broad in time, and narrow in frequency, or vice versa, so long as $\Delta f/\Delta t = \frac{1}{2}$ (Fig. 6): such changes of proportion are represented merely by multiplying and dividing the $f$ and $t$ scales in Fig. 5 without altering the shape of the curve at all.

It having been established that there is a definite minimum signal, the one remaining link in the investigation is to find out whether existing methods of signalling use the fewest possible number of logons, neatly packed together like sardines in their communication channels. This is where one leaves the relatively firm paths of mathematics and becomes involved in psychology and things like that. We have noted (Fig. 3) that methods of signalling can be extravagant. Merely for the purpose of bringing the recipient's attention to a particular word from the English dictionary, Fig. 3a is no better,

Fig. 4. The interchangeability of time and frequency scales, exemplified in Fig. 3, applies to all shapes of signals. Here is another example: a sloping-sided pulse (a) occupies the frequencies shown in (b); and a pulse shaped in time like (b) occupies a frequency band as shown by (a).
eye with the sight of square-cut morse characters, only that limited amount of rounding-off can be practised which the signaller reckons will not be noticed by the said eye.

The same thing enters into sound communication. If all that is necessary is to reproduce spoken words so that the meaning is understood, the channel can be much narrower than if it is necessary also to convey the aesthetic pleasure of hearing those words spoken almost indistinguishably from the original voice. And the recognizable outline of a tune costs less to send than a thrilling performance of it. There are also difficult questions of language and telegraph codes as vehicles of information.

These matters are still being investigated, but one thing that is quite clear is that even just-intelligible speech is a less efficient method of signalling than telegraphy. There is reason to believe that it occupies about 40 times the theoretical minimum width of channel needed to convey the words at the same rate. Is it, then, possible to "code" the human voice for electrical communication, translating the code back into voice at the receiving end? This is rather an ambitious undertaking, because not only the mere words but also the intonation (which often indicates whether the face-value of the words, or its opposite, is to be taken as the true meaning) is included in the total information to be signalled. Yet the attempt has been remarkably successful; the essentials of speech, normally requiring a channel about 3,000 c/s wide, have been compressed into about 300 c/s by means of what the American inventors named (for obvious reasons) the Vocoder.

The basic principle of the Vocoder is not to transmit the actual voice sounds at all, but only signals for turning the appropriate sounds on and off. To telephone such sounds as "th"

![Diagram of frequency response](image)

**Fig. 6.** All of these signals are logons, shaped as in Fig. 5. The different shapes here correspond to different ratios of time scale to frequency scale in Fig. 5.

in the ordinary way, it is necessary to have quite a wide channel —wider than the ordinary G.P.O. normally provides, anyway.* But one can install a machine at the receiving end capable of making a "th" sound, and turn it on from a distance whenever that sound occurs in the conversation, which is not frequently enough for the switching signal to need much of a sideband. Even after arrangements for making all the other voice sounds have been added, the frequency of the signals needed to switch them on whenever required is much lower than the frequencies in the sounds themselves. Each syllable needs only a few signal cycles to cause it to be uttered, though the actual sound may consist of scores or even hundreds of cycles.

Going a little more into detail, spoken sounds are of two main kinds. Whispering consists entirely of one kind, and humming entirely of the other. The former is enough to convey the words, the latter the intonation and "body." "Th" in "thin" is wholly of the first kind; "th" in "this" has the second kind

* If you don’t believe me, phone up a friend and ask him to write down this message and let you see it—"I faw your photograth in the newtatae ve uver bay."
Channels of Communication—
added, which enables it to be sung, whereas the first sort of "th" interrupts singing whenever it occurs. At the reproducing end of the Vocoder the two types are represented by two sound generators; one makes a general noise such as one gets from an over-sensitive amplifier, covering the whole audio spectrum, without definite pitch; the other is a variable-frequency oscillator. At the sending end there is an analyzer which develops a signal whose strength depends on the pitch of voiced sounds. With unvoiced sounds like "f" this signal naturally fails, and as a result only the noise-maker is effective at the receiver. But directly a voiced sound is uttered at the transmitter, the pitch signal switches in the oscillator and also controls its pitch.

There is also at the transmitter a spectrum analyzer which measures how much sound there is from moment to moment in each of ten 250-c/s frequency bands into which the whole accepted speech-frequency band is divided. The ten resulting signal amplitudes are passed along ten 25 c/s-wide channels and cause corresponding slices of the noise spectrum to be reproduced in the correct proportions.

So altogether eleven 25 c/s channels are required; total, 275 c/s. How these channels can be packed tightly side by side without wasteful "voids" is for the bright communication engineers to work out. They seem able to do anything like that.

The speech turned out at the receiving end is undeniably synthetic, but quite intelligible.

The equipment, of which I have given only a rough idea, is too elaborate to use for multiplying conversations along ordinary telephone lines, but there are particularly expensive telephone circuits—such as the transatlantic radio—where it seems the extra cost would pay for itself very quickly. And, incidentally, fox unauthorized listeners-in more thoroughly than ever.

This is not the only scheme for dehydrating speech to economize in its transport; another is to extract all but sufficient cycles to identify each sound, and then make up the quantity at the receiver. This is done by slowing down all the frequencies with increasing the time (thus there must be fewer of every sort) and then speeding them up again in the reconstituting process at the receiving end.

Just one last point about channels. Authorities responsible for them are repeatedly emphasizing that radio ought never to be used when lines will do. And rightly so, because (except for boundaries due to limited range and directional radiation) there is only one radio medium for everybody, whereas there are millions of lines and there can be millions more, each capable of providing many channels. From the earliest days of radio it was customary to send several messages at once, by dividing the "ether" into channels on a frequency basis (frequency-division multiplex). The slices are becoming so thin now, even up to 200 Mc/s, that the business slogan "There is always room at the top" seems to be ceasing to apply to radio 

channels. In line telegraphy, before the frequency-division idea occurred, Baudot invented a system in which several senders were allowed the use of a single line for fleeting moments in strict and rapid rotation ("time-division multiplex"). But now the frequency-division method has been applied on a grand scale to line telegraphy and telephony (we like to think it was inspired by success with radio), so that a single coaxial telephone line is used to carry hundreds of conversations. And radio occasionally uses time-division, as in television (vision and sync. and perhaps even sound on one frequency channel) and in certain pulse communication systems.

Now that time and frequency are being so finely divided, the one remaining prospect of increasing the supply of channels is in the packing department. Broadcasting, in which the aesthetic aspect matters, is the most likely to be damaged by these new high-pressure packing methods, so will have to look out.

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**Short-wave Conditions**

**Expectations for July**

**By T. W. BENNINGTON**

(Engineering Division, B.B.C.)

DURING May there was a very considerable decrease in the daytime maximum usable frequencies for these latitudes, whilst there was a considerable increase in the night-time M.U.F.'s. Communication on the higher short-wave frequencies—like 20 Mc/s—was not very reliable—particularly in east/west directions, but medium frequencies were usable for very long periods, and those as high as 15 Mc/s were often usable the night through. Some medium-distance communication on very high frequencies by way of sporadic E occurred.

There was less ionosphere stormsness than during the previous two months, though some storms did occur, the most disturbed periods being 1st, 14th-17th, 23rd-24th and 26th-28th. Several "Dellinger" fadeouts occurred, the most intense of these being at 1017 on 6th, 1247 on 16th and 1420 on 20th.

**Forecast.**—There should be very little difference in either daytime or night-time M.U.F.'s during July, as compared to those for June. Working frequencies for long-distance transmission should therefore be relatively low by day and high by night, except on sporadic paths to places in the high latitudes of the Southern Hemisphere. Medium frequencies—like 17 Mc/s—should remain of use for very long periods, and 15 Mc/s may remain usable the night through on many circuits. Daytime communication on the very high frequencies will be possible only infrequently.

The E and F, layers will control transmission over medium distances—up to about 1,500 miles—during the daytime, and in these cases daytime as well as night-time frequencies will be relatively high.

Communication over distances up to about 1,400 miles may often be possible by way of sporadic E—which is likely to be prevalent this month—and when this happens frequencies far above the normal M.U.F.'s for the distances in question may be usable.

Below are given, in terms of the...
broadcast bands, the working frequencies which seem likely to be regularly usable during July for four long-distance circuits running in different directions from this country. All times given here are G.M.T. In addition a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25 per cent of the time during the month for communication by way of the regular layers:

Montreal:  
0000 15 Mc/s  
0200 11  
0800 15  
1200 17  

Buenos Aires:  
0000 17  
0100 15  
0700 11  
0900 16  
1900 17  
1400 21  

Cape Town:  
0000 15  
0200 11  
0500 16, or 17 Mc/s  
0700 21  
1400 26  
1700 21  
2100 15  

Chungking:  
0000 15  
0600 17  
2000 15  

Ionosphere storms are not usually very troublesome during July (though last July was in fact a very disturbed month), so it is hoped that radio conditions may be relatively stable. At the time of writing it would appear that the most likely periods during which disturbances may occur are June 30th, July 1st, 3rd, 4th, 5th, 12th, 15th, 18th and 20th-22nd of the month.

Footnote.—Though there is no space to set out the detailed predictions in this section of Wireless World to publish tabular lists of predicted working frequencies, readers can, however, construct a tolerably accurate set of circuit curves from the figures given and, though they will not be quite correct, they will at least show the general diurnal variations in the frequencies of use over various circuits. For amateur use, the figures in brackets are likely to be most useful, remembering that these will give a curve whose frequency values are above the average predicted M.U.F. for the month. The example given will show how this may be done, the points being taken from the Cape Town table, and showing when the indicated frequency is first usable during the day.

R.F. Tuning Wand

**This** is a useful device for checking the trimming accuracy of signal and I.F. circuits in receivers having coils that are accessible. The wand is 6in long and 3in diameter and has a brass plug at one end and a dust iron one at the other. Either end brought close to, or inserted in, a tuned circuit coil will affect the tuning and hence the strength of the received signals. If the presence of the wand produces louder signals, the indications are that the circuit is out of trim. And the end of the wand which produced this improvement will indicate whether the circuit is tuned to a higher or to a lower frequency.

A test on a V.H.F. set at 60 Mc/s showed it to be extremely sensitive to very small amounts of mistuning so that the claim that it is effective up to 200 Mc/s seems a reasonable one.

The wand is obtainable from A. & H. White, 105-107, Talbot Road, London, W.r.t, and the price is 5s.

---

C.P. 20A 15 WATT AMPLIFIER

For 12 volt battery and A.C. Mains operation. This improved version has switch change-over from A.C. to D.C. and "stand by" positions and only consumes 4 watts current from 12 volt battery. Fitted mu-metal shielded microphone transformer for 15 ohm microphone and provision for crystal and moving iron pick-up with tone control for bass and top and outputs for 7.5 and 15.0 ohms. Complete in steel case with valves.

As illustrated. Price £28 0 0

"SUPER FIFTY WATT" AMPLIFIER

This Amplifier has a response of 1000000 to 300,000 c/s., within ±db., under 2 per cent. distortion at 40 watts and 1 per cent. at 15 watts, including noise and distortion of pre-amplifier and microphone transformer. Electronic mixing for microphone and gramophone of either high or low impedance with top and bass controls. Output for 15,250 ohms with generous voice coil and moving iron pick-up to minimise speaker distortion. New style easy access steel case with recessed controls, making transport safe and easy. Exceedingly well ventilated for long life. Amplifier complete in steel case, with built-in 15 ohm mu-metal shielded microphone transformer, tropical finish.

Price 36½ Gns.

AD/47 10-VALVE TRIODE CATHODE FOLLOWER AMPLIFIER

For this recording and play-back Amplifier we claim an overall distortion of only 0.01% as measured on a distortion factor meter at middle frequencies and low output. The output transformer can be switched from 15 ohms to 2000 ohms, for recording purposes, the measured damping factor being 10 times in each case. Full details upon request.

Dealers and Export Agents should write for special terms to:

VORTEXION LTD.
257-261, THE BROADWAY,
WIMBLEDON, LONDON, S.W.19

Telephones: Lutyber 2814 and 6242/3.
Telegram: "VORTEXION, WIMBLE, LONDON."
RANDOM RADIATIONS

Planes and Television

FROM letters which readers have kindly sent me I gather that the reflection of vision signals from low-flying aeroplanes is a more frequent form of nuisance in some localities than I had realized. Before the war low-flying planes—in deed planes of any kind—were uncommon in my part of the world and since the war I have not been operating a vision receiver at all regularly, on account of a bit of eye trouble. The usual complaint is flutter, due to phase differences between the direct and the reflected signal. One reader tells me that finds the effect at its worst when the 'plane is right overhead. He does not say whether or not he uses a reflector, but I infer that he does since he is mainly troubled when the 'plane is flying so that his aerial is between it and A.P. A reflector should certainly help here. This reader describes one extraordinary effect which occasionally occurs: sixteen dark bars occupy the screen when reflected and direct signals are in phase. The bars are horizontal and about four times as wide as the spaces in between them. He lives close to a big aerodrome and the interference which he describes seems to be most likely to be due to some kind of radar (possibly G.C.A.) using pulse transmissions with a constant recurrence frequency. He suggests Gremlins!

The Good Old Times

"FREE GRID'S" photograph in last month's issue sent my memory back to the days when those of us who began our radio careers in the Early Broadcasting Age—used to litter every part of our homes (including the drawing rooms of our long-suffering wives) with knob-studded boxes, trailing wires and acid-spalshing accumulators. How we used to dread the space and wire of which we were apt to be undertaken as surprise operations the moment we were safely out of the way! The most devastating bit of spring cleaning that ever came my way concerned a 120-volt high-tension battery; and H.T.B.s of that size cost about thirty good shillings in those far off days. As that was before we had begun to indulge in niceties such as grid bias, it hadn't wander-plug sockets; just two straightforward terminals marked o and +100V. Possibly I did leave it on top of the china cabinet. But why not? It was a beautiful battery, surely an ornament in itself.

I know that there was what was disparagingly described as "a squiggle of wire dangling down from one of those screw things." But is the connection of its negative to its positive pole with a piece of flex the proper way to tidy up a H.T.B.? And was I to blame for the damage to the china cabinet by those horrid ooings from eighty short-circuited and ruptured cells? Time, the great healer, has drawn a merciful veil over this and other painful incidents of the pioneering days of wireless. As such, I wouldn't mind wagering that not a few of my fellow pioneers, including perhaps "Free Grid," acquired in self defence a certain proficiency in the art of french polishing.

Same Old Game

The wives of wireless enthusiasts had a hard time of it in the old days. In the light of a recent experience I am not sure that Tennyson's dictum that men must work and women must weep does not still hold good. Mrs. Diallist and I were invited the other day to the home of one of the younger Authorities in the World of Radio. He had just completed the construction of the Last Word in Radiograms; its high fidelity must be heard to be believed; would we come to tea, he and it believe? My own experience of Last Words in both wireless sets and radiograms is that they are curiously like gardens: you always seem to turn up—even if it's by invitation—on the wrong day. "If only you could have seen the petunias (or the delphiniums, or the paeonies) last week." "If only you could have come next week, you'd have seen the salvia (or the phlox, or the lupins) in their full glory." We were not therefore surprised (Mr. Diallist has learnt a thing or two about wireless with the passing of the years) when our host, showing a certain furrowing of the brow, informed us as we entered the front door of his home, that, though it had been working perfectly on the previous evening... The lady of the house—it was interesting to observe the attitude of the younger radio-addict's wife—didn't say much about the super-set, but let slip the remark that she liked it, but found it "a square blemish" because it enabled her always to be sure of getting the nine o'clock news.

Just Like the Old Days

We were conducted into the drawing room. Mark that, the drawing room. In one corner was a gigantic loudspeaker. Over at least an eighth of its parquet floor sprawled (Continued on opposite page)

Books issued in conjunction with "Wireless World"

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Obtainable from booksellers everywhere or direct (cash with order) from the publishers

the most marvellous diversity of wireless bits and pieces that I have
seen for many a long year. There were little chassis containing one or
two valves; there were medium-
sized chassis with three or four;
there were large chassis with five or
six. Wires trailed gloriously from
here to there and from there to all
sort of unexpected places. Knobs
sprouted like mushrooms in a lush
pasture after a September rain.
Performance was, of course, frankly
horrible; but, knowing the skill
and the eradulation of the maker of
the set, I am sure that it would have
been fine if our visit have taken
place a day earlier or a day later.
Wireless, it appears, is more and
more the same old game no matter
how rapidly improvement follows
improvement.

Plastics and Television

SOMETHING was said in the June
W.W. about the work done by
Dr. Starkie of I.C.I. and his lab-
team in developing plastics for big-
screen television purposes. I went
to his recent lecture before the Tele-
vision Society and was impressed not
only by the story he unfolded but
also by the well-thought-out and well-
designed demonstration apparatus.
The big snags in the use of a
Schmidt optical system with a small
C.R.T. are two. First of all, the
screen end of the tube must be pro-
cessed to a considerable degree of
optical precision. Secondly, the
half-angle now obtainable does not
exceed 45 degrees, which means that to
provide an image of reasonable
size on the viewing screen the "throw" from spherical mirror to
screen must be so long that it would
not be possible to accommodate the
whole system in a cabinet of reason-
able size for domestic use. Dr. Star-
kie told us that an inexpensive pro-
cess is being worked out for
processing the ends of C.R.T.s
separately and later sealing them on
to the bulbs. If this can be done,
the process should not be a very
costly one, for the required contour of
the C.R.T. screen is spherical:
the work can therefore be done as
a repetition job by automatic
machines. He said that a con-
siderable increase in the half-angle
was being obtained by new methods
and that much shorter throws
should soon be practicable.

One speaker in the discussion following his lecture brought out an inter-
esting point: would it not be possible
to house the C.R.T., the spherical
mirror and the spherical corrector
screen inside the television cabinet,
but to have the viewing screen out-
side it and quite separate from it?
This raises an interesting possibility.
If such an arrangement were feas-
able, the viewer could arrange the
size of the image (within the limits of the illumination available) to suit
himself, by using a longer or a shorter
throw as might be required.

One very interesting demonstration
was that of a specially corrected flat
viewing screen, on which images
could be seen at a remarkably wide
angle without undue distortion.

Direct Recording Gear

DESIGNED for fitting to existing
turntables, the "Technifon"
Model T.G.1 traverse gear is driven
through worm gearing from a flange
fitting over the turntable spindle.
The standard groove pitch is 120
per inch, but separate lead screws
are available for 96 and 104 grooves
per inch. The standard direction of
cut is from an inside start, but an
outside start can be supplied. All
mechanisms are provided with a
time scale calibrated from 78 r.p.m.
to indicate the unexpired recording
time.

The electromagnetic cutting head
can be supplied with an impedance
of 4 or 15 ohms and is stated to
have a uniform frequency response,
with a 4-inch stylus, from 50 to 6,000
c/s. The input power required is 4
watts.

"Technifon"
Model T.G.1 traverse gear.
Unbiased
By FREE GRID

Jumbled Jargon

WE who move in professional radio engineering circles often pride ourselves on the accuracy of our terminology, not always, I fear, with complete justification, otherwise we should not tolerate such a horrid hybrid word as "television." I wonder if any of you can tell me when and where this dreadful word was first used and why？

It is every bit as bad as the American use of the hybrid "mortician" instead of the more correct "thanatologist," although in either case a man who is "skilled in death" suggests to my mind a gangster rather than a respectable member of the honourable profession followed by the sepulchral Mr. Sowerby and his young apprentice Oliver.

Personally speaking I am a great stickler for technical and terminological accuracy even to the extent of approving the use of the word "chemist," which I noticed recently on a shop in South London, instead of "chemist." Needless to say, I shall in future buy my "chemicals" there as the proprietor's efforts at accuracy in terminology suggests that he will make an equal effort not to confuse drugs which are of dangerously similar appearance, like Epson-salt and oxalic acid crystals.

The word "television" has, I fear, come to stay, but it is not too late to straighten out another case of what, with Mr. Churchill's permission, I will call terminological inexactitude. It had its origin a quarter of a century ago when Lisle Street was the Petticoat Lane of every wireless experimenter, and the commanding presence of a very gracious lady, long since gone to her Valhalla, lent it an atmosphere all its own. In those days we used to ask humbly for a ten- or twenty-plate condenser and none but the boldest of us talked learnedly of microfarads, unless we wished to run the risk of being thrown out of the shop.

Nowadays, of course, a condenser is a capacitor and the particular electrical property which it possesses is no longer capacity but capacitance, and quite rightly too. Unfortunately, however, a device which possesses the property of resistance is not always a resistor as it ought to be, even in Wireless World (April issue, page 122). There seems also to be some confusion about the word inductance which does not always refer to the electrical property of that name but sometimes to the wire, or coil of wire, which possesses it.

To call the latter thing an inductor may result in further confusion, for the term could equally well refer to a boy's horseshoe magnet which, when waggled near a wire (which, of course, possesses inductance) causes induction. The term inductor and inductee might well be applied to the magnet and the wire. If we replace the horseshoe magnet by a waggling current passed through the wire and cause induction that way, then surely the current becomes the inductor the wire being at all times the inductee?

No doubt I shall either be told that I am all wrong or that these terms have been precisely defined long ago, but, if so, why not put them right or, alternatively, use them rightly, whichever cap happens to fit.

P.A. to be Mechanized

I HAVE often thought that the introduction of P.A. systems at our great railway stations was more of a drawback than otherwise. What is gained in being able to make train announcements is more than offset by the irritating reiteration of such items of information which one has to put up with if waiting long on the station, as one invariably does nowadays. Interspersed with such announcements are so-called musical items which although pleasant enough in themselves, become inextricably mixed up with the clang and clatter of porters' barrows and the bawling of babies. The resultant noise, if not exactly nerve shattering, is at any rate enough to disturb the serenity of a Mark Tupley.

There is nothing amusing with the apparatus, it being the method of using it which is at fault. Music may have charms to soothe the savage breast but as we are not yet savages, in spite of the shortage of clothing coupons, I suggest that it be cut out. With regard to the announcers, I don't suppose that I could do any better myself without a few lessons in elocution and I will say no more than that I prefer the Mike Maulers of Stations in the North of England and in Scotland as I cannot understand one word of what they are talking about and do not, therefore, have my nerves rasped raw either by "reiteration" or "repetition" of speech.

Now that we are to have this P.A. business introduced into the sanctity of our railway carriages so that the guard can announce the stations as we approach them, it would seem to me like the proverbial last straw were it not for something of which I had news the other day.

The thing in question is an entirely new P.A. system which is to be brought into use shortly at one of our railway stations. It consists virtually of dozens of gramophone records each with its own pickup and constantly revolving turntable. Each record has on it a message relating to "the train on No. 6 platform" and so on. Each message is being constantly repeated and anyone of them can be brought into use by a push-button, whole banks of which like a mammoth typewriter are mounted on a control desk. The only type of message requiring "live" announcing will be emergency ones. A high fee will be demanded for the privilege of breaking the artistic continuity of the recorded voice which, by the way, is that of a well-known B.B.C. announcer trying to earn an honest tax-free penny.
Miniature V.H.F.
Transmitter-Receiver

Details of the Plessey Mobile Radio-Telephone

By using miniature components wherever possible the Plessey Company has produced a complete mobile radio-telephone which measures only 9¼in x 7½in x 8in, including the power unit. The complete set is small enough to be mounted on the rear carrier of a motor cycle.

This V.H.F. equipment is intended for any mobile service requiring a compact radio telephone for use on a single spot frequency between 50 Mc/s and 160 Mc/s and having full facilities for remote control.

The description "transmitter receiver" usually implies that some part of the equipment is common to both the transmitter and the receiver. This Plessey set is no exception and the receiver's A.F. amplifier is used for both send and receive, being fed in the one case from the receiver and operating either headphones or a loudspeaker, and in the other serving as the modulator for the transmitter. In addition the amplifier can be employed separately as a P.A. system.

This versatility of operation is provided by appropriate switching located on the remote control unit, the amplifier itself being incorporated in the power supply unit. This is a vibrator type giving 250 volts on receive and 375 volts on transmit. It takes its primary supply from a battery and on 12 volts consumes 5 amps on receive and 10 amps on transmit; this includes all filament supplies. A 6-volt power unit is also available.

Plessey V.H.F. radio telephone comprising transmitter-receiver, control unit and hand microphone.

Once set up on the operating frequencies, which can be quite different for transmit and receive, the equipment is operated from the small remote control unit. This contains a three-position receiver volume control switch, a radio/P.A. switch and a socket for the send/receive switch. Normally this is mounted on the hand microphone but it could be fitted in any position operationally more convenient if required.

The super-heterodyne receiver has a crystal controlled local oscillator, its 18th harmonic being extracted by frequency multipliers and fed to the frequency changer. One R.F. and three I.F. stages are used, the latter operating on 4.5 Mc/s and having a maximum bandwidth of 70 kc/s for A.M. or F.M. operation. This equipment can be operated on either A.M. or F.M. by fitting the appropriate types of units to the main chassis.

Crystals are also used in the transmitter, for A.M. as direct control of the frequency and on F.M. as a stabiliser in conjunction with a reactor valve. Its ninth harmonic is extracted to feed into a pair of EC52 valves in push-pull and operating as a power doubler. The R.F. output is 6 watts at 50 Mc/s, falling to 3 watts at 160 Mc/s.

In the assembly of the equipment the power unit forms the base and on to this is fitted, by means of hinges, the receiver and transmitter units. These open like the two halves of a door and expose the underside of all the chassis for servicing. Detachable hinges are fitted so that any unit can be removed for repair or replacement if it develops a serious fault. The transmitter and receiver units are further protected by a snap-on cover.

The flexible aerial provided is a quarter-wavelength long, and is fed through a 40-ohm coaxial cable.

20-25-WATT UNIVERSAL AMPLIFIER—U885
Gives considerably greater power output than usually expected from A.C./D.C. equipment. Constructed on the same lines as our 30-watt A.C. model and fitted with latest control panel carrying microphones, tone controls, mains switch and pilot lamp and special 3-position switch providing either change-over or mixer circuit for gramophone and microphone. Three-stage high-gain type having four valves in parallel push-pull in output stage. A total of 10 valves. Output for high and low impedance graphophone circuits.

Full details of this and other models sent on request.
Sensitive Photo-Electric Relay

Complete relay outfit, Type "PES-II," with light source and heat filter (top left), barrier layer cell (top right), and power supply and relay unit connected to a magnetic gas control valve.

Contact cells of the barrier layer type, using elements such as cuprous oxide and copper, or selenium sub-oxide and gold, have been employed commercially either as rectifiers or as light sensitive current generators in photographic exposure meters. J. A. Sargrove has investigated the effect of light on the rectifier characteristics of selenium sub-oxide/gold cells under A.C. conditions and has evolved a very simple and efficient relay, suitable for industrial process control, which dispenses with valve amplifiers and is more robust than the glass-bulb photo-emissive cells usually employed.

A family of rectifier characteristics with illumination ranging from zero to 10,000 lux (lumens per sq. metre) is given in Fig. 1. These curves relate to the "Mega-

electron" Type "N" cell used in the Type "PES-II" equipment made by Sargrove Electronics, Sir Richard's Bridge, Walton-on-Thames, and it will be seen that as the illumination is increased the forward resistance (indicated by the slope of the current-voltage curves) decreases very slightly, but that there is a much greater decrease in the reverse resistance. If an alternating (50 c/s) voltage is applied to the cell through a series resistance with sufficient amplitude to traverse the whole characteristic, the mean value of the unidirectional current component available will decrease as the illumination increases; a relay of the Post Office type connected in series will be held closed until the cell is illuminated when it will open. In a typical case the power dissipated in the relay changes by 85 mW between 10,000 lux and darkness. Using the same cell as a photo-electric generator with a comparable load the power difference for a similar change of illumination would be only 0.3 mW.

Barrier layer photocells would be destroyed by the application of sustained voltages required to plot the characteristics by conventional methods, and the curves shown in Fig. 1 were obtained by a pulse technique designed to allow the heat generated to be dissipated in each cycle. The use of A.C. in conjunction with a series resistance achieves the same object in practical applications. The use of a simple water-cell heat filter in the beam from the light source permits a higher electrical rating for the photo cell.

The high power ratio of the cell enables the relay switch to be mounted some distance away, and the small dimensions of the cell make it suitable for mounting in the confined spaces of complicated machinery for counting, sorting and similar processes.

It is claimed that with suitable time constants in the associated (Continued at the foot of next page).

**Fig. 1.** Characteristics of selenium sub-oxide/gold film barrier layer cell under different degrees of illumination.
Manufacturers' Literature

Four illustrated brochures, describing loudspeakers, switches, variable condensers and trimmers respectively, have been issued by The Plessey Co., Ilford, Essex.

"The Hy-Meg Handbook"—a catalogue of insulating varnishes and compounds, with technical notes on choice and application, from Lewis Berger and Sons, 35, Berkeley Square, W.1.


Folder of technical information on the Type LSD.2 microsecond photographic flash tube from Mullard Wireless Service Co., Century House, Shaftesbury Avenue, London, W.C.2.

"Developments in Rubber"—a collection of technical papers on various aspects of rubber-to-metal bonding—from the Andre Rubber Co., Kingston Bypass, Surbiton, Surrey. Available to educational institutions, etc., by application on official notepaper.

Leaflet RF/D.147 describing Ferranti-Wild-Barfield dielectric heating equipments from Wild-Barfield Electric Furnaces, Watford Bypass, Watford.


Sensitive Photo-Electric Relay—circuits, the light-modulated rectifier might find application in teleprinter and photo-telegraphic services.

A paper on "A.C. Behaviour of Barrier Layer Photo Cells" by J. A. Sargrove, M. Brit. I.R.E., A.M.I.E.E., published in the Journal, Brit. I.R.E., No. 2, 1947, includes a detailed hypothesis to account for the observed phenomena and also many circuits suitable for practical applications.

Complete range of pressure switches

High quality Bulgin switches especially suitable for refrigerators and other equipment where circuit is required on opening or closing of the apparatus. S.365 is a single-pole, 3 Amp. toggle lever switch with push-action, biased to "Off," pressure on the knob placing the switch in "On" position, circuit being maintained whilst the knob is depressed. On release of pressure the switch returns to "Off" position. Designed for 6-250 v. a.c. or d.c. circuits; max. test voltage 1000 peak. Fixing by single 15/32" hole for panels up to 3/16"; solder tags for connection.

S.357 is similar but change-over, biased to one position, and rated at 2 Amp. Other types available are:

S.358 similar to S.365 but incorporating 6.BA. terminals.

S.359 similar to S.358 but reverse action, i.e., push for "Off," returns to "On."

S.366 similar to S.359 but connection by tags.

"The choice of critics"

Telephone: Rippleway 3474 (5 lines).
RECENT INVENTIONS
A Selection of the More Interesting
Radio Developments

AERIAL FEEDERS
A ROTARY aerial system, as used, say, for radiolocation, is coupled to a stationary S.W. generator or amplifier through a connection which includes no rubbing contact nor any inductive source of troublesome radiation.

In the diagram, A is the outer tube, and B the inner core of a coaxial feeder, which is connected at its far end to the rotating aerial. A1 and B1 are the corresponding parts of a coaxial line connected to the fixed or stationary equipment. The two feeders are coupled together by enlarging the end of the tube A so as to overlap the end of the tube A1 by a quarter-wavelength, the core B1 being recessed to admit the reduced end of the core B for a similar distance.

The spaces between the overlapping parts simulate quarter-wave lines which are open at both ends, so that they offer no impedance to oscillations travelling in either direction. At the same time, the feeder AB can be rotated freely about the line A1B1. The use of open and closed quarter-wave stubs is also described for switching the aerial on and off as it passes from one section of its rotation to another.


FREQUENCY MODULATION
CENTIMETRE waves are frequency modulated by the action of a vibrating member which varies the effective volume, and therefore the tuning, of the hollow resonator of an oscillation generator of the rhombatron type.

An aperture formed in the outer wall of the resonator, beyond the sealed-in portion, is protected by an open-ended quarter-wave stub, which prevents the escape of the internal oscillations. A plunger, driven by the moving coil of a loudspeaker, works into the stub, so that its free end projects into the resonant cavity, thus controlling the frequency of the generated oscillations. Alternatively, the aperture in the resonator may be closed by a flexible diaphragm for direct speech modulation.


CRYSTAL RECTIFIERS
BORON carbide in contact with a metal point is used for receiving centimetre waves, its efficiency being found to remain substantially constant wherever the metal is placed on the crystal surface. The boron carbide should be highly polished, and the metal point should be smooth and round, the point of tungsten or of a gold-silver alloy.


WAVEGUIDES
TO give a waveguide of rectangular cross section some degree of flexibility, the two broader walls are made from a pair of sheet metal plates, which are connected together along the edges by closely spaced parallel wires to form the narrower walls. This allows the guide to be flexed at right-angles to the metal plates.

By giving the plates an initial axial twist of 90 deg, the completed guide will be flexible in all directions perpendicular to, and about, the axis; whilst if the first twist is followed by a similar section of reversed twist, the guide is free to expand or contract, concertina-like, about the main axis. The metal framework is preferably protected by a rubber or other flexible covering.


AERIAL SYSTEM
A RECEIVING aerial is so placed and orientated, with respect to the radiation field of a nearby transmitting aerial, that signals from a distant station can be received on substantially the same frequency as the local transmission. The arrangement is particularly useful for relay systems in which incoming signals are boosted and re-radiated from point to point.

As shown, the receiving frame aerial is set at right angles to the plane of the loop formed by the feeders F which energize the transmitting aerial T from R.F. source S. Since the currents in each branch of the symmetrically arranged feeders is equal, and in phase, the magnetic pickup will be neutralized in the receiving aerial. The electrical field is eliminated by screening the feeders, as shown, a gap being left at the point of junction with the open aerial T. The capacity of the latter may be increased by the provision of a top cross-wire.


SECRET SIGNALLING
THE carrier wave is first frequency modulated by a complex masking wave formed from a coded selection of the higher harmonics of an auxiliary frequency, after which the carrier is frequency modulated by the signal proper. Before it is radiated, the resulting wave is also amplitude modulated by the auxiliary frequency, in order to provide a synchronizing signal.

In reception, the synchronizing signal is separated and applied to control a harmonic generator, pre-set to the masking code used at the transmitter. The output from this unit is applied to restore the plain signal to its original form. To prevent the masking signal from being analysed by an unauthorized listener, it is interlocked with the plain signal at the transmitter in such a way that it can never be radiated alone.

ERIE RESISTOR LIMITED
CARLISLE ROAD · THE HYDE · LONDON · N.W.3 · ENGLAND
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RESISTORS · CERAMICONS · HI-K CERAMICONS
SUPPRESSORS · POTENTIOMETERS
VITREOUS ENAMELLED WIRE-WOUND RESISTORS
Time and again lives have depended upon the sensitivity of a pair of Headphones. The enthusiastic radio amateur, experimenter and serviceman using headphones of just average sensitivity should make sure that the next pair they purchase are of the utmost sensitivity as well as capable of giving true quality reproduction.

The famous S. G. Brown Type "A" Headphones give highest possible efficiency; this is attained by the Adjustable Reed Movement which replaces the usual flat diaphragm.

Resistors produced by the cracked carbon process remain stable to ± 1% of initial value.

- Tolerances ± 1% ± 2% ± 5%
- Low temperature co-efficient.

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