

Wireless World

RADIO AND ELECTRONICS

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In This Issue

OUR COVER: G.P.O. Receiving Centre, Burnham (See Page 96)

EDITORIAL COMMENT	81
P.C.M. By Thomas Roddam	82
TELEVISION "GOODNESS FACTOR" By R. W. Hallows ..	87
SINGLE SIDEBAND RADIO-TELEPHONY By H. D. B. Kirby	90
CARONIA RADIO EQUIPMENT	91
ELECTRONIC CIRCUITRY By J. McG. Sowerby	92
MIDGET A.C. MAINS RECEIVER By S. W. Amos	94
SUPERHETERODYNE TELEVISION UNIT (Concluded) ..	97
SHORT-WAVE CONDITIONS	102
VOIGT PERMANENT-MAGNET LOUDSPEAKER	103
WORLD OF WIRELESS	104
RANGE OF V.H.F. By M. V. Callendar	107
THÉVENIN'S THEOREM By "Cathode Ray"	109
CLASSIFICATION OF BROADCAST AERIALS	113
UNBIASED By "Free Grid"	114
LETTERS TO THE EDITOR	115
RANDOM RADIATIONS By "Diallist"	118
RECENT INVENTIONS	120

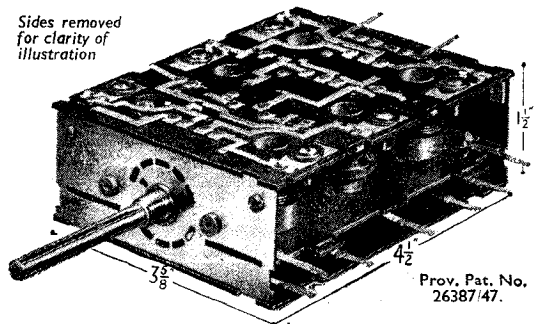


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Valves and their applications

EC91 GROUNDED-GRID AMPLIFIER

The sensitivity of a V.H.F. receiver is largely determined by the first valve. In most cases the design is a compromise between good performance and simplicity of construction, and a circuit which

meets both requirements is of great value. In this respect the EC91 grounded-grid triode is a very useful valve in the 100-250 Mc/s frequency range.

The signal-to-noise ratio which can be obtained in a receiver with a given signal voltage at the aerial terminals is limited by two factors, receiver noise and noise radiation external to the receiver. At frequencies up to 90 Mc/s the external noise level due to atmospheric interference or noise radiation from the Milky Way is relatively high and only a small increase in signal-to-noise ratio can be achieved by reducing the receiver noise below that of a modern high-frequency pentode such as the EF91 or the EF42. At higher frequencies, however, the receiver noise becomes progressively more important and improvements in the receiver will give an effective increase in signal-to-noise ratio.

The receiver noise at V.H.F. is almost entirely dependent on the equivalent noise resistance and input impedance of the first valve. The triode is superior to the pentode because (a) partition noise (due to random current division between screen-grid and anode) is absent, (b) negative feedback by an impedance in the cathode circuit has little effect on the signal-to-noise ratio, and (c) the signal-to-noise ratio is less critically dependent on the aerial coupling.

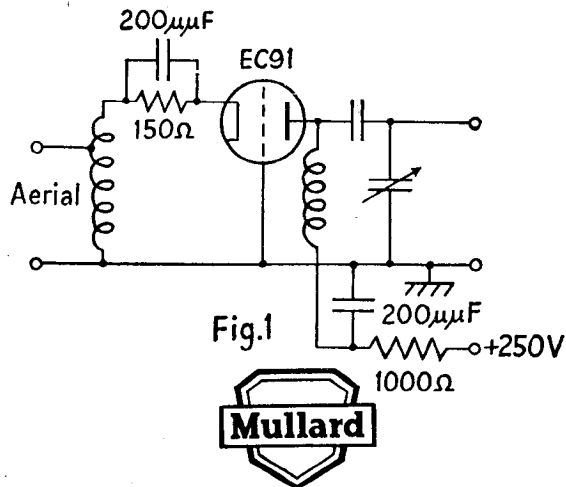
Various circuits have been devised to make a triode amplifier stable at high frequencies, and of these the most simple is the grounded-grid circuit in which the grid is used as a screen between input and output. The EC91 miniature triode (B7G base) has been designed for grounded-grid operation and is particularly suitable for the frequency range 100-250 Mc/s. Its static characteristics are summarised below:

V_h	6.3V	V_a	250V	r_a	12,000 Ω
I_h	0.3A	V_g	-1.5V	R_{cq}	400 Ω
c_{a-g}	2.5 μ F	I_a	10mA	w_a max	2.5W
c_{a-k+h}	<0.2 μ F	g_m	8.5mA/V	I_k max	15mA
c_{g-k+h}	8.5 μ F	μ	100		

The feedback input impedance of a grounded-grid amplifier is approximately $1/g_m$ when the load resistance is small. The input circuit may therefore have a very wide bandwidth (about 100 Mc/s) without the deterioration in signal-to-noise ratio which a damping resistor would produce. The receiver construction may be simplified by leaving the input circuit tuned approximately to the centre of the frequency range. The signal-to-noise ratio is not critically dependent upon the aerial coupling.

A typical EC91 circuit which has been used at 180 Mc/s is shown in figure 1. The aerial tap is about 2/3 of the tuning coil for an 80-ohm source. The measured sensitivity (for unity signal-to-noise ratio) expressed as an open-circuit signal voltage at the aerial terminals was $3.5\sqrt{\Delta f}$ μ V where Δf is the bandwidth in Mc/s. This figure was measured at the output of the last intermediate-frequency amplifier.

It may be noted in conclusion that a grounded-grid EC91 provides a satisfactory input circuit for a 90 Mc/s AM/FM receiver for the reception of the B.B.C.'s experimental transmissions.



Reprints of this report from the Mullard Laboratories together with additional circuit notes can be obtained free of charge from the address below.

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Wireless World

VOL. LV. NO. 3

MARCH 1949

RADIO AND ELECTRONICS

Comments of the Month

INTERNATIONAL TELEVISION STANDARDS LESS than six months ago the Post Office, the Television Advisory Committee and the Radio Industry Council affirmed with complete unanimity their faith in the B.B.C. 405-line television standards and stated that the British system was to remain unchanged for a number of years. At the same time, strong hopes were expressed that these standards might be accepted to some extent internationally, if only for Western Europe. The advantages of doing this from the point of view of international programme exchanges are self-evident. Equally obvious are the benefits likely to accrue to industry through a form of standardization that would facilitate export trade.

Unfortunately, we are forced to admit that the efforts made in so many quarters to gain international acceptance of these ideas have so far failed. The French have adopted an 819-line system, while other countries are obviously inclining towards a considerably greater number of lines than in the B.B.C. system. Facing this, the British radio industry has evidently decided, if there cannot be a 405-line international standard, it is better to have some kind of standard. As a result, consultations have been held, and an agreement was announced between the main British manufacturers of transmitting equipment and the Dutch firm of Philips. Later, one of the British firms—E.M.I.—disclaimed any part in the agreement.

This agreement, which applied only to the mainland of Europe, provided for a 625-line definition, positive modulation, 25 frames a second with 2:1 interlacing, vestigial sideband operation and 6-Mc/s bandwidth.

At the present time, when the effectiveness of the agreement may well be negated by the non-participation of one of the principal British manufacturers, comment does not seem very useful. In any case, is the European adoption of any par-

ticular standard—other of course than our 405-line system—of any very great value to British industry, especially to makers of transmitting gear? Surely everyone abroad knows that our designers have the knowledge and ability to produce equipment for any reasonable standard. Also they know the commercial axiom "the customer is always right" is sufficiently valid to ensure that demands for television equipment of the kind to which their fancy inclines will be met.

At the same time, the art of the best kind of tradesman, who takes the long-term view, lies in leading the customer's fancy towards the thing that will ultimately be best for him. We still think that for large sections of the world, and especially for Europe, 405 lines is best. It is the system most suited for countries suffering from the economic aftermath of war and which are geographically capable of taking advantage of the relatively easy international exchange of programme material which the system makes possible.

THE NEW ACT At the time of writing the Wireless Telegraphy Bill is passing through its final stages and will presumably become law without any further amendments. The passing of the new Act will mark an important stage in the history of British radio, which, since its inception, has virtually been governed exclusively by the Act of 1904.

In spite of the great developments that have taken place, the Act introduces practically no new ideas beyond conferring on the Postmaster-General the right to control man-made interference. The main purpose of the measure is to define much more closely than before the powers vested in the P.M.G., which can now be described without exaggeration as sweeping. Almost all the activities with which this journal and its readers are concerned become—or are capable of becoming—what is legally defined as "wireless telegraphy."

P.C.M.

Being an Elucidation of the Mysteries

of Pulse { Code Count } Modulation

By THOMAS RODDAM

IT is not so very long since modulation meant, quite unambiguously, amplitude modulation. People were talking about frequency modulation, but that, we said knowingly, was all just some obscure racket: someone or another had proved that it didn't really do any good. Then frequency modulation turned out to be quite something after all, even if the mathematics were a bit tricky for some of the old stagers. Finally, if that is a safe word to use, everyone began on pulse modulation: they modulated the amplitude of pulses, they modulated the duration of pulses, they modulated the spacing between a pair of pulses and they modulated the pulse epoch, which is a way of saying the phase, though rather more pedantically. Fortunately for the sanity of those of us who have to plan radio systems, there is usually a good reason for choosing one or other modulation technique. The barriers are weakening, however, as the pressure rises: the amplitude modulation party is making better noise limiters, the pulse party is shaping its pulses for greater bandwidth economy. Soon it will cost us more to choose our design basis than to make the design itself!

Meanwhile, using the cycles* lavishly, a new modulation system has been under test in America. The original patent, filed in France by an Englishman, dates to before the war, but wartime developments in circuit technique have probably helped to bring the system to its present state. This system is p.c.m.: these letters at first stood for pulse code modulation, but since this article was first begun references to pulse count modulation have appeared.

Now this is not just another way of modulating a train of pulses. Although it is called p.c.m., the modulation is not at all the sort of thing we usually associate with the word modulation. P.c.m. is, in fact, half-way towards the "Vocoder": the message transmitted is essentially an instruction

to the receiving equipment, not a replica, in some direct form, of the signal. This must not be misunderstood; the breaking down of speech by the "Vocoder" has no obvious counterpart in the coding circuits of p.c.m. In both, however, there is a breaking down of the speech, the transmission by a means which does not contain the intelligence directly, and then a synthesis at the receiver.

To understand the principle of p.c.m. we can take a very simple analogy. The Editor has rung me

up to tell me that I have forgotten to enclose a curve, Figure X, for an article. As I cannot afford a stamp to send the curve by post, I give him the co-ordinates of a selected number of points on the curve, which he then causes one of his faithful stooges to plot, and a fine smooth line is drawn joining them. This, of course, is the idea we use in all pulse modulation systems: we sample the signal curve regularly and then smooth the resulting stepped output with a low-pass filter. P.c.m. involves two extra features. First of all, instead of modifying the transmitted pulse by an amount depending on the sample* number, a group of pulses is transmitted for each sample, and the group forms a sort of inner message giving the amplitude for that particular sample. It is as though instead of saying "the next ordinate is 2.54," I were to use the morse code.

This leads us to the second feature of p.c.m. As I pass the points on my curve over the telephone, I do not say 2.5437, but round the value to 2.54, or more probably to 2.5. If the curve is drawn through the modified points it will not be quite the right shape, and I choose the approximation closely enough for the error to be unimportant. In p.c.m. there is the same problem. To get reasonably good speech the signal must be sampled 8,000 times a second.

Each sample is a number, which is to be transmitted as a code signal, so that there are 8,000 groups a second. Each group is made up of a number of pulses; we shall see why later. Suppose that a group consists of only one "pulse." Then there may be an actual pulse, or it may be suppressed, and the sample size may therefore be either 0 or 1. We

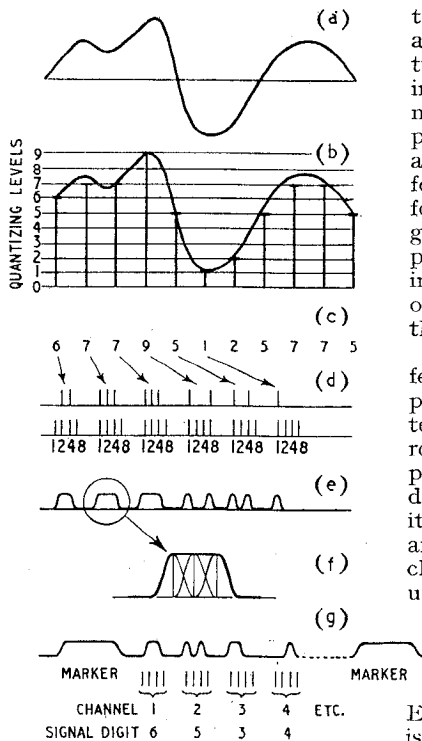


Fig. 1. Stages in the development of a p.c.m. signal: (a) original waveform (b) sampling at regular intervals to find nearest discrete step in amplitude (c) resultant message in digits (d) coded train of pulses with basic train for reference (e) rounding of pulses so that neighbours run together (f) detail of a pulse group (g) combination with pulse trains from other channels and marker pulses.

* To write "cycles per second" would be absurd, and the plural of "hertz" is awkward.

* "Sample" is here used as the statisticians use it, to mean a single thing, which in this case has a numerical magnitude.

P.C.M.—

could produce a signal of this kind by really savage peak chopping of the speech, then using the chopped speech to open a gate to let pulses through. Only when the speech happened to be passing through the zero amplitude axis would a zero be sent. If we use two pulses, the first pulse can stand for an amplitude of 2, and the second for an amplitude of 1. Then two pulses together mean 3; if the second is missing the amplitude is 2; if the first is missing but the second is there the amplitude is 1. This is what is known as operation in the scale of two, and anyone who has worked with thyratron or multi-vibrator counter circuits will recognize it. If we have n pulse positions, in which pulses either are there, or are omitted, we can send any digit from 0 up to $2^n - 1$; thus with 5 pulse positions we can send any whole number up to 31. Suppose that my curve in the example above was a valve characteristic, with a maximum current of 15 mA: then, using a five impulse code, I should have to give the current at any bias to the nearest 0.5 mA. By using a six digit code, I could give it to the nearest 0.25 mA. A little thought will show that near cut-off a line through these "nearest" points will look rather distorted, and that the more digits I use, the better it will be.

In p.c.m. we are actually transmitting a point-by-point plot of

most interesting features of p.c.m., and both its virtue and its limitation. The limitation is, of course, the distortion. As we have

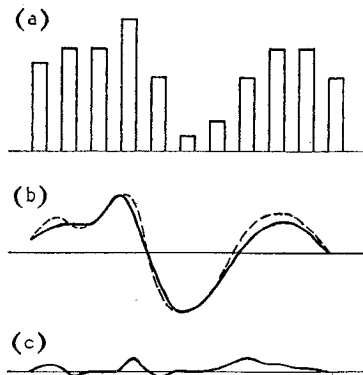


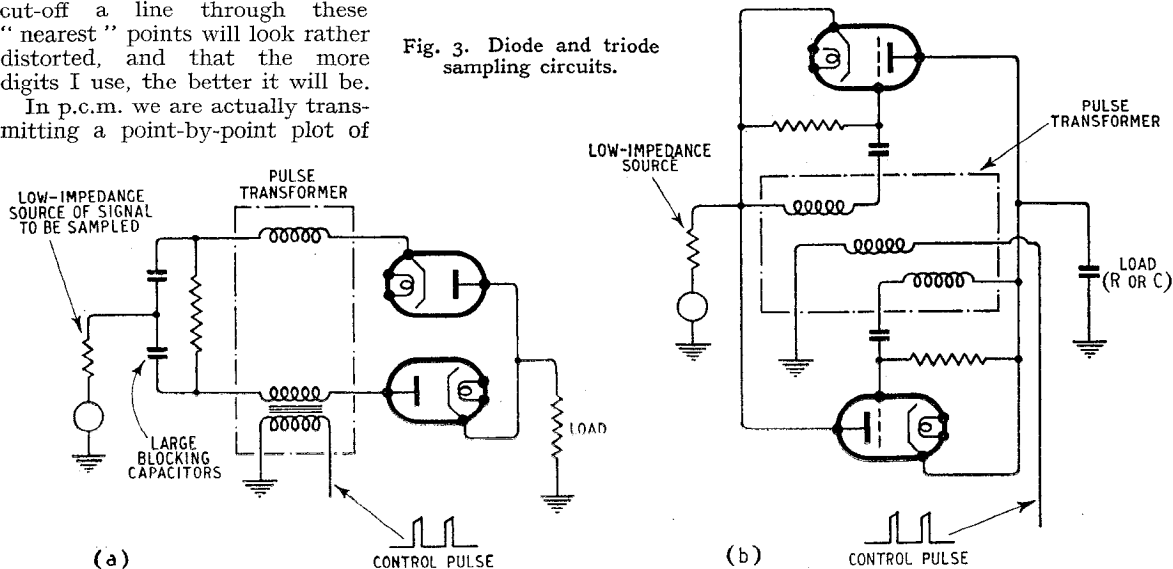
Fig. 2. Reception of pulse code modulation: (a) signal as reconstructed at the receiver (b) after smoothing (the dotted curve is the original signal) (c) quantizing false signal.

seen, we don't transmit the actual waveform, but an approximation to it. The difference is, in effect, a false signal, and is called "quantization noise": it is only 33 db below full signal level when a 5 pulse code is used, although even this means that 40,000

of pulses whose exact timing and amplitude are not significant. clean regular pulses can be produced by selecting the middle of the received signals, and so long as no noise impulse is large enough to produce a false triggering of the receiver circuits, the system is completely undisturbed by normal noise. Consequently lower power levels can be used, because the receiver no longer demands a large signal to override the internal first-circuit noise. With the rather low duty ratio involved in p.c.m. links and the high frequency which must be used to provide the bandwidth, there is at present some advantage in using low power for transmission even at the cost of complication.

The number of steps needed is reduced by a most ingenious arrangement. Very roughly, the ear is sensitive to fractional changes of level, not absolute changes of level. That is why the loudness scale is a logarithmic one. It is therefore reasonable to make the voltage steps not equal but increasing in magnitude from step to step. In this way the half-step size, which is the error in specifying the instantaneous voltage, is proportional to the

Fig. 3. Diode and triode sampling circuits.



the waveform, and, of course, we cannot do it exactly. This taking of the measured points to the nearest fixed step is called "quantizing"; it is one of the

pulses a second are being used to transmit 4,000 c/s of speech. The virtue of quantizing is that circuit noise can be eliminated completely. As a message is made up

actual magnitude of the voltage, and the result is a constant "quantizing fractional error" for all signal magnitudes. This can be done by applying the audio-

P.C.M.—

frequency signal to a potential divider which includes a non-linear resistor and thus acts as an instantaneous compressor. Equal sizes of step after this compressor correspond to a graded series before the compressor.

Let us recapitulate the essentials of the system. The input audio-frequency signal is first passed through a low-pass filter to keep the bandwidth down to the standard telephony bandwidth. Then it is applied to the instantaneous compressor, which

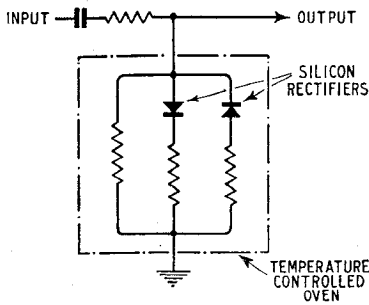


Fig. 4. Circuit of instantaneous compressor.

squashes down the larger amplitudes. Somewhere before the compressor a constant-volume amplifier, or "Vogad," may be fitted, to bring the speech level to that required on the circuit. Then the speech is applied to the sampler, which decides which of the 2ⁿ levels is the appropriate one at the instant of measurement. This information goes to the coder, which sends out a group of *n* pulses or spaces between pulses, corresponding to the number given by the sampler. The signal is then fed to the combining unit, where the interlacing of a number of channels takes place, and the whole complex pulse system is applied to the magnetron modulator.

At the receiver the pulse groups belonging to the different channels are sorted out, and each pulse group is then examined by the decoder. This produces a pulse, the amplitude of which is dependent on the actual code group. These amplitude-modulated pulses are sent through the instantaneous expander, which opens up the larger amplitudes, and then through a low-pass filter which

removes the pulse structure, leaving only the audio-frequency signal. This sequence is shown in Fig. 2.

This description of the process is rather over-simplified and does not represent the latest system. As described, the signal consists of groups of separate pulses. This would mean an unnecessarily large bandwidth, as all that is needed is the information that a pulse is or is not there. The pulses are therefore rounded off, so that two or more pulses in succession run together to form a single long pulse. This gives a useful reduction in the bandwidth required, and there is a very good reason for reducing the bandwidth. Although there is plenty of room in the microwave region, the video-frequency amplifiers will have an amplification, which is inversely proportional to bandwidth, so that halving the bandwidth enables the same gain to be obtained with half the number of stages. Another requirement is that the receiver should be able to pick out groups of pulses from the continuous train which it receives. A marker pulse is therefore added at the transmitter so that the receiver can be synchronized.

The experimental system* was a twelve channel system; that is, twelve audio-frequency circuits were combined in the one radio circuit. This number was chosen because it corresponds to present-day multi-channel carrier telephony practice; most telephone systems are now planned on a basis of primary trunk groups of twelve channels. As each speech band extends up to 3,400 c/s a sampling repetition rate of 8 kc/s is used, requiring 96,000 signals per

second for a 12-channel group. A seven-digit code is used, so that the number of pulses per second is 672,000. The pulse length used within the terminal equipment is 0.4 μ sec, but the pulses radiated are longer than this.

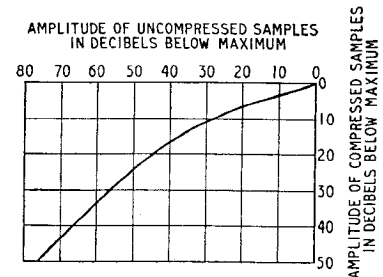


Fig. 5. Characteristic of instantaneous compressor.

As we have already seen, the speech for transmission is first passed through a low-pass filter, to eliminate frequencies above 3,400 c/s. After the filter a peak-chopper circuit is used to restrict the amplitude applied to the following equipment. To this point the twelve channels remain separate: they are now sampled and joined together. The sampling

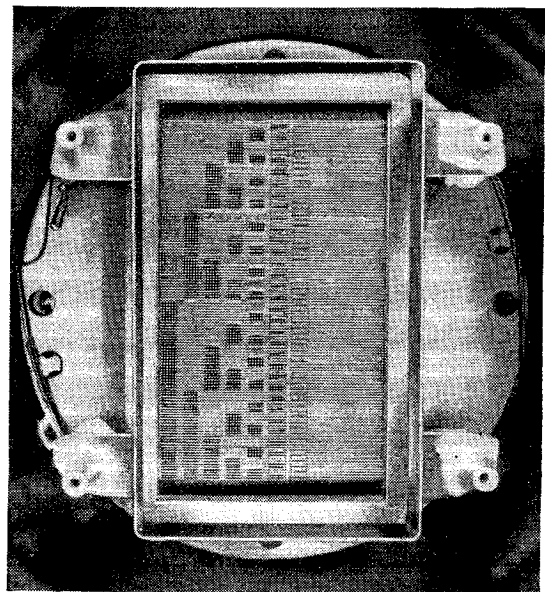


Fig. 6. Interior of coder tube viewed from gun end.

* "An Experimental Multichannel Pulse Code Modulation System of Toll Quality," by L. A. Meacham and E. Peterson, *Bell System Technical Journal*, Vol. XXVII, No. 1, Jan., 1948.

circuit consists of two diodes, shown in Fig. 3(a). (This is Fig. 12 of *B.S.T.J.*, Vol. XXVII,

No. 1). When the control pulse appears at the pulse transformer both diodes conduct and connect the input to the load: the blocking capacitors are charged up, and at the end of the pulse the charge remains to keep the diodes cut off for the relatively low signal voltage. The next pulse again opens the diode gate. The triode circuit in Fig. 3(b) operates in the same way, except that the gate is opened by the pulse applied to the grid while the signal path is from cathode to anode. The output of the sampling circuit is a series of pulses, the amplitude of which is the peak signal amplitude at the instant the pulse is on. By connecting one of those circuits to each speech channel, supplying a

some ways. The pulses are applied to the Y plates and the Y deflection is then held constant while the beam is swept across by a horizontal sweep circuit. The beam is then cut off until the next pulse deflects it again. As the

takes place: the resulting electrons go to the collector and produce a bias which moves the

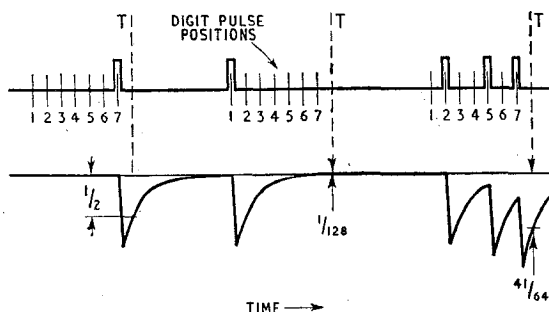


Fig. 8. Decoding waveforms from simple R-C circuit.

beam sweeps in the X direction it passes over an aperture plate, which has a pattern of slots in it.

beam into the space between two wires. This is actually a feedback amplifier circuit and the equivalent of 20 db of feedback is provided. The collector, the quantizing grid and the aperture plate are all visible in Fig. 6. The collector is the box structure which frames the aperture plate. The output takes the form shown in Fig. 7 (Fig. 9, p. 56 of *B.S.T.J.*, Vol. XXVII, No. 1).

The circuits which follow are fairly straightforward. The decoding circuit used at the receiver is perhaps the only other circuit of special interest. The input to this circuit is, of course, a group of up to 7 pulses. A resistance-capacitance circuit is used: if a charge is put on the capacitor, the voltage across it falls during some time t to 50%. During the next interval t , it falls to 50% of the value at the beginning of the

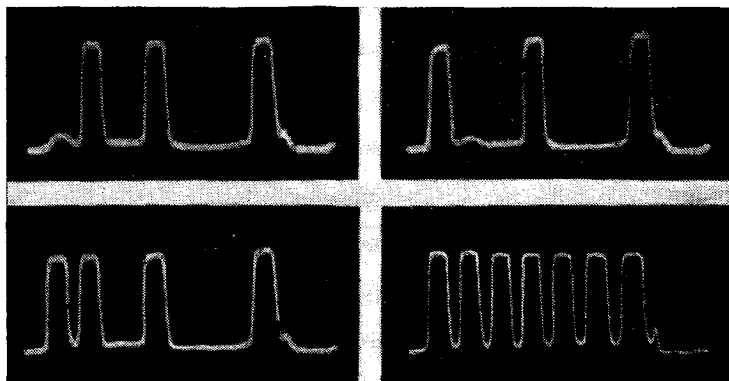


Fig. 7. Typical pulse code outputs.

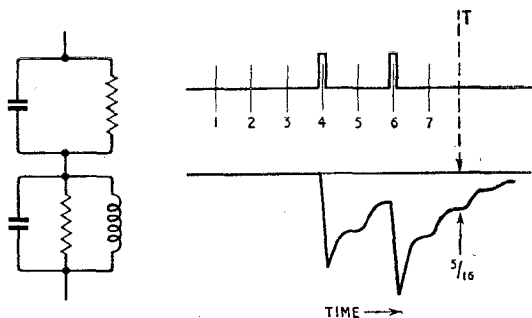
train of "12-way interlaced" pulses to each gate and paralleling the outputs a single set of interlaced amplitude-modulated pulses is provided which contains all the intelligence from the twelve channels.

These pulses are now applied to the instantaneous compressor. In the simplified description it was stated that this was before the sampler, but that was purely to help to indicate the action. The compressor leaves unaffected the lower level signals, but reduces the higher levels considerably so that an increase of 15 db in the input produces only 5 db rise in output. The circuit and its characteristics are shown in Figs. 4 and 5 (Figs. 13 and 14, *loc. cit.*)

The compressed amplitude-modulated pulses are now applied to the coding valve, which both quantizes and codes. This valve resembles a cathode-ray tube in

The electrons which pass through slots fall on a pulse plate and produce impulses in the output circuit. The impulse pattern depends on the slot pattern at the particular value of Y and the slots are so arranged that they give the required code. The aperture plate, with its slots, is shown in Fig. 6 (Fig. 19, *loc. cit.*). To make sure that the beam sweeps across at a definite "quantized" level, a parallel wire grid and a rectangular collector electrode are mounted in front of the aperture plate, and feedback is provided from this collector to the vertical amplifier. If the beam falls on a wire, secondary emission

Fig. 9. Shannon-Rack decoder and modified waveform.



second interval, that is to $\frac{1}{4}$ of the initial value. By making this time t equal to the pulse interval, the contribution to the voltage across the capacitor made by the

P.C.M.—

last pulse will be $\frac{1}{2} \frac{Q}{C}$ where Q is the charge, and the voltage is measured one pulse period after

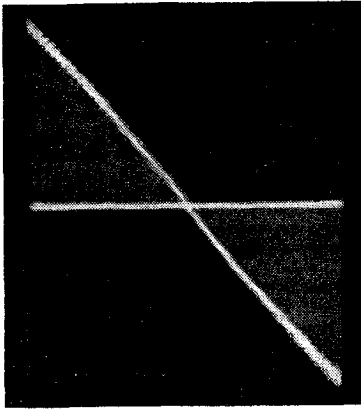


Fig. 10. Overall characteristic of coder (horizontal) and decoder (vertical) including compressor and expander.

the last pulse. The last but one pulse will contribute $\frac{1}{4} \frac{Q}{C}$ and earlier pulses $\frac{1}{8}, \frac{1}{16} \dots \frac{1}{128}$,

all multiplied by Q/C . If a full set of 7 pulses is present, the final voltage will be $127/128$ and any intermediate multiple of $1/128$ can be produced. The decoding circuit is arranged so that each digit pulse delivers a standard charge to the capacitor, and the result is the waveform shown in Fig. 8 (lower half of Fig. 21 *loc. cit.*). By adding a tuned circuit, as shown in Fig. 9 (Fig. 22 *loc. cit.*) a "flat" is put on the waveform so that accurate timing in sampling the decoded wave at T is not so necessary.

The input-output characteristic of the system is shown in Fig. 10 (Fig. 25 *loc. cit.*). The tapered steps can be seen quite clearly and the overall linearity gives an indication of the accuracy of matching between the compressor and the expander, which is an amplifier with a compressor in the negative feedback path.

In measurements of noise on ten links in tandem, a maximum audio signal-to-noise ratio of 58 db was obtained. Crosstalk from any one channel to any other was 66 db down and perfect reception was obtained when the radio signal-to-noise ratio was 18 db.

MANUFACTURERS' PRODUCTS

Television Magnifiers

AN increase of effective picture size of $2\frac{1}{2}$ times is claimed for the Magnavista television lenses made by Metro Pex, Ltd., 71, Queens Road, Peckham, London, S.E.15. Sizes suitable for 9-in and 10-in tubes are available, either for mounting directly to the receiver, or on separate telescopic stands. Prices range from £6 6s to £8 18s 6d.

Modified Oscilloscope

AN alternative cathode-ray tube having a blue trace with yellow-green afterglow can now be supplied by Taylor Electrical Instruments, 419-424, Montrose Avenue, Slough, Bucks, in their Model 30A oscilloscope. The price of the instrument, which is known as "30A with persistent trace," is £33 10s.

New Drive Mechanisms

TWO new condenser drive mechanisms have been added to the range made by Jackson Bros., Kingsway, Waddon, Surrey. Both

models are fitted with three-wave-band coloured scales, calibrated with station names on medium and long waves and framed in florentine bronze escutcheons. Type SL8 at 25s has a cord drive with spin-wheel control knob, and type SL5 at 24s is fitted with a reverse vernier control.

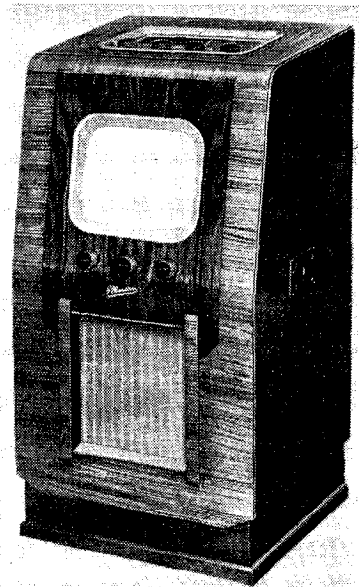
New Domestic Receivers

A BATTERY set giving power output and quality comparable with those of mains-operated receivers has been introduced by Murphy Radio, Welwyn Garden City, Herts. The four-valve superhet circuit covers short, medium and long waves, and a QP25 push-pull output valve feeds an 8-in permanent magnet loudspeaker. The type number is B141 and the price is £21 4s 9d including tax. The new Murphy A122M for a.c. mains is a modified version of the A122 with a redesigned cabinet and costs £26 17s 9d including tax.

Two new a.c./d.c. superhets (4 valves plus rectifier) have been developed for the export market by Vidor, Ltd., West Street, Erith, Kent. Both are housed in walnut

and sycamore inlaid cabinets with "mirror" finish. Model CN385 covers 13.5-32m, 32-100m, 190-550m and 1,000-2,000m, while Model CN 386 covers 10-12m (band-spread), 13.5-32m, 32-100m and 190-550m.

A special c.r. tube giving enhanced picture brightness, and coupled contrast and brightness controls are features of the new Marconiphone VRC52A and H.M.V. Model 1805 television receivers. Automatic interference suppression on sound and a vision interference limiter are provided and the picture size is $8\frac{3}{4}$ in \times $6\frac{1}{2}$ in. The H.M.V. Model 1805 costs £89 5s and the



Marconiphone VRC52A television and radio receiver.

Marconiphone Model VRC52A, which includes a radio receiver for short, medium and long waves with preset tuning for two stations in medium waves, costs £110, both prices including purchase tax.

Metal Detector

AN industrial electronic metal detector has been produced for Cinema Television, Ltd., Worsley Bridge Road, Lower Sydenham, London, S.E.26. This has been designed for use in conjunction with a conveyer-belt system for the examination of chocolate and other food products which are carried through a search head which detects any metal particles, operates a suitable alarm and automatically stops the conveyer belt in the presence of either ferrous or non-ferrous particles.

TELEVISION "GOODNESS FACTOR"

Why More Lines May Mean a Worse Picture

By R. W. HALLOWS,

M.A. Cantab, M.I.E.E.

FROM discussions that I have heard and from questions that I have been asked I know that not a few people find the statement that a larger number of scanning lines may result in a worse image on the screen of the television receiver a dark saying. This article attempts two things. It aims at giving the initiated some useful figures and it offers them a way of answering the dread seeker after enlightenment. Further, the article suggests straightforward methods of determining whether or not a given television system is capable of providing a balanced image (the term "balanced" will be explained in a moment), of finding the extent of the unbalance, should this be present, and of calculating the number of scanning lines that can be employed to the best advantage for any range of modulation frequencies genuinely transmitted and received.

When a person suffering from ocular astigmatism looks at two crossed wires, or two black straight lines crossing on a white background, he may see them as shown in Fig. 1 (a). If he focuses the horizontal line AB sharply, then PQ is muzzy. The angle θ at which the defocusing of PQ is most marked varies from eye to eye and is mainly dependent on the departure from simple spherical form of the cornea, and not as a rule the lens of the eye. The oculist's part is to discover the degree of inequality between the horizontal and vertical focusing powers of the eye and the angle at which this inequality is at its worst. He then prescribes a corrector in the form of a spectacle lens with both "sphere" and "cylinder" elements. If the spherical element enables the eye to obtain a sharp focus horizontally, the cylindrical element, placed at the proper angle, counteracts the deformity of the living optical system and enables it to provide sharp focusing in the vertical sense as well. Aided by the correcting lens, the eye now

sees both of the crossing lines equally clearly as in Fig. 1(b).

In other words, the living optical system, plus the correcting lens, gives perfectly balanced focusing in both directions. The term "balance" as used in this article means that resolution of an image is equally good in the vertical and the horizontal directions. Without such balance no image can be perfectly clear. It

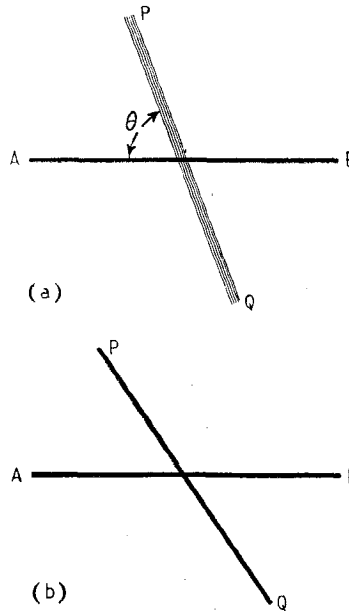


Fig. 1. (a) Crossed wires as seen with the unaided eye by a sufferer from optical astigmatism. The angle θ at which the defocusing of PQ is at its worst depends upon the deformity of the individual optical system. Diagram (b) shows the same wires as seen by an eye with no astigmatism or by the astigmatic eye looking through a correcting lens. At (a) horizontal and vertical definition are unbalanced; at (b) they are balanced.

may be acceptable if the unbalance is slight; but so long as there is any unbalance it is not so good as it might be. The greater the

unbalance, the worse the image.

In television the angle at which unbalance may occur is fixed. It is always a right angle.* The scanning lines slice the image into horizontal strips and thus determine the degree of definition in the vertical sense; the changing brightness of the scanning spot divides the image into minute light and dark patches as it moves from side to side of the c.r.t. screen and so limits the horizontal definition. Perfect balance in the transmitted and received image cannot be ensured unless the system in use is capable of slicing the image into vertical strips as narrow as the horizontal.

Don't be confused by the terms "horizontal" and "vertical" as applied to the slicing of the image and the corresponding sense of definition. A moment's thought will show that the number of horizontal cuts (scanning lines) determines the top-to-bottom, or vertical definition. The greater the number of these, the narrower are the alternate black and white horizontal lines that can be resolved: if the image is built up by 377 active scanning lines interlaced, it would be possible for it to show $188\frac{1}{2}$ white lines and the same number of black. To make the horizontal definition equally good it must be possible to resolve vertical lines as narrow as the narrowest horizontal lines that the system can handle. Since the aspect ratio of the B.B.C. transmission is $5/4$, it follows that for its transmission with 377 active scans per image this number of alternate vertical black and white lines is $377 \times 1.25 = 471\frac{1}{4}$.

When a pattern consisting of alternate black and white vertical lines is scanned by the electron beam of the Emitron the output of the head amplifier for each scanning line is a.c. of the form shown in Fig. 2(b). These a.c. voltage waveforms are used as modulation frequencies in the

* Or as nearly a right angle as makes no matter. Actually, the scanning lines are of course, not quite horizontal, but have a slight downward slope.

Television "Goodness Factor"— transmitter. In the receiver a.c. at vision frequency appears at the output of the video amplifier stage and is converted into d.c. voltage fluctuations for application to the grid of the c.r.t. by the action of the d.c. restorer.

It will be seen that a change from black to white or *vice versa* requires one half-cycle of a.c. For this change to be as sharp as it is between the white background of this page of *Wireless World* and the outlines of the letters printed upon it a.c. of square waveform would be required. The rise from *p* to *q* and the fall from *q* to *p* would have to be perfectly vertical. In other words these rises and falls would occur in no time at all, or in zero wavelength, which corresponds to infinite frequency. Hence to produce the perfectly square waveforms required for absolutely sharp contrasts the modulation would have to contain all frequencies up to infinity. Actually, there is no need for this since the resolving powers of our eyes are limited to something not much better than one minute of angle. Examine a printed page with a powerful magnifier and you will find that the transitions from black to white are not what the unaided eye reports them to be. Sinusoidal waveforms such as those in Fig. 2(b) where the middle of each white vertical line results in a "crest" and the middle of each black line in a trough give the quite acceptable reproduction on the c.r.t. screen indicated in Fig. 2(c).

What this comes to is that to be able to resolve adequately the 471 vertical lines of (1) we need

$471/2 = 235\frac{1}{2}$ cycles . . . (2)
in the active portion of each scanning line. But the active portion of the line lasts only 83.5 μ sec and the time for the whole line is 99 μ sec. Hence the number of cycles required for the whole line is approximately

$235.5 \times 1.2 = 282.6$ cycles (3)
The total modulation bandwidth needed to give balanced definition in a 405-line system with 25 images per second of 5/4 aspect ratio is:

$$f = \frac{282.6 \times 405 \times 25}{2.86 \text{ Mc/s}} \dots \dots (4)$$

We can tidy up the results of

(1), (2), (3) and (4) into the handy form:

$$f_{\text{min}} = \frac{L'}{2} \times arLn \times 10^{-6} \text{ Mc/s} \dots \dots (5)$$

where

- f_{min} = minimum modulation bandwidth to give balanced definition;
- a = aspect ratio
- r = ratio of whole line to active portion
- n = images per second
- L = total scanning lines
- L' = active scanning lines:

From (5) we can obtain a means of ascertaining the maximum

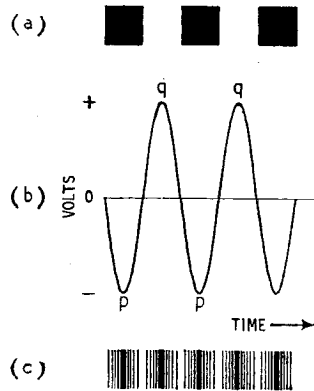


Fig. 2. (a) Consecutive elements of a scanning line for an image consisting of alternate black and white vertical lines. (b) Corresponding a.c. voltage waveform at output of head amplifier. (c) Resulting reproduction on screen of receiver cathode-ray tube.

permissible number of scanning lines for any given modulation bandwidth. A slight reshuffling is necessary, for both L and L' are unknowns. Since $L' = pL$, we have:

$$L_{\text{max}} = \sqrt{\frac{2f_{\text{mod}}}{arnp}} \dots \dots (6)$$

where

- L_{max} = greatest permissible number of lines
- f_{mod} = actual modulation bandwidth
- p = ratio of active lines to total scanning lines

and the remaining factors a , r , n are as before.

Further, we can obtain what may be termed a Definition Ratio, or "goodness factor" for any television system, or for a particular transmitter. Calling this factor D , we have

$$D = \frac{f_{\text{mod}}}{f_{\text{min}}} \dots \dots (7)$$

For the present B.B.C. system

$$D = \frac{2.7}{2.86} = 0.944.$$

My suggestion is that television systems should be described not just by the number of their scanning lines, but by this number *and* the definition factor. The B.B.C.'s, for example, would be termed a 405-line, 0.944 system. This method could also be applied to receivers in test reports and possibly in manufacturers' specifications; in this case, of course, D , would be the ratio of the maximum frequency adequately dealt with by the set and the maximum modulation frequency of the transmission. If a British receiver cut off at 2.4 Mc/s it could be described as having $\frac{2.4}{2.7} = 0.89$ or 89 per cent. definition.

From (5) and (6) the truth of the statement that more lines may mean a worse image is readily seen: they certainly will unless the range of the modulation frequencies is increased accordingly. Two other statements, both rather puzzling at first sight, may also be shown to be true. These are (1) with the standard 405 lines . . . increasing the bandwidth to some 4-5 Mc/s results in very noticeably higher definition;† and (2) no one has yet seen a real 405-line picture.‡

The figure arrived at in (5) gives the *minimum* modulation bandwidth for balanced definition. The resolution resulting is of the kind shown in much exaggerated form in Fig. 2(c). Black shades off into white through greys, which may be regarded as paler and paler blacks and less and less dark whites. Make the frequency higher and the waveforms become squarer, with the result that the transitions are more abrupt and vertical lines more clearly painted on the receiving screen. Hence a bandwidth of 4-5 Mc/s is bound to result in a noticeable improvement in definition.

This is one reason why we have never yet seen a 405-line image as it might be. There are at least two others of importance.

† Television Standards, *Wireless World*, Oct. 1948, p. 382, Col. 1, line 20.
‡ *ibid.*, "Editorial Comment," p. 351, Col. 2, line 28.

With 377 active lines the greatest bandwidth that can be usefully employed is probably not more than 5 Mc/s. This is due partly to the limited resolving powers of our eyes and partly to the fact that a slight blurring of outlines may be necessary to aid persistence of vision in producing the illusion of movement from the observation of a rapid succession of still images. Such lack of sharpness is certainly to be found in individual frames of a cine film. But why should only 377 of the 405 lines be active and 28—nearly 7 per cent—be used for the frame sync pulses? Some systems use only 5 per cent; some, possibly even less. An increase in the number of active lines would improve the vertical definition and the bandwidth might then be put up to a little over 5 Mc/s to give a corresponding improvement in the horizontal definition.

The second point is that there are minute gaps between the scanning lines: it is as though the image were sliced horizontally with a rather coarse saw rather than with a razor blade. To eliminate the gaps is a difficult problem, but a solution will no doubt be found. When "lineness" has been removed the television image will be much more pleasing.

It is interesting to see how the balance of definition works out for 525-line television. There are now a great many 525-line systems in operation in the United States,

but there appear to be no generally accepted standards of bandwidth or number of frame sync pulses. The only standards adopted by all in addition to 525 scanning lines are an aspect ratio of approximately 4/3 and an image frequency of 30 per second. The last is probably a liability rather than an asset. It is demanded by the standard 60-c/s periodicity of American a.c. mains supplies; but since an image frequency of 25 per second gives all the necessary steadiness, the greater number means that part of the modulation bandwidth available must be employed in serving no very useful purpose.

Let us take the case of a 525-line system with a bandwidth of 3 Mc/s and 94 per cent of the scanning lines and 84 per cent of each line active. Then L' works out at 488.25, which we may take as 489, since interlaced scanning demands an odd number of active lines; $a = 1.33$, $n = 30$, $r = 1.19$. From (5) we have:

$$f_{\min} = \frac{489}{2} \times 1.33 \times 1.19 \times 30 \times 525 \times 10^{-6} = \text{approximately } 6.1 \text{ Mc/s}$$

From (6) we have a surprising result:

$$L_{\max} = \sqrt{\frac{6 \times 10^6}{1.33 \times 1.19 \times 0.94 \times 30}} = 365$$

Here, indeed, the increased number of scanning lines means a poorer image than that given by our 405-line system, even though the bandwidth is assumed to be greater by 0.3 Mc/s. From (7)

the definition ratio is $\frac{3}{6.1}$, or 0.492

as compared with 0.944. If a 525-line system were used with a 5/4 aspect ratio in a country where there is a 50-c/s a.c. supply, f_{\min} would come down to 4.75 Mc/s. Assuming an actual modulation bandwidth of 3 Mc/s, the definition ratio would be 3/4.75 or 0.632.

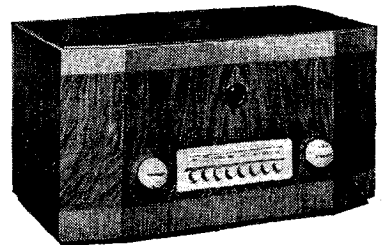
It seems clear that it is of little use to go beyond about 405 lines unless and until transmitters, relay links and moderately-priced televisors can deal adequately with modulation bandwidths well above 5 Mc/s. It is actually disadvantageous to do so owing to the inferior definition of the images.

HIGH QUALITY REPRODUCER

TWIN elliptical diaphragm loudspeakers fed from an 8-watt push-pull output stage with negative feedback form the backbone of the new H.M.V. Model 2000 record reproducer. The automatic record changer is fitted with the latest

H.M.V. lightweight pickup and there are independent tone controls for bass and treble—the latter with five positions to give the best compromise between h.f. response and surface noise on records of all types and ages. A low-impedance input of 5 ohms is provided for coupling to a radio receiver, a power of 0.5 watt being required for full audio input.

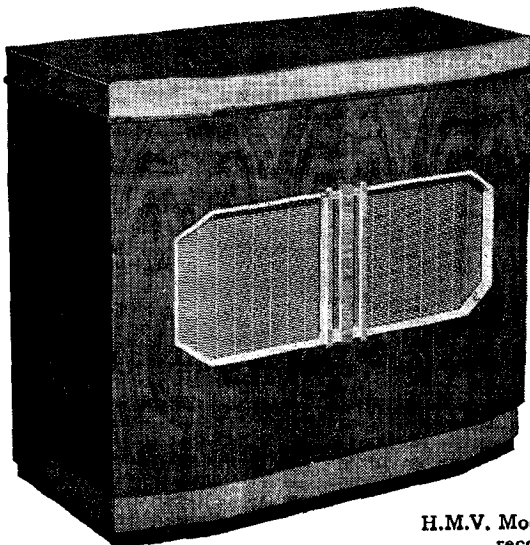
The Model 2500 high-quality receiver unit has been designed to work



H.M.V. Model 2500.

in conjunction with the Model 2000 reproducer and has the requisite 5 ohms output impedance. It is a push-button superhet with an r.f. stage and wide-band intervalve couplings. A specially stabilized oscillator has been provided to minimize frequency drift. There are five push buttons for medium-wave stations and two for long waves. A three-position "fidelity" switch gives variable bandwidth in the i.f. coupling. The receiver has an output of 2½ watts and can be used with a loudspeaker direct, where the extra power of the Model 2000 reproducer is not required.

The makers are the Gramophone Co., Hayes, Middlesex, and the prices are: Model 2000, £112 17s 6d; Model 2500 £45 19s 10d, both prices including purchase tax.



H.M.V. Model 2000 "Celebrity" record reproducer.

SINGLE SIDEBAND RADIO-TELEPHONY

First Use of the System in Marine Communications

By H. D. B. KIRBY

(Standard Telephones and Cables)

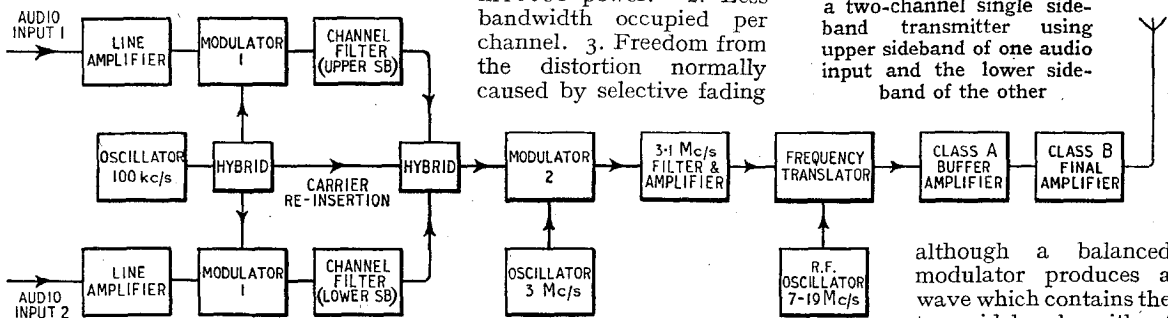
THERE has been since the war a general extension of the use of single-sideband operation on long-distance point-to-point radio-telephone links throughout the world. Now the use of this system has been extended to the long-distance ship services with the installation of single-sideband equipment in the new Cunard White Star liner *Caronia*.

What exactly is this system, and what advantages can it offer over the normal double-sideband method of transmission? To answer these questions it is necessary to consider first what happens when a speech wave is used to modulate an r.f. carrier. This has been discussed at some length in previous issues of this journal,^{1,2} so it will simply be stated here that the ordinary process of amplitude modulation produces a wave which may be analysed into three groups of sine waves, the upper sideband, the lower sideband and the carrier. If the carrier has a frequency f_c and the modulating signal consists of a number of frequencies between 100 and 5,000 c/s then the upper

sideband is, as it were, a mirror image of the other, so that each contains the same intelligence as the other. Consequently the only medium necessary to convey the modulating signal from the transmitter to the receiver is one of the sidebands. Unfortunately, however, although the intelligence is present in the sideband, it cannot be extracted at the receiver without the use of the carrier. In the ordinary d.s.b. system the carrier is transmitted together with both sidebands, and when these are applied to a non-linear impedance in the demodulator stage of the receiver a number of new frequencies are produced among which are the original signal frequencies. In the s.s.b. system the carrier is still necessary for the process of demodulation, but since it does not vary with modulation it can either be generated at the receiver or transmitted at a very low level and amplified separately.

The advantages of the system may be summarized as follows:

1. Improved signal-to-noise ratio at the receiver for a given transmitter power.
2. Less bandwidth occupied per channel.
3. Freedom from the distortion normally caused by selective fading



Block schematic diagram of a two-channel single sideband transmitter using upper sideband of one audio input and the lower sideband of the other

sideband will comprise a band of frequencies between $(f_c + 100)$ and $(f_c + 5,000)$ c/s and the lower sideband frequencies between $(f_c - 100)$ and $(f_c - 5,000)$ c/s.

The frequency, phase and amplitude of the carrier remain unaltered whatever the modulating signal, and it therefore contains no intelligence. Moreover, each

and multi-path propagation. What do these advantages mean in the field of marine radio-telephony?

Since the radio equipment carried on board ship is necessarily limited in size, weight and power consumption, it has been the practice in the past to attempt to improve communication between ship and shore by using more

powerful transmitters and more sensitive receivers on land. This is not effective above a certain point, at least in the ship to shore direction, since noise then becomes the limiting factor. By the use of s.s.b.; however, it is possible to concentrate the whole of the available output power in the one intelligence-bearing sideband. The effect of this is that the signal at the receiver is equivalent to that which would be received from a d.s.b. transmitter about four times as powerful. This will double the distance at which the level of the received signal will be satisfactory for public use.

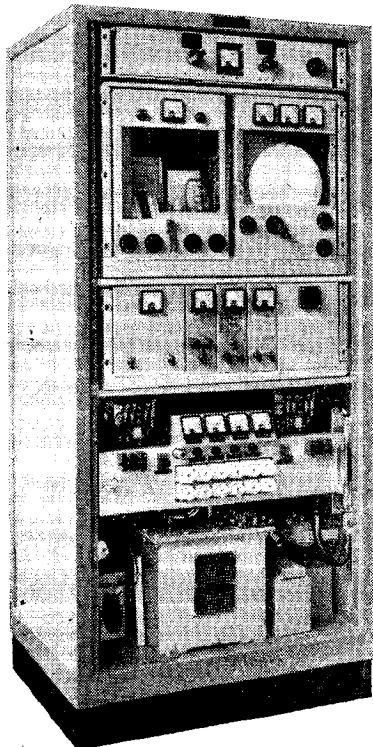
The decrease in bandwidth will reduce the noise picked up at the receiver since it will be possible to tune the filter circuit more sharply. This again will increase the useful range of the equipment.

Thirdly, much of the unpleasant distortion usually caused by selective fading is considerably reduced, so that a link which is quite unworkable on d.s.b. may well provide a reasonable speech circuit under similar conditions with s.s.b. operation.

We do not yet know of a satisfactory method of producing a single-sideband signal directly,

although a balanced modulator produces a wave which contains the two sidebands without the carrier. Thus a very simple transmitter could be used to transmit such a suppressed carrier signal, but the receiver would have to be very complicated since for demodulation a locally generated carrier would be required not only of exactly the same frequency as the original carrier, but also of the same phase. Since this would

be very difficult to produce it is necessary to suppress also one of the sidebands. This is normally done by means of crystal filters.



Single channel sideband transmitter rated at 300 watts as installed in the *Caronia*. It is made by Standard Telephones

The carrier frequencies normally used for long-distance telephone communication are between 2 and 30 Mc/s and the audio frequencies which must be reproduced are between 100 and 5,000 c/s. Thus it can be seen that each sideband is separated from the other by only 200 c/s and that with a carrier frequency of, say, 10 Mc/s the upper sideband filter would have to pass the band 10,005,000 - 10,000,100 c/s, but cut-off at 9,999,900 c/s. Since it would be practically impossible to design a filter to comply with these requirements it is necessary to generate the s.s.b. signal at a comparatively low frequency, convert it to the required frequency for transmission, and then feed it to the aerial through linear amplifiers.

The accompanying block diagram shows a low-power two-channel transmitter. Each audio input after amplification is fed to-

gether with the output of a 100-kc/s oscillator to a balanced modulator. Crystal filters select the upper sideband from the output of one modulator and the lower sideband from the output of the other. The two are then mixed, together with a very much reduced carrier, and applied to a second balanced modulator with the output of a 3-Mc/s oscillator. A 3.1-Mc/s filter selects the upper modulation product, which is then mixed with the output of a third oscillator, the frequency of which is variable between 7 and 19 Mc/s. This gives a signal frequency variable between 4 and 22 Mc/s. Three stages of linear amplification are provided at this frequency, negative envelope feedback being incorporated to increase the linearity.

A number of transmitters and receivers for single-sideband operation have been developed by Standard Telephones & Cables

during the last few years. The transmitters have output powers ranging from 300W to 40kW, and the receivers vary in complexity according to the facilities required. The 300-W transmitter shown here is self-contained, but the larger ones have separate drive units, which contain all the stages shown in the block diagram up to the 3.1-Mc/s amplifier.

For land-stations diversity reception is normally used to give the best possible quality and freedom from fading effects. Such receivers are necessarily somewhat complex. Those designed for marine use do not include facilities for diversity reception and are therefore considerably simpler and easier to operate and maintain.

REFERENCES:

- 1 "Sidebands Again," by "Cathode Ray," *Wireless World*, December, 1947.
- 2 "Modulation," etc, by "Cathode Ray," *Wireless World*, July, 1948.

CARONIA RADIO EQUIPMENT

AMONG the other radio equipment which has been installed by the International Marine Radio Company in the *Caronia* is a double sideband high-power transmitter for r.t., c.w. or m.c.w. operation. It will be used for normal telegraph traffic and for supplementary telephone services with land stations not equipped for single sideband working.

This set, the ES4B, can operate on several spot frequencies in each of six separate pre-set channels in the band 1.76 to 22 Mc/s and delivers 300 watts to the aerial on r.t. or m.c.w. and 1kW

on c.w. telegraphy. It is remotely controlled from the receiving room, which adjoins the transmitting room.

There is one other general-purpose transmitter, the type IMR29, which covers 3 to 17 Mc/s



Two of the receiving positions in the *Caronia*. The single sideband receiver is seen in the right rear alongside the telephone terminal equipment

Caronia Radio Equipment

in the h.f. band, 365 to 515 kc/s in the m.f. and 107 to 160 kc/s in the l.f. Radio-telephone facilities are available on reduced power of about 150 watts, the c.w. output being of the order of 400-500 watts.

A 400-watt h.f. telegraph transmitter covering 4 to 24 Mc/s and a complete battery-operated emergency transmitter and receiver, the former giving 50 watts output, and the single-sideband set completes the principal equip-

ment in the transmitting room.

Four main operating positions are provided in the receiving room, two are primarily for radio-telephony and two are exclusively for radio-telephony. Each is fitted with two communications receivers which together cover all frequencies from 15 kc/s to 25 Mc/s. It is interesting to record that for long-wave reception, 14 kc/s to 500 kc/s, a t.r.f. set is used; the others are super-hets.

There is some subsidiary radio

equipment on the navigating bridge. It comprises a ship-shore r.t. set giving about 200 miles range and operating on 10 spot frequencies, switch selected, in the band 1.5 to 4 Mc/s. Here also is a loop direction finder and two radar sets, a Metropolitan-Vickers "Seascan," giving a coverage of about 30 miles radius, and an Admiralty type 268. All the radio equipment, except the emergency and the IMR29 transmitter, operate from the ship's 220-volt 3-phase a.c. supply.

ELECTRONIC CIRCUITRY

Selections from a Designer's Notebook

By J. MCG. SOWERBY (Cinema Television Ltd.)

A GOOD deal of interest has been shown lately in the so-called "bootstrap" circuit¹ for the production of a saw-tooth waveform, for use in triggered and single-stroke time bases for pulse

The "Bootstrap" Circuit

examination and photographic recording of high-speed transients. The circuit was widely used in American radar equipment² during the war, but has not been so much used in this country. The fundamental circuit is shown in Fig. 1.

The valve V_3 is normally kept conducting by the positive bias return of R_g , and consequently the standing potential across C

is only the few volts occasioned by current flowing through the h.t. supply V_1 , R and V_3 . If a negative pulse (as shown) of sufficient amplitude is applied to the grid of V_3 , that valve is abruptly cut off. Immediately C begins to charge up positively taking with it the grid (and hence the cathode) of the cathode follower V_2 . The time constant $C_e R$, is very long compared with RC, and so as the cathode of V_2 moves positively, V_1 is cut off and the charging current is transferred from V_1 to V_2 . Thereafter a nearly constant potential is retained across R so that the charging current through it is also nearly constant; the potential at A is "pulled up by its own bootstrap." In fact if R_C is very large (and preferably returned to a negative source of supply) C will appear to be charged through a resistance of approximately μR , where μ is the amplification factor of V_2 .

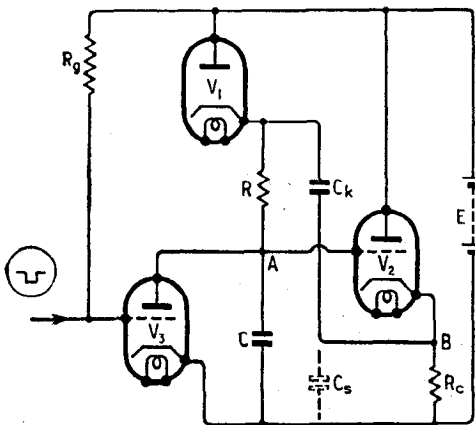


Fig. 1. Fundamental "bootstrap" circuit.

By way of example, suppose we allow C to charge up to 100 volts; let $E = 400$ volts and $\mu = 50$.

Then the apparent supply potential is about 20 kV, and the saw-tooth sweep potential across C will be linear within about 0.5 per cent.

It is obvious that the potential across C starts to rise immediately V_3 is cut off. The potential at the

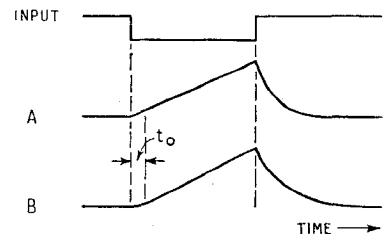


Fig. 2. Showing the potentials at A and B in Fig. 1 in response to a step input.

cathode of V_2 follows only after a short time lag needed to charge up the stray capacitance, C_s , between the cathode of V_2 and earth. This lag is determined by the time constant C_s/g_m , where g_m is the mutual conductance of V_2 . From this, and the foregoing, we see that V_2 should have both a large μ and a high slope.

When V_3 is restored to conduction, C discharges through it, and the grid potential of V_3 falls, taking with it the cathode. However large C_k may be, it will have lost some charge during the sweep period, and this is restored through the diode and R_C in series.

Fig. 2 shows qualitatively the waveforms at A and B related to the input waveform.

The lag t_0 is generally of the order of 0.1 microsecond if V_2

¹ O. S. Pucke, "Time Bases." 1st Edn., p. 94. (Chapman & Hall.)
² Soller, Starr and Valley, "C.R.T. Displays," p. 137. (McGraw Hill.)

is the EC52 class of valve. An approximate relation useful in design is:

$$RC = \frac{Et}{V}$$

Where

E = h.t. supply potential (volts)

V = amplitude of required sweep (volts)

t = time for V volts (micro-seconds)

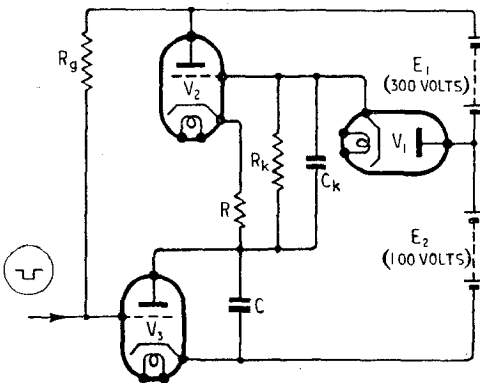
R is in $M\Omega$

C is in $\mu\mu F$ (pF)

The charging current V_3 is called upon to carry during the sweep is approximately $i = E/R$. During the sweep C_k is being charged by this same current that flows into C , so that in order to retain linearity C_k should be at least 100 times C .

An interesting variant of the fundamental circuit is shown in Fig. 3. Here the charging current flows directly through the cathode follower V_2 with no coupling condenser interposed. The coupling condenser is now only to the grid of V_2 , and the time constant $C_k R_k$ can be made very long indeed by making R_k very large. In the quiescent state the grid potential of V_2 is held at a value nearly equal to E_2 by V_1 . As soon as V_3 is cut off the potential across C rises cutting off the diode via C_k and taking the grid of V_2 positive. As before a nearly constant voltage is obtained across R during the sweep. The maximum amplitude of sweep obtainable is less than the previous case by E_2 volts. For very slow sweep rates the circuit of Fig. 3 is advantageous as it often permits

Fig. 3. Modified "bootstrap" circuit.



the use of a smaller coupling condenser than that of Fig. 2. On the other hand, the same amplitude of sweep can only be obtained at the expense of a supply voltage greater by E_2 volts. The previous design relations remain true if E_2 is substituted for E .

It is often desirable to control the speed of a small motor for one purpose or another. A typical application is the control of film or paper speed in recording oscillographs with drum cameras.

Simple Thyatron Motor Control

Most a.c. motors are unsuitable for the direct application of speed control, and one is usually forced to use a d.c. motor. This is inconvenient as the mains supply is usually a.c.

A remarkably simple circuit³ using only one thyatron—shown in Fig. 4—may be used in many applications where a speed constant to a few per cent with normal load variations is good enough; it uses a d.c. shunt motor and an a.c. supply. In the figure, V is a thyatron, m.a. is the motor armature, E is a source of d.c. potential at low current (which may be derived from the a.c. by rectifiers, etc.), and P is a potentiometer, across it. R_g is merely a grid stopping resistance. Suppose now that we set P so that a voltage e appear across its lower limb. As the a.c. rises on the positive half-cycle V will conduct and pass current through m.a. until the a.c. voltage has fallen to a few volts above the cathode potential. On the negative half-cycle V passes no current. Thus on a 50-c/s mains supply m.a. is fed with pulses of current at 50 c/s, each pulse lasting less than $1/100$ sec. Consequently, the motor rotates, generating a back-e.m.f. across its armature terminals at the cathode of V , and backing off e until only sufficient current is drawn through V to maintain the speed called for by

³ Greenwood, Holdam and Macrae, "Electronic Instruments," p. 485. (McGraw Hill).

the particular setting of the potentiometer P .

If the setting of P is now changed,

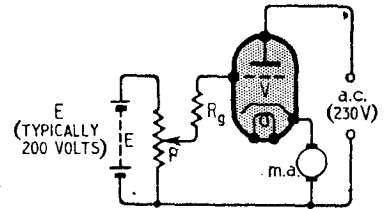


Fig. 4. Simple thyatron motor speed control.

a new set of equilibrium conditions will arise, and a new speed will be obtained. This speed is nearly independent of the motor load, but as the load is increased, the current drawn through V increases.

Slightly erratic performance may be experienced due to commutator ripple appearing between grid and cathode of V , but this can be reduced by the addition of a suitable condenser across m.a. A speed range of 50 : 1 can usually be obtained without difficulty.

The field coil is not shown in Fig. 4, and of course this must be energized with d.c. This usually presents little difficulty as the field current of a shunt-wound motor is usually low. A motor with permanent-magnet field is especially suitable. By reversing either field or armature connections, the direction of rotation of the motor is reversed.

MANUFACTURERS' LITERATURE

Illustrated leaflets describing vibration meter type 1402C and sound level meter type 1400B from Dawe Instruments, Harlequin Avenue, Great West Road, Brentford, Middlesex.

Leaflets describing "Holmar" industrial sound amplifying equipment from Industrial Sound Equipment, 10, West Central Street, London, W.C.1.

Illustrated leaflet describing recent radio receivers from Mullard Electronic Products, Century House, Shaftesbury Avenue, London, W.C.2.

Lists of copper instrument wires, insulating materials and screws from Post Radio Supplies, 33, Bourne Gardens, London, E.4.

Brochure describing the coaxial construction of R & A loudspeakers from Reproducers and Amplifiers, Frederick Street, Wolverhampton.

Catalogue (Issue 3) of silvered mica capacitors from Stability Radio Components, 14, Normans Buildings, Central Street, London, E.C.1.

MIDGET A.C. MAINS RECEIVER

An Inexpensive Portable Made With Surplus Components

By S. W. AMOS, B.Sc. (Hons.)

Engineering Training Department, British Broadcasting Corporation

THE following article gives details of a midget a.c. mains receiver intended for use as a bedside set. It was built to receive the Home, Light and Third programmes in the London area. For this purpose the selectivity and sensitivity have proved adequate with any reasonable aerial; naturally better results could be obtained by using as efficient an aerial as possible. As the aerial coupling is weak, the receiver may be satisfactorily used with any value of aerial impedance. The receiver was built largely of Government surplus components and at a total cost of under £3.

Most midget receivers are of the a.c.-d.c. type because these do not require a bulky mains transformer, and can, therefore, be made particularly compact, but it was decided that this receiver should include a mains

transformer with h.t. and l.t. windings, so that h.t. negative and the chassis could be isolated from the mains, as in full-sized a.c. mains receivers. The mains transformer is the most bulky component in the receiver, but

it has been accommodated with the loudspeaker on a chassis measuring only $6\frac{1}{4}$ in. \times $4\frac{1}{4}$ in.; the overall height of the receiver is $4\frac{1}{4}$ in. The photographs illustrate the general layout and the circuit diagram in Fig. 1.

The receiver includes two valves, both EF50's, one functioning as a leaky-grid detector and the other as output valve. These valves were chosen because they are cheap, plentiful and have a low heater consumption, a consideration of some importance when the heater power must be supplied from a midget mains transformer. As an output valve

in excess of 100, which makes it also suitable as a leaky-grid detector.

The receiver is intended for medium-wave reception only and a single tuned circuit is used. To economise in space the tuning capacitor is a small air-dielectric type of 100 pF maximum capacitance and the tuning inductor is of about 550 μ H inductance. This gives a frequency range of approximately 600-1530 kc/s and permits reception of all three local programmes in the London

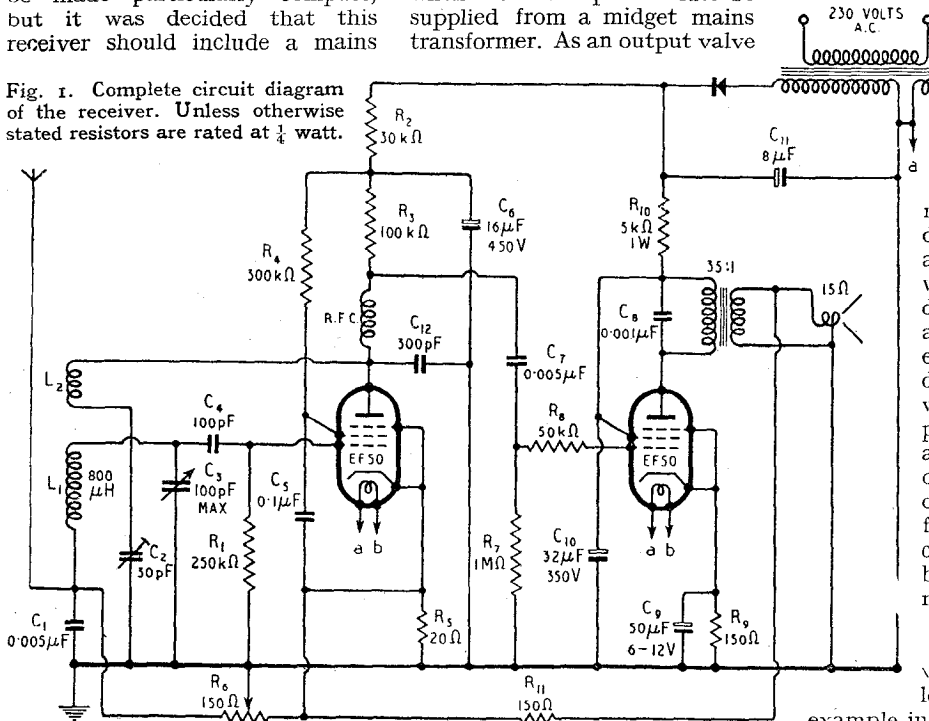
area. The inductor consists of 108 turns wound on a polystyrene former contained within a dust-iron core giving a closed

magnetic circuit. Full details of the inductor are given in Fig. 2. The wire used was 38 s.w.g., double silk covered, but as this only half filled each slot, wire of larger diameter could be used with advantage. The pot-type dust-iron core and the former can be obtained from Neosid, or from other manufacturers, but similar components are also to be found in ex-Government equipment.

It may be desired to modify the inductance value slightly to suit local requirements. For

example in the Midlands it would be advisable to use a slightly larger inductance (say 135 turns) to give reception of the Third Programme on 583 kc/s. In this area the Light Programme is radiated on 200 kc/s and can be received by switching a capacitor of approximately 0.001 μ F in parallel with

Fig. 1. Complete circuit diagram of the receiver. Unless otherwise stated resistors are rated at $\frac{1}{4}$ watt.



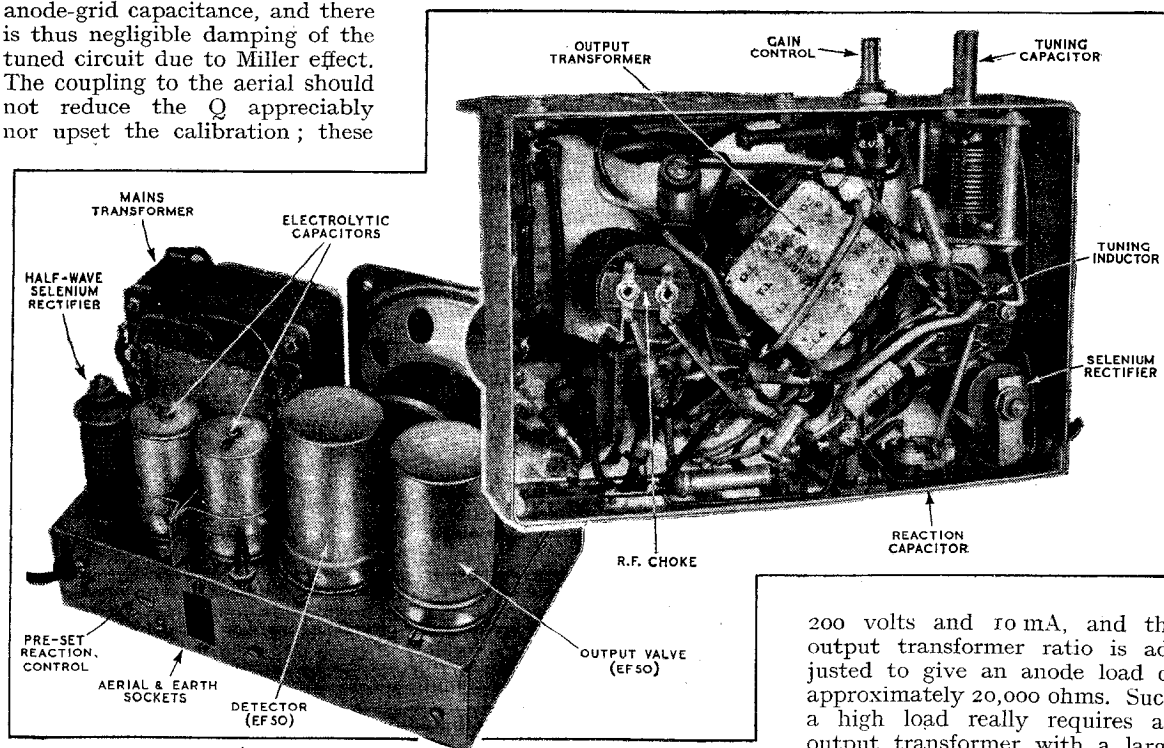
transformer with h.t. and l.t. windings, so that h.t. negative and the chassis could be isolated from the mains, as in full-sized a.c. mains receivers. The mains transformer is the most bulky component in the receiver, but

the EF50 will deliver approximately $\frac{1}{2}$ watt for 1 volt input; this power is about the maximum which can be accepted by the midget speaker used. With a high-value anode load resistor, the EF50 will give a stage gain

the existing tuning capacitor. As only a single tuned circuit is used for tuning, this must clearly have a high Q to give good selectivity. The detector valve is an r.f. pentode with a very small anode-grid capacitance, and there is thus negligible damping of the tuned circuit due to Miller effect. The coupling to the aerial should not reduce the Q appreciably nor upset the calibration; these

normally advanced until the detector nearly oscillates; the resulting improvement in selectivity is very acceptable and the improvement in voltage gain makes up

component, and some space could be saved by using a smaller modern type supported in the wiring. The output valve is operated with an anode supply of



General view of the finished receiver. The overall dimensions are 6½ in. × 4½ in. × 4½ in. The underside of chassis shows the positions of some of the principal components.

aims are achieved by coupling the tuned circuit to the aerial by a shunt capacitor of 0.005 μF. This gives very low voltage transfer (about 4 from aerial to grid) but restricts the reduction in Q due to aerial damping to less than 5 per cent., and tuning calibration is completely independent of the aerial constants. A further reason for using the shunt-capacitance aerial coupling circuit is that it gives the receiver an input impedance of only a few ohms; this low input impedance is necessary for the gain control as will be seen later.

Reaction is used to improve the Q, regeneration being controlled by a pre-set ceramic capacitor of 30 pF maximum capacitance mounted on the rear of the chassis and adjusted by a screwdriver. Details of the reaction winding are given in Fig. 2. Reaction is

for the low voltage transfer of the aerial-coupling circuit.

A disadvantage of pre-set reaction is that the receiver bursts into oscillation for a few seconds shortly after switching on. This can be de avoided by setting the gain control to zero, but even then faint whistles may still be heard unless the r.f. screening is good; further details about such screening are given later.

The r.f. choke in the anode circuit of the detector is essential; if it is omitted or if a resistor is used instead, it is very difficult to prevent r.f. signals being handed on to the output valve where, after amplification, they give trouble in the output transformer by upsetting the a.f. negative feedback circuit or by causing r.f. positive feedback. The particular r.f. choke used was an old-fashioned and unnecessarily bulky

200 volts and 10 mA, and the output transformer ratio is adjusted to give an anode load of approximately 20,000 ohms. Such a high load really requires an output transformer with a large primary inductance, and the inductance of the midget component used is certainly inadequate, but the tendency to lose bass is offset by negative feedback.

The feedback voltage is obtained from the secondary of the output

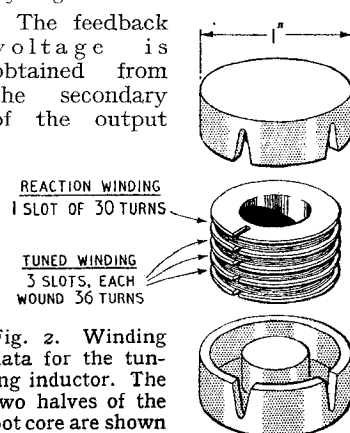


Fig. 2. Winding data for the tuning inductor. The two halves of the pot core are shown parted to expose the coil former.

transformer and is injected into the detector cathode circuit. The cathode resistor is very low (20 ohms) to avoid giving the

Midget A.C. Mains Receiver—

cathode a positive bias which would upset detector operation, and the grid leak is returned to h.t. negative, not cathode, so that the negative feedback can operate properly. Gain is controlled by varying the negative feedback; the gain control R_6 is arranged to short-circuit the cathode resistor R_5 when rotated fully clockwise. This system has the disadvantage of a limited range of control and does not reduce the output to zero when the control is rotated fully anticlockwise. To give zero output R_6 is arranged to short-circuit the aerial and earth terminals at its minimum setting. To operate satisfactorily, such a system requires a low value of R_6 and a low receiver input impedance; the method of obtaining the latter has already been described. The value of R_6 is 150 ohms, but as maximum changes in gain occur near the maximum and minimum settings a somewhat smaller value (say 50 ohms) might give smoother control. Quality becomes shrill near the maximum gain setting due to the removal of feedback; but this can be overcome by increasing the capacitance across the primary winding of the output transformer. In regions of high field strength, signals may be picked up directly by the tuning inductor; such signals spoil the performance of the gain control by giving an output from the receiver when the control is set to zero. This effect can be avoided by fitting an earthed plate on the bottom of the chassis so as to screen all the r.f. components completely. Such a plate can be fitted to the bottom of the cabinet and bonded to the chassis.

Positive Feedback

It was found in the experimental stage of the design of this receiver that the gain of the a.f. amplifier without feedback is quite sufficient to cause oscillation if the grid circuit of the detector is in close proximity to the anode circuit of the output valve. Thus these circuits should be kept well apart, or, if this is impossible, the anode circuit should be screened.

The loudspeaker used is a midget type with a diaphragm 3 in. in diameter and, as would

OUR COVER

Some of the thirty-two operating positions at the re-equipped G.P.O. receiving centre at Burnham, Somerset, are illustrated on this month's front cover. The station's thirteen transmitters at Portishead, some twenty miles away, are remotely controlled from this centre.

be expected, the quality tends to be dominated by an extremely good upper register. The receiver has, however, been used to drive full-sized loudspeakers and its quality is extremely pleasant. With the particular midget loudspeaker used there is a tendency for bass notes to modulate high ones; this is probably due to the large excursions at low frequencies of the speech coil, which moves out of the linear part of the magnetic field in the gap. This effect may not be present to the same extent with all types of midget loudspeaker but can in any case be reduced by using a bass-cut circuit in the receiver. A convenient way of cutting bass is to reduce the capacitance of C_7 . At low settings of the gain control, feedback will probably offset this bass loss but this is of no consequence as volume will then be low. As the gain control is advanced and volume increases the bass cut will become more effective.

The loudspeaker used had an impedance of 15 ohms and the output transformer, which is a midget multi-ratio type was arranged to give a ratio of 35:1. If a 3-ohm speaker is used, the ratio should be 80:1 and R_{11} should be reduced to about 50 ohms.

The power pack incorporates a half-wave 230-volt 30-mA selenium rectifier mounted vertically through a hole in the chassis behind the mains transformer, and the output from the rectifier is adequately smoothed by two RC circuits one for each valve. Two midget electrolytic capacitors are used, one containing an 8- and a 16- μ F capacitor and the other a single 32- μ F capacitor. It was originally intended to modify a small output transformer to be used as a mains transformer, employing the existing primary and secondary windings for mains and l.t. supplies respectively and adding a third winding for h.t. Experience has shown that this can be done successfully, if the

existing primary winding and the h.t. secondary are interleaved and capable of withstanding voltages of the order of 230 volts r.m.s. Alternatively a transformer can be wound to the following specification:

Primary (untapped 2530 turns 38 s.w.g. enamelled.

H.t. secondary 2300 turns 43 s.w.g. enamelled.

L.t. secondary 73 turns 24 s.w.g. enamelled.

No primary tapings are necessary as the receiver is used only on 230-volt mains. The total secondary load is less than 7 watts and the laminations can be quite small, say 2in. by 2½in. with a core section of approximately ¼ sq. in. The author was fortunate enough to obtain from a surplus store a commercial transformer which proved suitable without alteration, though it is slightly larger than strictly necessary, and the windings have a number of tapings which are not needed in this circuit. This transformer is shown in the photographs. No on-off switch was fitted to the receiver but there is room above the chassis for a small switch.

VALVE DATA

BEFORE the war the publication of valve data was an annual feature in *Wireless World*. Since 1940, however, it has not been practicable, for reasons beyond our control, to issue other than a reprint of the information contained in the May issue of that year.

It has now been made possible for us to resume publication, but, owing to paper restrictions, the information cannot be included in *Wireless World*, and it is therefore issued separately in book form (price 3s 6d, plus 3d postage).

"Radio Valve Data," which contains 80 pages of *Wireless World* size, gives characteristics and base connections for 1,600 British and American receiving valves, including metal rectifiers, barretters, voltage stabilizers and crystal valves. An index to all valves by type number and a list of British-made American types are also included.

When valves are out of date BRIMARIZE - no need to wait!

TYPE 76 and its octal based equivalent type 6P5G are general purpose triodes used as oscillators and amplifiers in radio receivers and test gear.

Type 6J5G will replace type 6P5G directly with change of bias resistor if necessary, whilst replacement of type 76 will involve a change of socket.

For oscillator applications the slight differences in inter-electrode capacitancies may necessitate re-trimming. When used in paraphase amplifiers the increased gain of type 6J5G will involve re-balancing of the inputs to the push-pull valves.

PUNCH HOLES HERE

76
6P5G
INSTRUCTIONS: Punch holes where indicated and cut away this portion. Cut out and file them in the order in which they appear. This column will then give you a quick reference index.

CHARACTERISTICS			
	TYPES 76, 6P5G		TYPE 6J5G
Heater Voltage	6.3		6.3 volts
Heater Current	0.3		0.3 amp.
Anode Voltage	250		250 volts
Anode Current	5.0		9.0 mA.
Bias Resistor	2500		1000 ohms.
Mutual Conductance	1.5		2.6 mA/V
Amp. Factor	14		20

RESISTANCE COUPLED OPERATION			
(Supply Voltage 250 volts)			
Anode Load Resistor	0.05	0.1	0.05 0.1 meg.
Cathode Bias Resistor	3000	7500	2000 4000 ohms.
Voltage Gain	9	10	15 16

KEY
TYPES
6J5G, 6P5G

TYPE 76

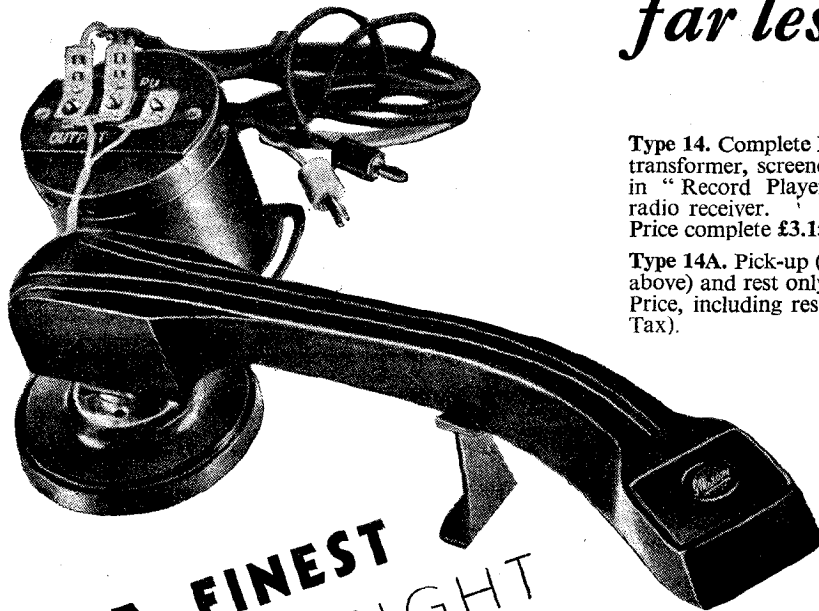
CHANGE VALVE		CHANGE SOCKET		CHANGE CONNECTIONS		OTHER WORK NECESSARY	PERFORMANCE CHANGE
FROM	TO	FROM	TO	FROM OLD SOCKET	TO NEW SOCKET		
76	6J5G	U.X. 5 Pin	Inter-national Octal	Pin 1 " 2 " 3 " 4 " 5	Pin 2 " 3 " 5 " 8 " 7	1. Change Bias Resistor in accordance with table above. 2. Re-trim receiver if necessary.	Increased oscillation or gain depending on the application.
6P5G	6J5G	International Octal	NO CHANGE	NO CHANGE		AS ABOVE	

BRIMAR says..
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R.C.M.F. EXHIBITION
STAND 96

BRIMAR
RADIO VALVES

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

*A sure way to far better reproduction—
far less record wear*



**THE FINEST
LIGHTWEIGHT**

PICK-UP

Type 14. Complete Pick-up unit with rest, matching transformer, screened lead and plugs for insertion in "Record Player" or "Pick-up" sockets of radio receiver.

Price complete £3.15.0 plus £1.1.8 (Purchase Tax).

Type 14A. Pick-up (identical with type 14 described above) and rest only.

Price, including rest, £2.10.0 plus £1.1.8 (Purchase Tax).

● **Minimum Record and Needle Wear.** This Marconiphone Pick-up is designed to provide the highest quality reproduction with the absolute minimum of record and needle wear. To those whose record library contains specimens that are irreplaceable this is a most important advantage.

● **Extended Frequency Response.** The frequency response has been greatly extended and by the elimination of any spurious resonances a perfect balance of tone is obtained over the musical range. It is sensibly linear over the section 50 — 8,000 c/s.

● **Adaptability.** By means of the special matching

transformer supplied, which incorporates a tone compensation circuit, the pick-up provides more than sufficient volume with almost any radio receiver to which it may be connected. The pick-up may be used without this transformer in conjunction with record reproducing equipment of individual design.

● **Pick-up-output** for average record, 6 mV.

Output at secondary of matching transformer is 1.5V.

● **Needles.** Needle changing is simple (no needle screw to operate) and up to 100 playings with steel needles and 2,000 playings with all-sapphire needles are possible. Ordinary needles must not be used with these instruments. Recommended types are the Columbia 99, Columbia Permanent sapphire or Columbia Miniature Thorn.

MARCONIPHONE- *the REAL thing*

SUPERHETERODYNE TELEVISION UNIT

Mechanical Details and Alignment

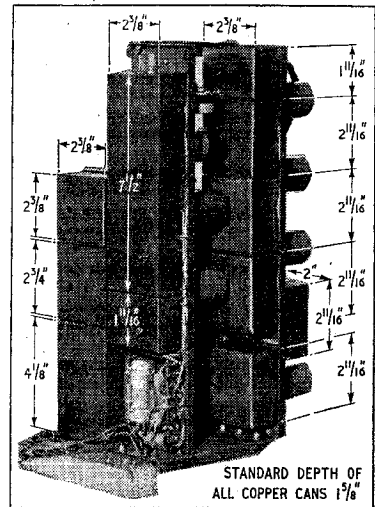
THE vision i.f. amplifier is built on a chassis consisting of a flat copper plate with the edges turned down to form a $\frac{1}{4}$ -in lip all round for stiffening. It measures 14in by 2 $\frac{3}{8}$ in when completed. All parts are mounted on the underside except for L₁₂ and C₄₉. The detector V₁₁ passes through a hole in the chassis and is partly enclosed by the can under the chassis which screens T₅, and partly by the can above the chassis which screens L₁₂.

Small tubular-paper capacitors are used for bypassing and are connected directly between the appropriate valveholder contacts and the chassis with very short leads. All earth leads are soldered to the chassis. In the i.f. stages one heater lead, the suppressor-grid connection and the two 'internal-screen' connections are soldered directly to the chassis.

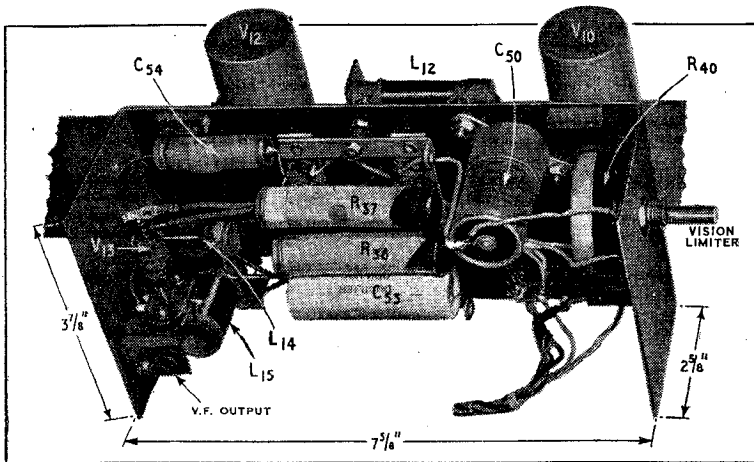
sary to provide suitably placed slots in the edges of the cans to clear leading out wires and, of course, the adjacent sides are cut away sufficiently to clear the valveholders. The can covering L₁₂ has tabs left on its ends which are bent over to form feet by which it can be secured by 6BA screws to tapped holes in the chassis.

Although the v.f. valve is on this chassis, most of the components associated with it are mounted in a separate unit mounted alongside it, and bolted to it. This separate unit need not be of copper. Any convenient metal can be used; brass was employed in the original model. The top and bottom are filled with a sheet of metal gauze to provide screening while permitting adequate ventilation.

The potentiometer R₄₀ for the



Dimensions of all screening boxes are marked on this photograph.

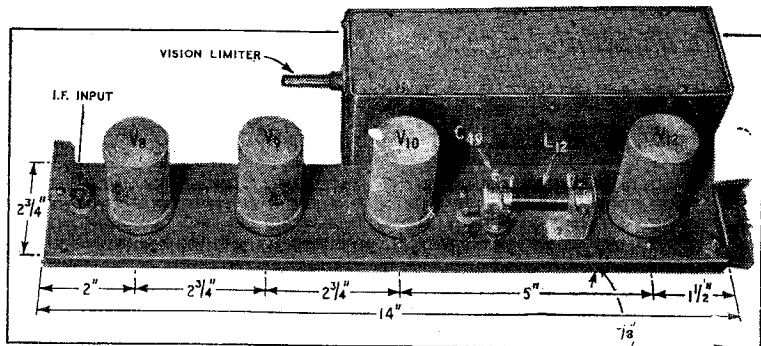


The interior of the v.f. compartment is shown here; R₃₈ and R₃₉ are on the tag board but hidden from view by C₅₃. The photograph on the right shows the top of the i.f. chassis.

The wiring is very simple because the absence of permanent screens makes everything very accessible. Dimensions of the screening cans are given in one of the photographs; they drop over the appropriate parts of the chassis and are held in place by eyebolts. It is neces-

sary to provide suitably placed slots in the edges of the cans to clear leading out wires and, of course, the adjacent sides are cut away sufficiently to clear the valveholders. The can covering L₁₂ has tabs left on its ends which are bent over to form feet by which it can be secured by 6BA screws to tapped holes in the chassis.

Although the v.f. valve is on this chassis, most of the components associated with it are mounted in a separate unit mounted alongside it, and bolted to it. This separate unit need not be of copper. Any convenient metal can be used; brass was employed in the original model. The top and bottom are filled with a sheet of metal gauze to provide screening while permitting adequate ventilation.



VISION LIMITER

Superheterodyne Television Unit—ponents following V_7 , on the other. The bracket thus provides screening between the pre- and post-limiter circuits and is necessary to prevent stray capacitance from passing interference when V_7 is cut-off.

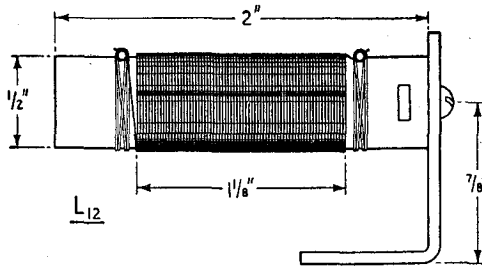
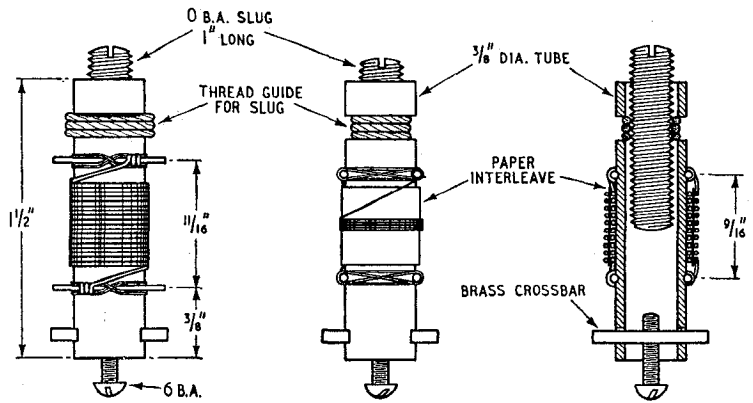
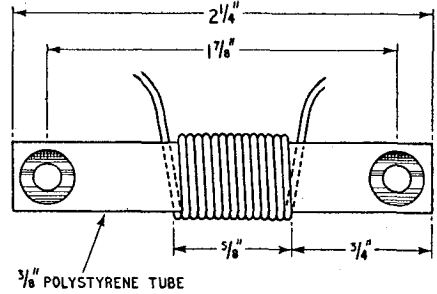
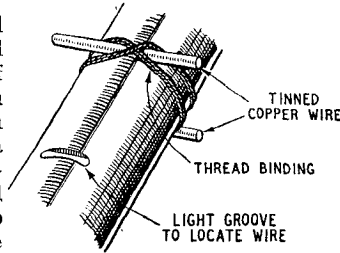
All the r.f. and i.f. coils used are of the same mechanical form and comprise a tube of $\frac{3}{8}$ -in outside diameter and $\frac{1}{4}$ -in inside diameter with slots in the walls at one end to carry a flat brass cross-piece for mounting. Slots at the other end permit a few turns of twine to be wound so as to engage in the thread of the o.B.A. tuning slug. Although all the coils utilize formers of the same mechanical type and are identical with those used in the straight set previously described, two different materials are used.

All coils tuned to the sound channel— $L_2, L_3, L_4, L_5, L_6, L_7, L_9$ and L_{11} —have polystyrene formers and copper slugs, whereas all coils in wideband circuits,— $T_1, T_2, T_3, T_4, T_5, L_8, L_{10}$,—have paxolin formers and brass slugs. The losses with paxolin and brass are heavier than with polystyrene and copper and their use is only permissible in circuits which require high losses for their proper

operation. If it is desired for uniformity, polystyrene formers and copper slugs can be used throughout, but the reverse is not permissible. If any difficulty is found in obtaining o.B.A. copper rod, it should be noted that $\frac{1}{4}$ -in

copper rod can easily be threaded with a o.B.A. die. Polystyrene is also used for the oscillator-coil former L_{12} , but paxolin for the coils L_{12}, L_{13}, L_{14} , and L_{15} .

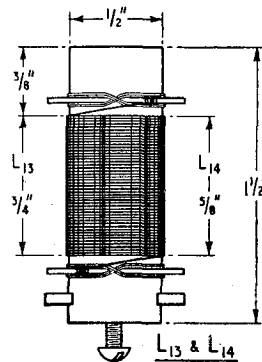
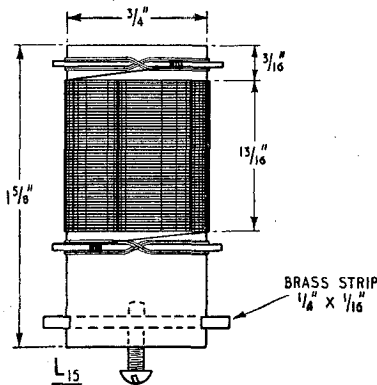
Except for T_1 and T_2 all coils are close wound. In T_1 and T_2



Details of the r.f., i.f. and oscillator coils are given above. On the left the drawings show the form of the filter and correction coils. The winding data appears in the Table on page 100.

the turns are spaced out to fill the winding space uniformly. After winding, the coils should be doped with shellac, in the case of those with paxolin formers, or polystyrene varnish, for the others. T_2, T_3, T_4 and T_5 are double-wound and should have a layer of shellacked paper between the windings to provide insulation. Primary and secondary are identical in T_2 and T_5 but in T_3 and T_4 the coupling windings have only a few turns, which should be placed in the centres of the main windings. Details of the windings are given in the table.

The set requires careful alignment and a calibrated test oscillator must be regarded as essential. The sound channel should be aligned first. Remove V_3 ; set



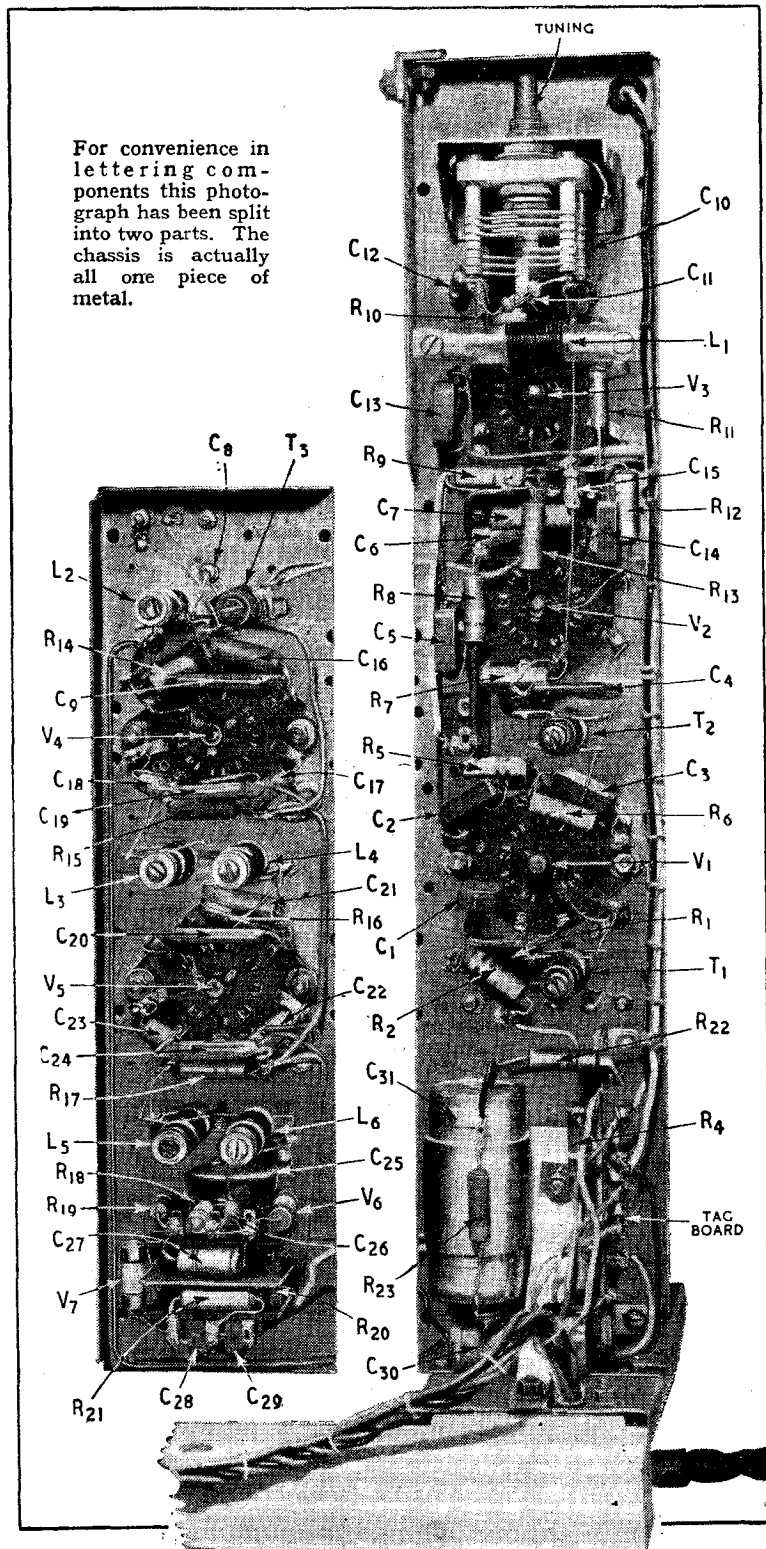
the signal generator to 9.5 Mc/s and connect it between the chassis and the grid of V_5 . Then adjust L_5 and L_6 for maximum output; L_6 will normally be flatter than L_5 . Transfer the signal generator to the grid of V_4 and adjust L_3 and L_4 . Disconnect C_4 from the secondary of T_2 and connect it to the signal generator; adjust L_2 . Then readjust all sound-channel trimmers with the gain control (contrast) at maximum starting with L_6 and finishing with L_3 .

It will be necessary progressively to reduce the signal-generator output as more circuits are brought into operation, and as they come into tune. The coupling between L_3 and L_4 and between L_5 and L_6 is adjustable by their spacing. This is normally $\frac{3}{4}$ -in between centres but is not critical. It should be slightly sub-optimum. Now connect the signal generator to the grid of V_{10} and set it to 11.5 Mc/s. Adjust T_5 for maximum response. The tuning is very flat and it is advisable to use a meter as an indicator; this should be an 0.1 millimeter connected in series with R_{24} and by-passed with an 0.001- μ F capacitor.

Transfer the signal generator to the grid of V_9 and with it set to 9.5 Mc/s adjust L_{11} for minimum output. This circuit is sharp and must be set precisely. Alter frequency to 10 Mc/s and adjust L_{10} for maximum output. Then connect the signal generator to the grid of V_8 and with it set to 9.5 Mc/s adjust L_9 for minimum output; then adjust L_8 for maximum output with the generator at 12.5 Mc/s.

Now connect the generator to C_4 just as in the case of the sound-channel adjustments, and connect a 470-ohm resistor in series with each end of the inter-unit cable. Disconnect R_{24} , set the generator to 9.5 Mc/s and adjust L_7 for minimum output. Then adjust T_4 for maximum output with the generator at 10.3 Mc/s. Reconnect R_{24} , disconnect R_{13} , set the generator to 12 Mc/s and adjust T_3 . Reconnect R_{13} and remove the 470-ohm resistors. The overall response curve should now be of the form shown in Fig. 2.

Connect the signal generator to the grid of V_1 , set it to 41.5 Mc/s,



R.F., Oscillator and Sound I.F. Chassis.

Superheterodyne Television Unit— insert V_3 and adjust C_{10} for maximum output on the sound channel. Swing the generator to a higher frequency. All output

earth. Set Brightness and Contrast for the best picture, re-adjusting Focus as necessary. If there is ignition interference adjust R_{40} until its setting just has no effect on the picture.

As this control is turned it will be found that it has no effect at all until a certain point is reached at which it suddenly takes out the brightness of the whitest parts of the picture. It should then be turned back a little so that it just has no effect on the picture quality. Any alteration to Contrast will require a re-adjustment of the noise limiter but Brightness does not affect it.

Care in the setting of this control is necessary. The aim is to adjust it so that the anode potential of V_{13} is very close to the instantaneous anode potential of

V_{12} with a peak-white signal. If it is more negative than this, the limiter will not reduce interference fully; if it is more positive, the diode will conduct on the signal and all detail in the white region will be lost.

The receiver draws a somewhat higher current than the earlier straight set and in consequence one change is desirable elsewhere. The resistor R_2 of Fig. 1, Part 6 (the limiting resistor in series with the focus control), should be changed to 200 Ω , 3 W. The resistor R_1 , of Fig. 1, Part 9, (+ H.T.3 feed resistor) need not be altered, however.

It is not possible to give much indication of the range of the receiver for it depends to a very large extent on local conditions. The set has been designed on the

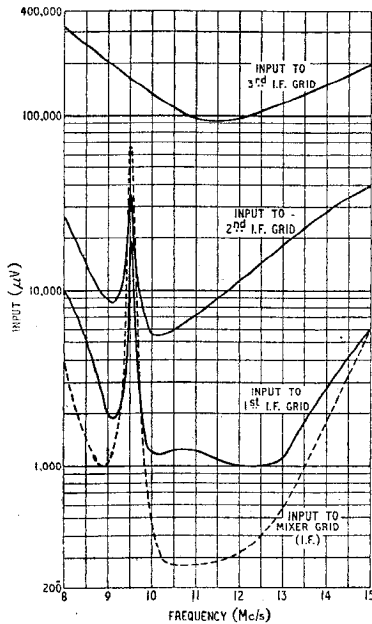


Fig. 2. These curves show the unmodulated r.m.s. signal input needed at various stages to produce a change of detector current of 0.5 mA; i.e., a change of 1.65 V across the diode load.

from the sound channel should rapidly vanish and should appear in the vision channel. There should be a maximum around 44 Mc/s and the response should be about one-half of this at 45 Mc/s.

When satisfied that the oscillator is properly set connect the signal generator to the input socket. With it set to 43 Mc/s, adjust T_2 for maximum vision-channel output, and T_1 with it set to 45 Mc/s.

The adjustments on a signal are the same as with any other receiver, but tuning with C_{10} must be carried out on the sound signal only. If C_{10} is adjusted for maximum sound output, the picture signal will automatically be tuned right provided, of course, that the i.f. circuits have been properly aligned. This correct setting of C_{10} is not one giving maximum vision signal, it is one giving one-half of the maximum. Initially put the noise suppressor out of action by tuning the control so that the slider of R_{40} is at

COIL-WINDING DATA.

Note—In all multi-winding assemblies, all windings are in the same direction, and grid windings are overwound on anode windings with one turn of shellacked paper between for insulation; adjacent ends are grid and anode on the one hand and earth and +H.T. on the other.

Component	Wire (S.W.G.)	Winding 1-2 (turns)	Winding 3-4 (turns)	Trimming Frequency (Mc/s)	Remarks
T_1 ...	36 D.S.C.	12	1½	45	3-4 interwound with 1-2 at earthy end.
T_2 ...	36 D.S.C.	9	9	43	1-2 overwound on 3-4 with one turn of shellacked paper between.
T_3 ...	38 enam.	45	4	12	3-4 overwound in centre of 1-2 with one turn of shellacked paper between.
T_4 ...	38 enam.	50	4	10.3	
T_5 ...	38 enam.	51	51	11.5	
L_1 ...	20 enam.	15	—	32	Polystyrene former, air core.
$L_2, L_3, L_4, L_5, L_6, L_7$	26 enam.	22	—	9.5	Polystyrene formers and copper slugs.
L_8, L_{11}	36 enam.	30	—	12.5	
L_{10}	36 enam.	45	—	10	
L_{12}	40 enam.	200	—	—	
L_{13}	38 enam.	108	—	—	
L_{14}	38 enam.	90	—	—	
L_{15}	40 enam.	142	—	—	

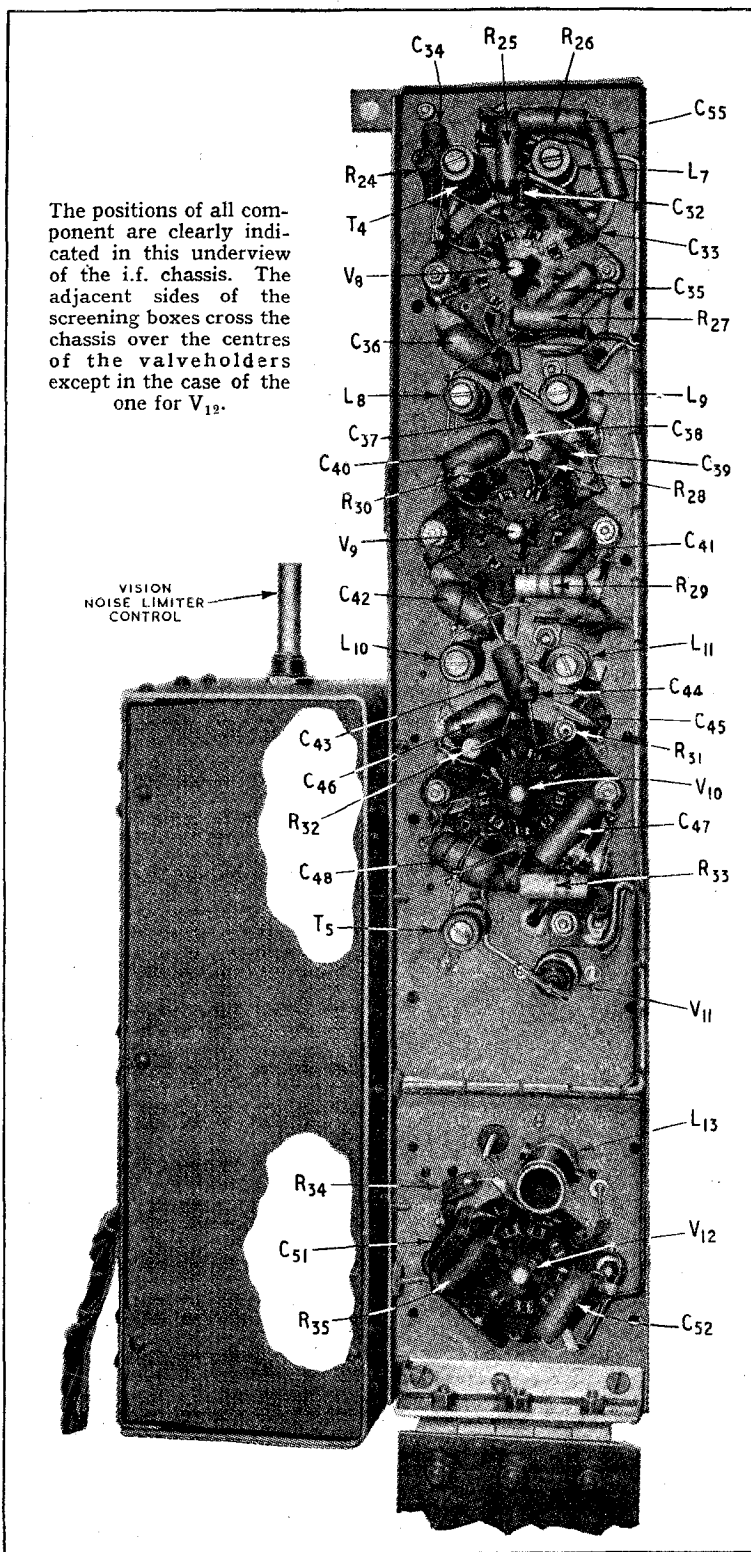
basis that a signal-noise ratio of 20 db is the minimum acceptable. This being so it has not been thought worth while to go to extremes in reducing set noise. A triode first stage, for instance, would theoretically be an improvement, but would at most be 6 db better. In practice, probably no more than 3 db would be gained. In either case, the improvement is small considering the overall requirement of at least 20 db. Matters are very different in radar where signals equal to the noise can be useful; an improvement of only 1 or 2 db may then justify considerable receiver complication.

When receiving a weak signal, receiver and external noise may well be appreciable and may affect the line synchronizing as well as produce a pattern on the picture. It has been found that the 'tearing of lines' is more disturbing than the direct noise. This can be greatly reduced, if not completely eliminated, by connecting a resistor in series with C_1 , Fig. 1, Part 6.

The effect of this is to form with the input capacitance of the sync separator an integrator which largely smooths out noise peaks and prevents them from tripping the timebase. If the resistor has too high a value pulling on whites may occur, but it should be made as high as possible as long as much pulling does not occur. Usually, 20 k Ω is a suitable value.

At extreme ranges when receiver noise becomes important it has been found that considerable improvement can be effected by the careful adjustment of the limiter. If it is set so that it does operate on the picture signal to some degree it removes quite a lot of the noise and although it degrades the picture to some extent the net result is an improvement. At such ranges the aerial becomes extremely important and is the place to which one must look for any major gain.

The receiver has been tested in a country district some 40 miles north-east of Alexandra Palace, but with rather a poor aerial. The aerial itself was a standard dipole and reflector but during the tests it was impracticable to mount it high enough above the roof of the house on which it was erected. The lower ends of the dipole rods



I.F. and V.F. Chassis

Superheterodyne Television Unit— were only a couple of inches from the tiles of the sloping roof and the centre of the aerial was no more than a couple of feet above the peak of the roof. It was estimated that at least 10 db more signal would have been obtained with a properly erected aerial.

Nevertheless, the picture obtained was indistinguishable from a local one, except of course, from

ignition interference from passing vehicles. On sound, such interference could be heard but was never obtrusive. On vision it was more noticeable, but only in the case of one or two particularly bad cars was it sufficient to mar one's enjoyment of the picture.

Corrections

In the list of components in the first part of this article the

rating of R_{10} was wrongly given as 3 W; it should be 1 W.

A by-pass capacitor C_{55} was also omitted from the circuit diagram and list of components. It is of the mica type and of $0.001 \mu F$ capacitance; it is connected to earth from the 'free' end of R_{28} and is considered advisable on account of the great length of the lead to the contrast control mounted in the other chassis.

SHORT-WAVE CONDITIONS

January in Retrospect : Forecast for March

By T. W. BENNINGTON and L. J. PRECHNER (Engineering Division, B.B.C.)

DURING January maximum usable frequencies for this latitude decreased by day and increased slightly at night. The daytime decrease was due to the "Mid-winter Effect," while the night-time increase was in accordance with the normal seasonal trend.

The month was again very disturbed, ionosphere storms being observed on 1st-2nd, 3rd, 8th, 13th and 24th-28th, the 25th-27th being exceptionally disturbed. Working frequencies for the whole month were, in fact, lower than had been expected, due to the storminess. So far as is known, no long-distance contacts were made on frequencies as high as 50 Mc/s, but transmissions of the order of 40 Mc/s from America, and 30 Mc/s from Australia, were fairly frequently received, while, during the night, frequencies as low as 3.5 Mc/s continued to be workable. From 24th-27th very little direct reception occurred on frequencies above 20 Mc/s. During this period there occurred great magnetic and ionospheric storms, which started almost simultaneously, as well as displays of Aurora Borealis, seen in places as far south as France and Austria. Some amateur transmissions on 28 Mc/s were received from the direction of the auroral zones, and not in the great circle direction between transmitter and receiver.

Again, an abnormally high rate of incidence of Sporadic E was recorded, this value being somewhat higher than in December. It is quite possible that the reception just mentioned of the 28-Mc/s band transmissions via the auroral zone was due to a considerable increase in the Sporadic E ionization in the auroral regions during the violent disturbance period.

Only three "Dellinger" fadeouts were recorded in January (15th,

17th and 18th), the fadeout on 18th being particularly violent.

Sunspot activity in January was slightly greater than in December. Two large groups were observed, which crossed the central meridian of the sun on 19th and 22nd. This last exceptionally large group was very probably associated with the violent disturbances mentioned.

Long-range tropospheric propagation was observed on a few occasions, particularly so during the foggy spell towards the end of the month. Thus transmissions on the 145-Mc/s band from Belgium were received by G6DH, Clacton, Essex.

Forecast.—During March there will probably occur in these latitudes a slight decrease in the daytime m.u.f.s, and a considerable increase for night-time. The seasonal and sunspot cycle effects taken together will tend to produce this result.

Daytime working frequencies for nearly all circuits should, therefore, remain quite high, and long-distance communication on high frequencies should often be possible in all directions for periods considerably longer than during February, due to the lengthening hours of daylight in the Northern Hemisphere. The 28-Mc/s amateur band should be regularly usable for long periods on some circuits. Frequencies lower than 11 Mc/s should seldom be necessary at any time during the night over many circuits, though on high-latitude transmission paths it is likely that frequencies of the order of 9 Mc/s will be required for limited periods.

For transmission over distances between about 600 and 1,000 miles, the E layer may sometimes control transmission during the daytime, and thus perhaps higher frequencies may be usable than would otherwise have been so. Sporadic E

ionization is not likely to be much in evidence.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during March for four long-distance circuits running in different directions from this country. All times are G.M.T. The figures in brackets indicate 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	9Mc/s	(13Mc/s)
	0200	7 "	(11 ")
	0800	9 "	(12 ")
	1000	15 "	(18 ")
	1100	17 "	(23 ")
	1200	21 "	(26 ")
	2000	17 "	(23 ")
	2100	15 "	(20 ")
	2200	11 "	(15 ")
Buenos Aires :	0000	11Mc/s	(16Mc/s)
	0800	17 "	(22 ")
	0900	21 "	(26 ")
	1000	26 "	(32 ")
	2000	21 "	(27 ")
	2100	17 "	(22 ")
	2200	15 "	(19 ")
	2300	11 "	(16 ")
Cape Town :	0000	11Mc/s	(16Mc/s)
	0300	9 "	(14 ")
	0500	11 "	(17 ")
	0600	17 "	(24 ")
	0700	21 "	(30 ")
	0800	26 "	(34 ")
	1800	21 "	(27 ")
	2000	17 "	(23 ")
	2100	15 "	(19 ")
		2200	11 "
Chungking :	0000	7Mc/s	(10Mc/s)
	0300	9 "	(13 ")
	0400	11 "	(16 ")
	0600	17 "	(25 ")
	0700	21 "	(28 ")
	1000	26 "	(32 ")
	1300	21 "	(26 ")
	1400	17 "	(23 ")
	1500	15 "	(19 ")
	1600	11 "	(15 ")
	2000	9 "	(13 ")
	2200	7 "	(10 ")

As a considerable amount of ionospheric storminess often occurs during March, it may be anticipated that some serious disturbances may occur. At the time of writing it would appear that such disturbances are more likely to occur within the periods 2nd-6th, 13th-14th, 19th-21st, and 29th-31st, than on the other days of the month.

THE "BELLING-LEE" PAGE

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

"DOOROD" INDOOR TELEVISION AERIAL

This has become very popular, and in fact we have been behind with deliveries ever since its introduction. For those who may have missed the original description, it is a fully dimensional half-wave dipole with one rigid and one flexible element. It is satisfactory for use within six or seven miles of Alexandra Palace, but its use in a steel framed building should not be encouraged. We cannot too strongly advise against exaggerated claims for any indoor aerial, even a fully dimensioned one like the "Doorod."*1.

Any indoor aerial will be influenced by vertical metal work situated within a distance of $\frac{1}{8}$, $\frac{1}{4}$, or $\frac{1}{2}$ wavelength, and it should be remembered that such metal work may well be hidden in walls; i.e., conduits or gas-pipes, or even lead covered telephone cables, either in connection with your own home installation, or that of your neighbour if in a semi-detached or terrace house. "Wireless World" readers should not have to be reminded that wireless waves have no respect for bricks and mortar.

THE LIFE OF WHITE POLYTHENE

We have received an enquiry from a wholesaler as to the position on L.336*2 balanced feeder using Polythene insulation. A statement has been circulated to the effect that white polythene deteriorates (photo-ages) if exposed to bright sunlight. We accept this, and have made arrangements to have future makings with the necessary admixture of carbon black which will retard the cracking and splitting which takes place. In other than seaside areas the deterioration is very slow and generally the cable would outlast the normal expectations of life of the installation, say five or more years.

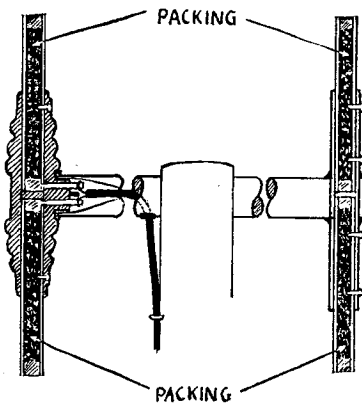
RADIATED INTERFERENCE

During January we received a letter demonstrating a particularly interesting example of interference being picked up from the mains in a house.

"I use an ordinary inverted "L" type aerial and when I use my set near the point of entrance the reception is free of interference, but I want to use the set in another

room. To do this I run my aerial for forty feet round picture rails, and in doing so I pick up so much interference (bangs, clicks, hisses, etc.) as to make listening very difficult. Would co-axial cable solve the difficulty and would I need transformers?"

The aerial having proved itself to be relatively free from interference pick-up, the answer to this very common problem is that the co-axial cable that would normally be used would have excessive capacity to earth, resulting in excessive attenuation of incoming signal. Therefore it would be desirable to use an impedance matching transformer system such as the "Eliminoise"*3 to overcome losses of the long screened lead. If the aerial itself had been picking up interference, we would have recommended the erection of a "Skyrod."*4



VIBRATING AERIALS

This winter has produced its usual crop of complaints of television dipoles vibrating in the wind. "Belling-Lee" steel elements were apparently immune, there may be effect at very high wind speeds but, under such conditions, there is so much other noise that the vibrations are not unduly troublesome.

With light high tensile alloy elements, this vibration is set up at lower wind velocities and can be very troublesome, particularly where the wind is undisturbed by hills or buildings. It would take up too

much space to say how the noise is set up, but much work has gone into the cure. It has been found that if each element is filled with sawdust, close up to the cross arm, the trouble clears. Dismantling of the elements is unnecessary. First, remove the rubber plug, ram home a plug of rag, then fill with sawdust, finally replace rubber plug. Other methods may be found, but we know that this works.

It was very gratifying to hear from a dealer, near Worthing, that on the coast all makes of aerials were apt to vibrate, but that Belling-Lee "Viewrods"*5 were the only ones that really stood up to heavy weather conditions in exposed locations.

PERSONAL SETS IN CARS

With the growing popularity of the Personal receiver, we are receiving enquiries regarding their use in motor cars. First of all the car must be suppressed, each plug with suppressor type L.1143*6 and distributor with L.630*7.

Unless you can think of some way of "locking" the receiver on to the bearing of the station, the set frame aerial will not be very satisfactory. There is generally provision on the receiver for an external aerial, and this should be connected to a vertical "Carod"*8 aerial L.582 or L.590.

*1. "Doorod" (Regn. app. for) indoor T.V. aerial, 30/-.

*2. L336 balanced feeder, 7 $\frac{1}{2}$ d. yard.

*3. "Eliminoise" (Regd. trade mark) L308 plus feeder, 70/-.

*4. "Skyrod" (Regd. trade mark) 18ft. vertical aerials from 60/-.

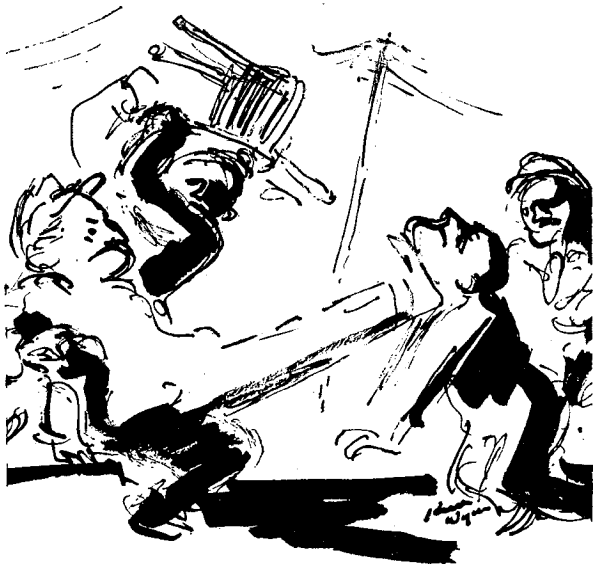
*5. "Viewrod" (Regd. trade mark) T.V. aerials from 52/6.

*6. L1143 Plug suppressor, 1/6.

*7. L630 Distributor suppressor, 2/-.

*8. "Carod" (Trade mark) car aerials, L590, light, 24/9; L582, heavy, 27/6.





THE SHOCKING OF DIM McCLUE.

A bunch of the boys were 'stepping it up' on transmitters south of Crewe, And in charge of this bunch of technicians was Dunderhead Dim McClue; As bosses go, he was rather slow, when you must be kinda slick When the power is switched to them humming wires, the juice flows mighty quick.

Now Dim scorned all transformers, said they were Cissy's game, And the way he fixed a circuit was surely far from tame: With hand on line, Dim yelled out "Fine. O.K., now let it roar!" - A mighty crack and Dim fell back - in cinders on the floor.

Now when you wire transformers, look out for those sudden shocks, Vibration, moisture, heat and cold, humidity and knocks. Beware of rust, and fumes, and dust; Yes, this you all should know, If you want full protection - you insist on PARMEKO.



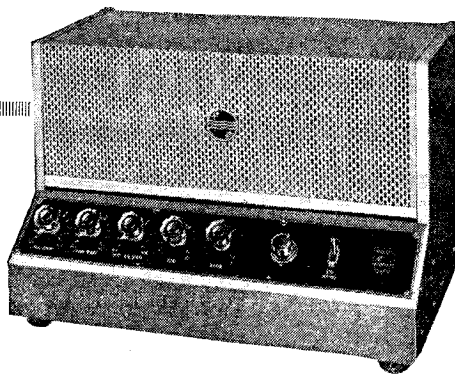
Parmeko
of Leicester

Makers of Transformers for the Electronic and Electrical Industries

★ With apologies to the late Robert Service

25 WATT & 50 WATT AMPLIFIERS

New high standard of stability and reproduction. Very high degree of amplification. Simplicity of operation.



EXTREME SENSITIVITY. Perhaps the most noteworthy feature of these amplifiers is their high sensitivity, which allows wide-range pick-up with low-level high fidelity microphones.

For example, the 25-watt has an overall power amplification of 133 d.b. or twenty-million-million-times. This is mainly achieved by the inclusion of a high-gain input stage completely enclosed in a rubber-mounted magnetic screening case.

OUTPUT. The output transformer of each amplifier is of generous size, and has an eight-sectioned primary in order that it can be included in the inverse feed-back loop. The following outputs are provided:—

Max. undistorted voltage (R.M.S.) 100, 50, 25 volts.
Load impedance (25-watt) - - 400, 100, 25 ohms.
Load impedance (50-watt) - - 200, 50, 12.5 ohms.

These amplifiers are normally intended to use with the 100-volt-line system in which each loudspeaker has its own transformer. This allows simple parallel connection of the loudspeaker load, the use of long lines, and the rating of loudspeakers in terms of their actual power consumption in watts.

MICROPHONE INPUT
Input required for full drive
0.8 millivolts

Impedance - - 1 megohm

GRAMOPHONE INPUT
Input required for full drive
90 millivolts

Impedance - - 0.25 megohm



PHILIPS ELECTRICAL
LIMITED

AMPLIFIER DEPARTMENT,
CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

VOIGT PERMANENT-MAGNET LOUDSPEAKER

Performance Similar to That of Energized Models

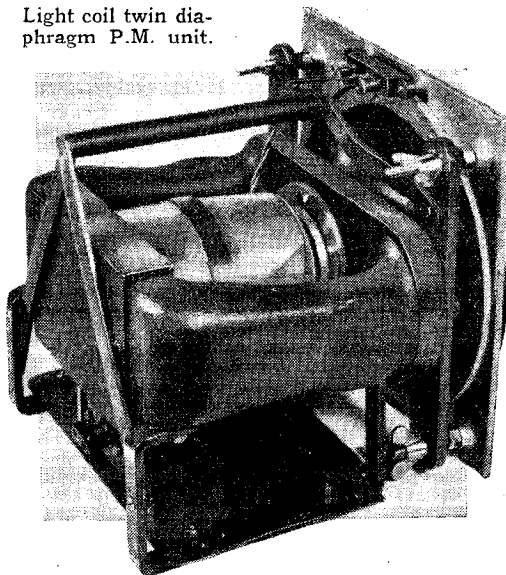
FOR many years the Voigt energized magnet has set a standard of performance far above the ordinary run of commercial designs, and there can be little doubt that the success of the first Voigt moving-coil loudspeaker was in no small measure due to the high flux density in the gap.

It is not easy, even in these days of anisotropic magnet alloys, to approach this standard with a permanent magnet, but as the result of several years' development work, P. G. A. H. Voigt has now succeeded in producing a magnet which gives 18,000 lines/cm² in a 1½ mm gap with an outside diameter of 40 mm and a depth of 5 mm.

The form of the magnet is similar to that of the original energized version, so that the firm's policy of continuity of design and interchangeability of parts, to provide for new developments, has been preserved. The magnetomotive force is supplied by a massive centre block of Titanium, and the return paths are through two side limbs of generous cross-section.

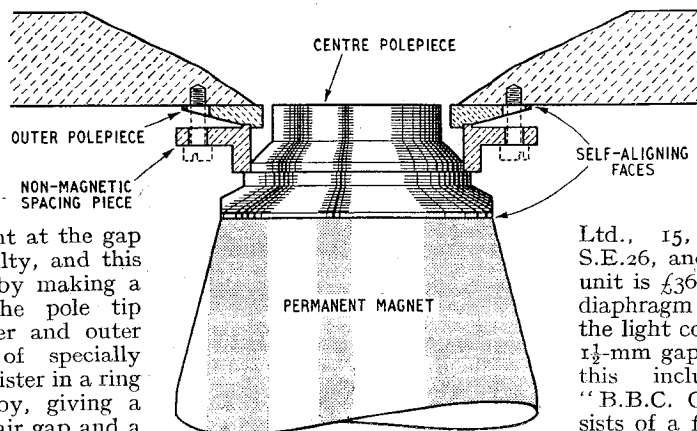
In a magnet of these dimensions, accuracy of alignment at the gap presents some difficulty, and this has been overcome by making a separate unit of the pole tip assembly. The inner and outer poles, which are of specially selected material, register in a ring of non-magnetic alloy, giving a perfectly concentric air gap and a rigid assembly which will withstand the stresses incidental to magnetization. Owing to the short-circuiting effect of the side members, which are virtually in parallel with the permanent magnet during the magnetizing process, ordinary magnetizers are not big enough for the job, and a

Light coil twin diaphragm P.M. unit.



special machine had to be designed with a magnetizing force of not less than 20,000 ampere-turns.

The joints in the magnet system are so arranged that alignment is automatic, and they also give latitude for subsequent alterations in



The magnet system is so designed that accurate machining is required only in the polepiece assembly.

design which may result from the discovery of even better magnetic alloys in the future. The weight of the loudspeaker with the new mag-

net system is about 30 lb.

Externally the light coil twin diaphragm has the same appearance as in previous models,* but the speech-coil impedance is now 15Ω, and a re-calculation of mechanical and electrical impedances has resulted in better matching between the damping forces and the characteristics of the diaphragm, horn and bass chamber.

In view of the permanently high flux and the difficulties of clearing the gap of filings, export models, at least, will be fitted with dust covers, back and front.

We have had an opportunity of comparing the new P.M. model with a pre-war energized model, and we are

of opinion that it will worthily uphold the traditions of the name for high electro-acoustic efficiency and fine quality of reproduction. The redistribution of matching between the various elements has effected a noticeable improvement

on the best transmissions, and in listening to the bass response it is impossible to detect coloration from any resonant effects.

The makers are Voigt Patents, Ltd., 15, Silverdale, London, S.E.26, and the price of the new unit is £36 for the standard twin diaphragm in a 2-mm gap. With the light coil twin diaphragm in a 1½-mm gap, the price is £40, and this includes an adjustable "B.B.C. Corrector" which consists of a filter in the speech-coil circuit and controls medium high frequencies without affecting extreme top. The units are designed to work into a horn load, and two types are available; the H.C. corner horn with bass chamber at £19 10s and the domestic corner deflector at £47 10s.

* Wireless World, March 9, 1939, p. 233.

WORLD OF WIRELESS

P.M.G.'s New Powers ♦ Licences ♦ Component and Instrument Shows ♦ Faraday Medalist

W/T Act

A MAJOR change was introduced in the Wireless Telegraphy Bill before its presentation to the House of Lords. A new section (12) has been included empowering the Postmaster General to prohibit the sale, except for export, of electrical apparatus which fails to comply with any regulations he may make as to its non-interfering properties.

Provision is made in the Act for the appointment by the P.M.G. of an advisory committee from nominees of the I.E.E. and also an appeal tribunal.

The Bill, which, when placed on the Statute Book, will be known as the Wireless Telegraphy Act, 1949, and will supersede the Acts of 1904-1926, has been published by H.M. Stationery Office, price 6d.

Prior to the third reading the R.I.C. sent to all members of Parliament a memorandum giving in non-technical language the causes of electrical interference and means of suppression.

Nearly 11,500,000

INCREASES during 1948 of 340,000 broadcast receiving licences and 60,000 television licences brought the total for Great Britain and Northern Ireland to 11,456,800.

Of this figure 92,800 were television licences.

If the monthly rate of increase in television licences (10,400) continued during the first part of this year, the 100,000 mark must have been passed in January.

R.C.E.E.A. Report

WHEN reviewing the past year's activities of the Radio Communication and Electronic Engineering Association, the chairman of this constituent body of the Radio Industry Council stated that the exports of communication equipment, navigational aids and industrial electronic gear were doubled during the year. The total value was over £3,000,000.

Broadcast transmitters accounted for some 15 per cent of the exports; communication equipment for 60 per cent, and marine and air navigational aids for 20 per cent.

Physical Society's Show

FURTHER details are now available of the 33rd annual exhibition of scientific instruments and apparatus organized by the Physical Society, which will be held at the Imperial College, South Kensington, S.W.7, from 5th to 8th April.

With the exception of the opening day, when the exhibition opens at 2.0, there will be both morning (10.0 to 1.0) and afternoon sessions—from 2.0 to 9.0 on the first two days and 2.0 to 7.0 subsequently.

The catalogue of the exhibition will be available from the Exhibition Secretary, 1, Lowther Gardens, London, S.W.7, early in March, price 6s, including postage.

Among the lectures which will be given during the exhibition are: "Some Problems of Wave Diffraction in the Ionosphere," by J. A. Ratcliffe, on 5th April, and "Some Modern Aspects of Scientific Instruments," by A. J. Philpot, on 6th April. Both lectures begin at 5.0.

Components Show

THE sixth annual private exhibition of British radio components, valves and test gear opens in the Great Hall, Grosvenor House, Park Lane, London, W.1, at 10 a.m. on March 1st. It is promoted by the Radio Component Manufacturers' Federation to acquaint radio and electronic manufacturers and engineers with the latest advances in the design and development of British components and accessories. Admission is restricted to holders of invitation cards issued by the Federation.

The show—there are to be 106 exhibitors—will be open on the 1st, 2nd and 3rd from 10 a.m. to 6 p.m.

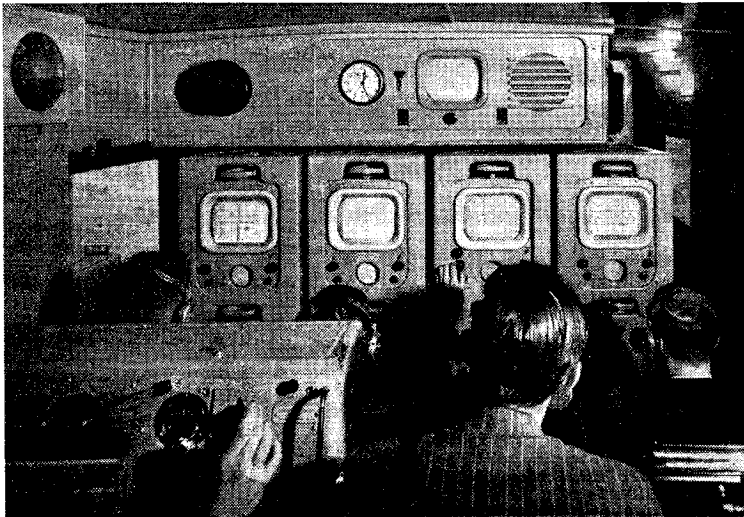
German Amateurs

IT was erroneously stated some months ago that German amateurs were again being licensed. Although the regulations had been framed, they had not become law and the only amateurs operating in Germany since the war have been members of the occupying powers.

The German Economic Council has now made the necessary legislation for the licensing of German amateurs in the British and U.S. zones, and it is expected that the licences will be issued at the end of February. Technical and Morse examinations have already been held and a list of some 500 successful applicants has been prepared. The prefixes DL1, 3, 6, 7, 8, 9 and 0 will be used.

Beam Pioneer Honoured

THE Faraday Medal for 1949 has been awarded by the I.E.E. to C. S. Franklin for his distinguished work in radio engineering, and more particularly for his development of the beam aerial and other devices that made long-range h.f. communication a practical possibility. Of the many other innovations for which he was responsible,



O.B. TELEVISION.—Interior of the O.B. van equipped by Pye to B.B.C. specification. Three of the four rack-mounted tubes monitor the three Photicon cameras and the fourth the picture transmitted from the van. The image received from A.P. is shown on the upper tube.

the Marconi "multiple tuner" was among the first. His name is



C. S. Franklin.

perhaps best known as the originator of the high-stability Franklin oscillator. Mr. Franklin was one of the original band of engineers who joined the Marconi Company 50 years ago.

News in Morse

IN response to requests from readers, we have secured and give below the latest schedule of official news bulletins transmitted in morse from Post Office stations.

G.M.T.	Call	Freq. (kc/s)	Zones
0130-0315*	GBV	78	1
	GIJ	6,985	1, 2
	GPG	7,735	3
	GCX	8,920	4
	MIJ	7,447	6
0445-0545	GBI	10,865	2
	GCV	19,365	3
0945-1045	GBV	78	1
	GIM	12,975	1, 2
1100-1200	GCV	19,365	3, 5
	GCF	19,005	4
1215-1315	GPA	20,100	6
	GIM	12,975	1, 2
1300-1430	GBI	10,865	3, 5
	GCF	19,005	4
1445-1545	GPA	20,100	6
	GAG2	17,425	2
1600-1700	GBV	78	1
	GIH	10,650	1, 2
1700-1800	GAH	8,065	3, 5
	GCF	19,005	4
1715-1815	GBV	78	1
	GBX	10,530	6
1830-1930	GBV	78	1
	GIH	10,650	1, 2
1945-2045	GAH	8,065	3, 5
	GCF	19,005	4
2100-2200	GCX	8,920	6
	GCX	8,920	6
2215-2315	GBV	78	1
	GDI	7,780	1, 2
2330-0100*	GAH	8,065	3, 5
	GIB	11,980	4
Midnight-0330*	MIJ	7,447	6
	GBV	78	1
	GIJ	6,985	1, 2
	GAH	8,065	3
	GCX	8,920	4
	MIJ	7,447	6
	GAC	6,945	7
	MIK	9,725	7
	GAF	7,308	8
	GIH	10,650	8

* Sunday included.

In addition to the usual details of time, call sign and frequency, we give the zone of reception (1, Europe; 2, Near and Middle East; 3, N.E. Asia; 4, Africa; 5, Australia and New Zealand; 6, India and S.E. Asia; 7, N. America and Mexico; 8, Central and South America). Bulletins are radiated on week-days only unless otherwise indicated.

PERSONALITIES

Sir Ben Lockspeiser, M.A., who has held a number of scientific administrative posts in the Ministries of Production and Supply and has been Chief Scientist in the latter since 1946, has been appointed Secretary to the Committee of the Privy Council for Scientific and Industrial Research in succession to Sir Edward Appleton, who is going to Edinburgh University. Sir Ben, who was knighted in 1946 and is 57, will take up his new position in April.



Sir Ben Lockspeiser, M.A.

Sir Cyril Radcliffe, K.C., who from 1941-1945 was director-general of the Ministry of Information, has accepted the Government's invitation to be chairman of the Committee of Enquiry into the B.B.C. before the renewal of its Charter which expires at the end of 1951.

H. G. Booker, M.A., Ph.D., who has been appointed a professor of electrical engineering at Cornell University in the U.S.A., was at one time in charge of the Mathematics Section of the M.O.S. Telecommunications Research Establishment. Since the war he has been working in the Cavendish Laboratory, Cambridge. A few months ago he was appointed a member of the B.B.C. Scientific Advisory Committee and also of the I.E.E. Radio Section Committee; he has resigned both appointments.

C. W. Oatley, M.A., M.Sc., of the Engineering Laboratory, Cambridge University, has been appointed to the I.E.E. Radio Section Committee to fill the vacancy caused by Dr. Booker's resignation.

Geoffrey W. Hart, M.A., who was until recently head of the Radar Division of E.M.I. Engineering Development, Ltd., is now development officer in the Council of Industrial

Design and is in charge of the industrial survey being undertaken in preparation for the 1951 Festival of Britain. He was vice-chairman of the Technical Committee of the R.C.E.E.A. last year.

O. W. Humphreys, B.Sc., who has been on the staff of the G.E.C. Research Laboratories at Wembley since 1925, has been appointed manager of the Laboratories.

F. S. Mockford (Marconi's W/T Co.) and V. M. Roberts (B.T.H.) have been elected chairman and vice-chairman respectively of the council of the Radio Communication and Electronic Engineering Association for 1949.

J. A. Ratcliffe, O.B.E., M.A., of Cavendish Laboratory, Cambridge, has resigned from the I.E.E. Radio Section Committee to which he was elected in 1947. He is succeeded by E. C. Cherry, M.Sc. (Eng.), of the City and Guilds of London Institute.

Dudley Stretton succeeds the late Alex Moody as organizer of the National Radio Exhibition which is to be held at Olympia from September 28th to October 8th. Since his discharge from the Army he has been with the Exhibitions Division of the M.o.I.

IN BRIEF

Decca.—Lane identification, by means of which marine or air navigators coming within range of the transmissions from a Decca Chain know immediately their position, has been officially introduced in the English Channel. The Decca Navigator is now recognized as a radio navigational aid in compliance with Air Traffic Control requirements. Two additional chains, one in S.W. England and another in Scotland, have been sanctioned by the Ministry of Transport.

Combined operations by Rediffusion, G.E.C., Pye and Ekco, co-ordinated by International Aeradio, have resulted in twelve radio installations for Burmese airfields being assembled ready for export in under three months.



Sir Cyril Radcliffe, K.C. (See "Personalities")

Plessey Apprenticeships.—A revised scheme for apprentices has been drawn up by the Plessey Co. It provides for occupational training and for technical education at the South-East Essex

World of Wireless—

Technical College throughout the whole terminates when the apprentice reaches the age of 21. Details of the scheme, which is open to juveniles between the ages of 16 and 17 without payment of a premium, are obtainable from the Plessey Co., Ilford, Essex.

No Radio Degrees.—At a January discussion meeting of the I.E.E. Radio Section it was agreed almost unanimously that the establishment of university degrees in radio was unnecessary, and even undesirable.

Business Radio.—G.E.C. radio-telephone equipment has been installed by the Midland Electricity Board to facilitate the direction of its service vans over an area of 120 square miles. F.M. is used with duplex working on two frequencies between 65 and 85 Mc/s. Both the headquarters and mobile transmitters have a 20-W output. The G.E.C. has also installed simplex equipment in the editorial office of *The Scotsman* in Edinburgh for use by reporters. Working on a fixed frequency it has no controls other than a press-to-talk switch on the telephone handset.

Piped Television.—The cost of 3s 6d per week, quoted in our note last month on the television aerial service to be available in certain L.C.C. flats, covers not only this service but also includes a four-programme broadcast relay service and the renewal of the £2 annual television licence.

Vacuum Technique.—A course of lectures on high vacuum technique has been arranged by the South-East London Technical College, Lewisham Way, London, S.E.4, for the six successive Mondays beginning on February 28th, from 7 to 9 p.m. The fee for the course, which has been prepared by J. Yarwood, M.Sc., will be £1. The syllabus includes details of pumps, de-gassing and gettering techniques, the deposition of metals *in vacuo* and the applications of vacuum technique in industry.

P.T. on Accumulators.—It was announced on January 18th that 2-V accumulators of a capacity not exceeding 7 Ah at the 14-hour discharge rate—except those having glass containers—will not in future be charged with purchase tax.

Ediswan-Mazda cathode-ray tubes are not manufactured at the company's Ponders End factory as stated on page 52 of the last issue, but at its Brimsdown Works, where the photograph was taken.

Metallic Finishes.—A British Standard has been issued (B.S.1448:1948) for the nomenclature of decorative metallic finishes, and is obtainable from B.S.I., 24, Victoria Street, London, S.W.1, price 2/6 post free.

E.M.I. has published reprints of papers on quality recording and reproduction read by members of its staff before learned societies, and they are available from the Advertising Division, E.M.I. Sales and Service, Ltd., Hayes, Middlesex, price 2/6. The titles are: "Commercial Disc Recording and Processing," B. E. G. Mittell; "The Development of Sound Recording and

Reproduction," Sir Ernest Fisk; "Sound Recording and Reproduction," G. F. Dutton; and "High Quality Disc Recording," W. S. Barrell. Others will be published in due course.

A.R.R.L. Handbook.—A supply of the 1949 edition of the Amateur Radio Relay League's *Handbook* is being secured by Arthur F. Bird, of 66, Chandos Place, London, W.C.2, who hopes to have copies available by March; price 15s 6d plus 11d postage.

For "B.E.E.J." read "B.E."—With the January issue our associated journal *British Engineering Export Journal* has changed its title to *British Engineering*.

"Ionosphere Review, 1948."—It is regretted that contraction of the wording in paragraph four, centre column, page 56, of this article in the February issue implies that records of measurements of ionospheric ionization go back to 1749. This is obviously not the case; the records associated with this date are those of solar activity.

INDUSTRIAL NEWS

R.C.E.E.A. Council.—Representatives of the following member firms of the Radio Communication and Electronic Engineering Association constitute the council for 1949: B.T.H., E.M.I., G.E.C., Henry Hughes, Marconi's, Metropolitan-Vickers, Mullard, Murphy, Plessey and Redifusion.

Indian Ekco.—As a result of the recent agreement between Ekco and the National Radio and Engineering Company, Bombay, for the manufacture of radio gear in India, a new company has been formed. It will be known as the National Ekco Radio and Engineering Co. Products will be distributed by General Radio and Appliances, Ltd. (previously Fazalbhoy, Ltd.). J. A. Howie, until recently works manager at the Ekco Works, Rutherglen, Scotland, will be general manager of the new company.

Partridge.—The factory and offices of Partridge Transformers, Ltd., are now at Roebuck Road, Oakcroft Estate, Kingston By-pass, Tolworth, Surrey (Tel.: Elmbridge 6737/8).

Scophony-Baird, Ltd., is the new name adopted by Scophony since the acquisition of John Logie Baird, Ltd.

Mail Order Supply Co. is opening a new retail establishment to be called the "Radio Centre" at 33, Tottenham Court Road, London, W.1.

MEETING

Institution of Electrical Engineers

Radio Section.—The Analogies between the Vibrations of Elastic Membranes and Electro-Magnetic Fields in Guides and Cavities," by E. C. Cherry, M.Sc. (Eng.), at 5.30 on March 2nd.

"The Development of Q-Meter Methods of Impedance Measurement," by A. J. Biggs, Ph.D., B.Sc., and J. E. Houldin, Ph.D., B.Eng., at 5.30 on March 8th. (Joint meeting with the Measurements Section.)

Discussion on "The Planning of Business-radio Services at V.H.F.," opened by D. H. Hughes at 5.30 on March 15th

The above meetings will be held at the I.E.E., Savoy Place, London, W.C.2.

East Midland Centre.—Faraday lecture on "Television" by Sir Noel Ashbridge, B.Sc. (Eng.), and H. Bishop, C.B.E., B.Sc. (Eng.), at 7.15 on March 16th at the De Montfort Hall, Leicester.

Cambridge Radio Group.—"Electronic Calculating Machines" by Prof. D. R. Hartree, Ph.D., M.A., M.Sc., at 8.15 on March 8th at the Cavendish Laboratory.

North-Eastern Radio Group.—"Induction Disc Motors for Relays and Instruments" by W. Gray at 6.15 on March 7th at King's College, Newcastle-on-Tyne.

Informal lecture on "Printed Circuits, including Miniature Components and Sub-Miniature Valves," by J. E. Rhys-Jones, M.B.E., and G. W. A. Dummer, M.B.E., at 6.15 on March 21st at King's College, Newcastle-on-Tyne.

Sheffield Sub-Centre.—Faraday lecture on "Television" at 7.0 on March 23rd at the City Hall, Sheffield.

Southern Centre.—"Aids to Training—the Design of Radar Synthetic Training Devices for the R.A.F.," at 5.45 on March 9th at H.M.S. *Collingwood*, Fareham.

"Fixed Resistors for use in Communication Equipment, with special reference to High-Stability Resistors," by P. R. Coursey, B.Sc. (Eng.), at 6.30 on March 16th at the Wedgewood Café, Albert Road, Bournemouth.

West Wales Sub-Centre.—"Communication over High-Tension Networks," by W. B. Warren at 4.0 on March 10th at the Osborne Hotel, Langland, Swansea.

Irish Branch.—"The Application of Carrier Telephony to Coaxial Cables," by A. J. Litton, B.E., B.Sc., at 6.0 on March 24th at Trinity College, Dublin.

Radio Society of Great Britain

"Technical Publishing," by G. Parr at 6.30 on March 25th at the I.E.E., Savoy Place, London, W.C.2.

British Sound Recording Association

"Design of a Cutter Head for Disc Recording," by D. O'C. Roe, B.Sc., at 7.0 on March 25th at the Royal Society of Arts, John Adam Street, London, W.C.2.

Institute of Navigation

"The Use of Radar Beacons," by K. A. B. Gilfillan, M.B.E., at 5.0 on March 18th at the Royal Geographical Society, 1, Kensington Gore, London, S.W.7.

Television Society

Midlands Centre.—"A Home - built Television Receiver" by W. I. Flack at 7.0 on March 4th at the Chamber of Commerce, New Street, Birmingham.

Junior Institution of Engineers

Sheffield and District Section.—"The Manufacture of Gramophone Records," by H. W. Bowen, O.B.E., at 7.30 on February 28th at the Metallurgical Club, West Street, Sheffield.

Institution of Electronics

N.W. England Section.—"Photo Electric Multipliers," by S. Rodda, B.Sc., at 6.30 on March 23rd, at the Reynolds Hall, College of Technology, Manchester.

British Institution of Radio Engineers

London Section.—"The Design and Characteristics of Marine Radar Equipment," by A. Levin at 6.0 on March 17th, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

THE effect of transmitter power upon range is a particularly important question from a practical and economic point of view, since a larger power increases cost, and also increases size, weight and battery drain—factors which are very important in airborne sets.

Theoretical maximum ranges of communication will not, of course, always be obtained in any given instance owing to such factors as slight deficiencies in the equipment, unfavourable terrain or meteorological conditions, or electrical interference. Nevertheless, a great deal of useful information can be extracted from the calculated range, which depends, of course, on the following two factors:—

(a) The field at any distance d from a transmitter radiating a known power P , the ground station aerial being at height h_1

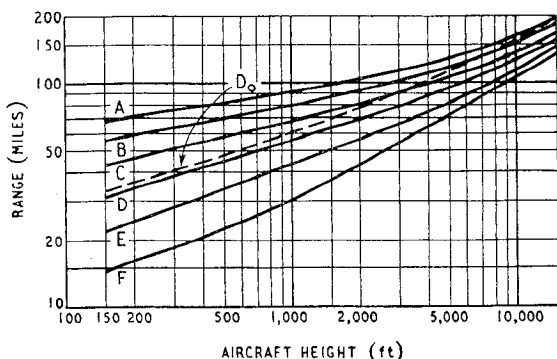


Fig. 1. Theoretical ranges of communication with aircraft for different ground transmitter powers and height of aerial. The dashed curve is the optical horizon with a ground aerial 100-ft. high.

above ground and the aircraft at height h_2 .

(b) The field required for intelligible reception in the aircraft, assuming a fully efficient receiver, and no external interference.

The range will be the same in both directions if the power radiated and the receiver are the same at each end, assuming that no electrical interference is present. Half-wave dipoles, or quarter-wave aerials with ground plane are normally used.

As regards the field required at the receiver, it can be shown from the available data on cosmic noise and on internal receiver noise, that a signal field of about $2 \mu\text{V/m}$ (equivalent to $2 \mu\text{V}$ from a signal generator) is just sufficient to give intelligible reception, assuming that the receiver is up to the maximum efficiency now

RANGE OF V.H.F.

Part I.—Air to Ground Communication

By **M. V. CALLENDAR**, M.A. (E. K. Cole, Ltd.)

available, and that local interference (e.g., from the aircraft ignition) can be neglected.

Practical ground receivers of good design (noise factor of, say, 10 db) are quite near to the maximum possible efficiency referred to, but an aircraft receiver may be well below this optimum owing to exigencies of space, weight, or battery drain; moreover, the aerial on the aircraft may be partly screened by the fuselage and a slight residuum of ignition or other interference may be unavoidable, even after careful suppression. It is therefore customary to make the

a transmitter operating on 120 Mc/s has been calculated from the available formulae (see Appendix). From these, the distance at which the field falls to the minimum required at the receiver has been extracted, and the figures thus obtained have been plotted in Fig. 1 which shows the theoretical range for any height between 150 ft and 15,000 ft under a variety of conditions. The "efficiency" quoted is relative to maximum possible efficiency and is intended to include any loss due to interference or to an inefficient aerial system, as well as any lack of efficiency (signal/noise ratio or noise factor) in the receiver, relative to a standard of 10 db noise factor.

At heights greater than 15,000 ft range will normally increase further. Fig. 2 shows a typical example, corresponding roughly to Curves E or F of Fig. 1: note the "lobes" caused by the vertical directional pattern of the aerial with earth reflection.

A curve for distance D_0 to the optical horizon has been plotted in (dashed) on both Figures, since

Use Curves in Fig. 1.

First Column is Efficiency Relative to the Maximum Possible.

Efficiency	Ground Aerial	Transmitter Power				
		0.1 w.	1.0 w.	10 w.	100 w.	1 Kw
0 db	100 ft.	D	C	B	A	—
0 db	30 ft.	E	D	C	B	A
10 db	100 ft.	E	D	C	B	A
10 db	30 ft.	F	E	D	C	B
20 db	100 ft.	F	E	D	C	B
20 db	30 ft.	—	F	E	D	C

ground transmitter at least 10 times more powerful than the aircraft transmitter, allowing for a deficit of at least 10 db at the aircraft receiver.

A series of curves for field from

D_0 is often used as an approximation for range. For low heights of aircraft, it is seen that the actual range may be as much as double D_0 , while at heights of the order of 20,000 ft D_0 represents a

Range of V.H.F.

maximum range only attainable with very high power.

Inspection of Fig. 1 shows that the curves are (in terms of miles) almost evenly spaced: we can, as a result, formulate the following useful simple rule; *an increase or decrease of ten times in transmitter power will alter the range by about ten miles for aircraft at any height between 150 and 15,000ft.*

This means, of course, that the only really important advantage

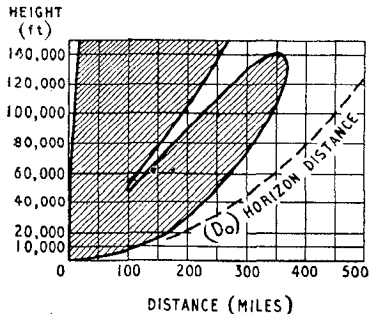


Fig. 2. Full-line curve shows calculated range for aircraft flying at great heights and a transmitting ground aerial at 50-ft. with power of 1 watt. Dashed line is approximate limit of range for higher power.

of increasing power is in respect of range to very low flying aircraft, where an extra ten miles may represent an increase of 30% to 50% in range: even here the effect, expressed as a percentage, of an increase in power above a few watts is not large unless the losses at the receiver are rather high. For sets in aircraft, therefore, quite a low power is adequate, since they are working to an efficient receiver under good conditions and this argument is, of course, reinforced in the case of light aircraft by the low battery consumption there desirable.

For aircraft at heights over 15,000ft range varies more rapidly with power, especially if the efficiency of the receiver is low. However, the use of a large power in the aircraft is particularly inadvisable under these conditions, since interference with other aircraft would then occur up to very large distances, e.g., over 500 miles at 40,000ft.

The curves of Fig. 1 may be used for practical estimates of

range in the 100- to 140-Mcs band, provided that the following points are borne in mind:—

(a) Unless actual measurement results are available, it is advisable to assume an "efficiency" of -10 db when transmitting from air to ground and -20 db when transmitting from ground to air.

(b) If the site of the ground aerial is higher than most of the surrounding country, ranges may be somewhat greater. On the other hand, range will be considerably curtailed beyond any neighbouring hills. Both these effects will be more noticeable with low-flying aircraft.

(c) Meteorological conditions will occasionally affect results (due to variation of atmospheric refractive index), especially at the longer ranges.

(d) With some installations, there may be a loss of range due to screening of the aerial by the aircraft body, and this loss may be dependent upon the heading of the aircraft.

Range at very great heights will usually lie between the full and dashed lines of Fig. 2.

Range to another aircraft is, of course, greater than to ground: it may be roughly estimated by finding the range from each aircraft to a 30ft ground aerial, and then adding together the figures obtained.

If the amplitude modulation now used were replaced by frequency modulation, the maximum range would not be much affected, but the audible noise,

background to signals, when within range might be noticeably reduced.

APPENDIX

The figures given are mainly based on a paper on "Range of Low Power Communication" by the present writer in *Journal I.E.E.* for November, 1948, and this should be consulted for formulæ and references. The figures for field at 5,000 and 10,000 feet were calculated directly from "Field Strengths over a Spherical Earth," by Domb and Pryce (*J.I.E.E.*, Sept., 1947).

The geometrical horizon [distance = $1.2(\sqrt{h_1} + \sqrt{h_2})$ miles] has often been used as an approximation for range. The normal optical horizon distance is 15 per cent more than the geometrical (due to refraction), and this has also been sometimes used for range estimation.

At distances well beyond the horizon, the field is controlled by diffraction (with secondary effects due to atmospheric refraction) and thus exhibits a uniform rate of attenuation with distance (0.8db per mile at 120 Mc/s). When the power or efficiency is low, the range is less than the horizon distance and the field is calculated by ray formulæ instead of diffraction formulæ. However, the attenuation at the distances in question here never exceeds some 1.2db/mile. The rule for variation of range with power is based on these considerations and corresponds to an average attenuation of 1db per mile. For very great heights, at distances well within the horizon, the field approaches that in free space and the attenuation is much less (e.g., 0.04db per mile at 200 miles) since the field here varies inversely as the distance.

NEWS FROM THE CLUBS

Barnet.—The next meeting of the Barnet Amateur Radio Society will be held at 7.30 on March 12th at 15, Station Road, New Barnet, when the subject to be discussed is audio amplifiers. Sec.: M. R. Jenkins, G3EIM, 1193A, High Road, London, N.20.

Brighton.—The Brighton and District Radio Club's transmitter, G3EVE, is now operating on 1.7, 3.5 and 7 Mc/s ('phone) and reports will be welcomed. Meetings are held on Thursdays at 7.30 at St. Mary's Hall, Bread Street, Brighton. Sec.: R. J. Donald, G3DJD, 2, Canfield Road, Brighton.

Derby.—The transmitter of the Derby and District Amateur Radio Society is now operating with the call G3ERD. The club, which meets on alternate Wednesdays at 7.30 at 67B, London Road, Derby, is issuing a quarterly magazine. Sec. F. C. Ward, G2CVV, 5, Uplands Avenue, Littleover, Derby.

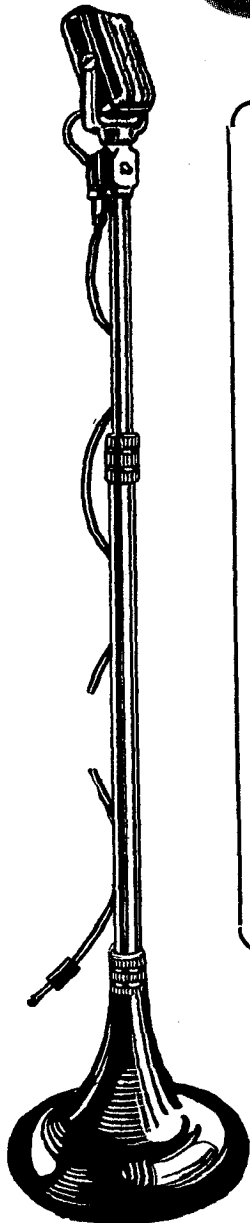
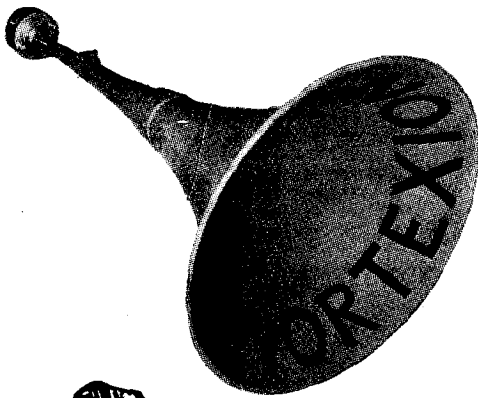
Gravesend.—Meetings of the Gravesend Amateur Radio Society are held

each Wednesday at 7.30 at 30, Darnley Road, Gravesend, Kent. Talks on receiver design and elementary radio principles are scheduled for the first two meetings in March. Sec.: R. E. Appleton, 23, Laurel Avenue, Gravesend.

Hampton Court.—The Thames Valley Amateur Radio Transmitters' Society is probably the first in the country to organize a regular network on two metres. It operates on Fridays at 10.30. Sec.: A. Mears, G8SM, Broadfields, East Molesey, Surrey.

Southport.—The recently formed Southport Radio Society meets at 38A, Forest Road, Southport, at 8.0 on the third Wednesday in each month and also holds Morse classes on Mondays at 8.0. Sec.: F. M. P. Lawson, 113, Waterloo Road, Southport.

Wandsworth.—The March meeting of the Wandsworth and District Radio Club will be held on the 9th at the Earsfield Men's Institute, Waldron Road, London, S.W.18. Sec.: A. R. Dyer, 28A, Isis Street, London, S.W.18.



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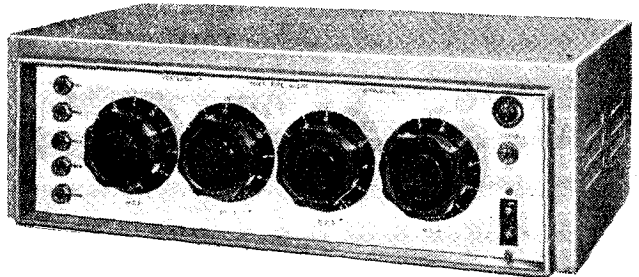
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THÉVENIN'S THEOREM

Its Application in Simple Network Calculations

By "CATHODE RAY"

THE very word "theorem" has a scholastic sound that repels all but the most studious. And as for Thévenin, who is he? Something of an interloper, apparently; because it really ought to be called Helmholtz's theorem.¹ But the name

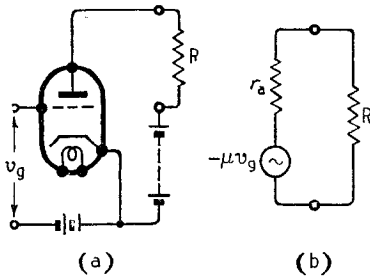


Fig. 1. (b) is the well-known "generator equivalent" of (a), and an example of the use of Thévenin's theorem.

of Thévenin is so universally attached to it that trying to change over to Helmholtz would probably just cause confusion. The only suggestion I can make for avoiding historical inaccuracy and at the same time giving a clue to what the thing is about is to call it the "Equivalent Generator Theorem." I am sure that many who look blank at the abrupt question "What is Thévenin's theorem?" would see light in that clue. For the familiar dodge of thinking of a valve as a generator with internal resistance (Fig. 1) is an example of the use of Thévenin's theorem.

Almost all useful circuits, at rock bottom, make up systems in which a generator feeds a load. Even such an elementary circuit as an electric torch (Fig. 2) is just that. The battery is the generator and the lamp filament is the load. It is the simplest application of Ohm's Law to calculate the current in the load:

$$I = \frac{E}{r + R} \quad \dots \quad (1)$$

The symbol alongside E in Fig. 2 represents a resistanceless

battery, and the resistance of the actual battery is denoted separately by r . The dotted line is a reminder that E and r can be separated only on paper or in the imagination. Together, they make up "the generator."

Another application of Ohm's Law gives the voltage obtained between the terminals of the generator:

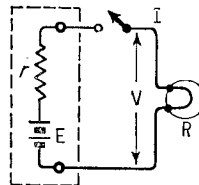
$$V = IR = \frac{ER}{r + R} \quad \dots \quad (2)$$

This result can be arrived at in one move by considering the e.m.f. E to be shared between r and R in proportion to their resistances.

Note that E is the voltage that exists between the terminals when no load current is drawn, and that r is the resistance that a measuring instrument would indicate between those terminals if E were inoperative.

What Thévenin's theorem states is that the above results apply to

Fig. 2. An even simpler example of generator and load; the circuit of an electric torch.



any pair of terminals or points in any circuit, no matter how complicated, so long as it is linear (i.e., so long as it does not include things like rectifiers in which the current is not proportional to voltage). There is another proviso, about "steady state" conditions, which need not always apply however, and which we will come to later.

All one has to do is to measure or calculate the open-circuit voltage and the internal resistance, and substitute them for E and r respectively in the above simple equations, (1) and (2), to get the current and voltage in any load, R. The theorem is even more general than that, because it applies to a.c. and impedances of any kind,

provided of course that one uses "j" or one of the other methods of taking account of phase differences.

Strictly speaking, the linearity rule excludes all valves and iron-cored coils, because they are never quite linear. But fortunately they are often near enough, within certain limits of current or voltage to give a useful approximation, as in the well-known case of Fig. 1. But although this is a very simple basic circuit, we saw some time ago² that it is not entirely straightforward; so first let us take a simple d.c. example to bring out the idea without complications.

Fig. 3, which is a type of circuit one often comes across in practice, looks only slightly less simple than Fig. 2. How would you tackle it? Without taking any short cuts, I suppose one would find the resistance of R_2 and R in parallel, add the result to R_1 to get the total circuit resistance, and use Ohm's Law to calculate the main current I_1 . Multiplying this by the resistance of R_2 and R in parallel gives V, and dividing that by R gives I.

Thévenin is appreciably easier. With R disconnected, the terminal voltage E is obviously $E_1 R_2 / (R_1 + R_2)$. (Except for the symbols used, it is identical with Fig. 2, equation (2)). And the resistance r is obviously R_1 and R_2 in parallel, $= R_1 R_2 / (R_1 + R_2)$. (E_1 being

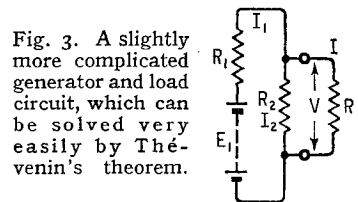


Fig. 3. A slightly more complicated generator and load circuit, which can be solved very easily by Thévenin's theorem.

disregarded by short-circuiting it). Writing them in place of E and r in (1) we get:

$$I = \frac{E_1 R_2}{R_1 + R_2} / \left(\frac{R_1 R_2}{R_1 + R_2} + R \right)$$

¹ "Circuit Conventions (The Valve "Equivalent Generator")," *Wireless World*, April, 1947, p. 129.

² *Wireless Engineer*, July 1943, p. 320.

Thévenin's Theorem—

which can be simplified by multiplying above and below by $R_1 + R_2$:

$$I = \frac{E_1 R_2}{R_1 R_2 + R(R_1 + R_2)}$$

and of course V is R times as much.

Now for Fig. 1(a). This can be looked on as the same sort of circuit as Fig. 2 if certain assumptions or stipulations are made. When, as is often the case, the currents and voltages in question are alternating signal currents and voltages, the steady currents and voltages on which they are superimposed can be disregarded, (except, of course, in so far as they determine the valve characteristics, r_a and μ). One conventional method of distinguishing them is to use small letters for the alternating quantities (instantaneous values) and capitals for the steady quantities. Another method is to use plain capitals for the alternating quantities (r.m.s. values) and I_0 and V_0 for the steady quantities.

To bring a valve circuit within the scope of Thévenin's theorem the currents and voltages must be restricted to limits between which the valve curves can be assumed to be straight; in other words, r_a and μ constant. Then the equivalent circuit, Fig. 1(b), may be considered to be a sufficiently close approximation.

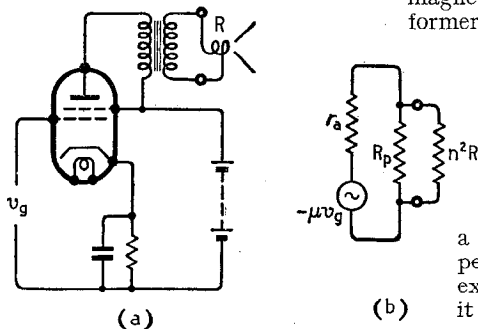


Fig. 4. A receiver output stage (a) is a practical example of the Fig. 3 circuit, in which the component values are as shown at (b).

You might object that if R is disconnected in Fig. 1(a), in order to measure μ and r_a for use in Fig. 1(b), the valve is cut off from its h.t. supply and cannot function. True; so one must

either discover the working values of μ and r_a in some other way, or else connect between the terminals a device (such as a choke or transformer) which passes d.c. but is virtually an open-circuit to the signal-frequency a.c. That may not be easy, especially with pentodes, which have such a high r_a that it would be impracticable to provide an impedance which by comparison would be virtually infinite. If it cannot be treated as a complete open circuit, however, it can be treated as R_2 in Fig. 3, provided its value is known.

The ordinary receiver output stage, Fig. 4(a), is a typical example. An ideal output transformer would, when the loud-speaker was disconnected, have an infinite impedance at all signal frequencies; but in the equivalent circuit, Fig. 4(b), it is represented by the finite resistance R_p . Neglecting transformer leakage inductance and other imperfections, the load resistance can be represented as if directly connected, by multiplying it by the square of the transformer ratio. So it reduces to Fig. 3, which we have already solved.

Unless you are content with what mathematicians call a first approximation, you will have to take into account various complications, such as the load and transformer shunt impedances not being pure resistances, and the magnetic leakage of the transformer (which can be represented by an inductance in series with R). It is in the solving of these more complicated circuits that the Thévenin approach is most helpful. Calculating the

Thévenin equivalent of a network of internal impedances may cause a fairly extensive outbreak of algebra, it is true; but many of the radio engineers' handbooks give the impedances of the most usual parallel and series combinations all ready worked out.

There are some valve circuits, such as d.c. amplifiers and voltage stabilizers, in which it is necessary to take account of the d.c. conditions. This can generally be done by adding a battery of suitable voltage to the equivalent generator in Fig. 1(b). As this case is not so well known, let us examine it.

Fig. 5(a) shows how to arrive at the appropriate voltage. On the usual I_a/V_a curve sheet draw a straight line (shown dotted) coinciding as nearly as possible with the $V_g=0$ curve over the working range of anode current. Note the point P , where this line cuts the anode voltage axis, and read off the anode voltage there, E_0 . (If the valve is a triode, P will generally be to the right of zero, indicating a positive voltage; if a pentode or tetrode, to the left, indicating a negative voltage.) Then E_0 is the steady voltage to add to $-\mu V_g$, as in Fig. 5(b).

To see why this is so, remember that in accordance with the basic assumption of Thévenin's theorem the equivalent generator must be a perfectly linear device. The actual valve is not; but so long as its characteristics approximate closely to the equivalent's charac-

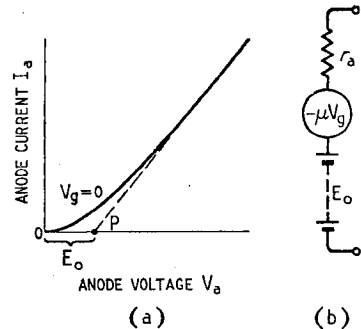


Fig. 5. Showing how to derive from the valve characteristic curves (a) the value of E_0 in the d.c. generator equivalent (b).

teristics over the working range, nobody need worry if it departs widely from them in conditions under which it is not used. So far as anybody can tell from experiments restricted to the working range, the valve curve continues to follow the dotted line. That being so, at zero anode current and grid voltage the anode voltage would be E_0 . Looking at Fig. 5(b), we see this condition correctly represented; r_a can be disregarded (because with zero current it drops no volts) and so can $-\mu V_g$; what we have left must be E_0 .

The equivalence can be checked for other conditions. If negative bias is applied, $-\mu V_g$ adds to E_0 and, if anode current is still zero, the voltage across the terminals is

greater. This corresponds with Fig. 5(a), where applying negative bias moves the valve characteristic bodily to the right. Similarly

The value of the current through the meter is then given by substituting in equation (1) the values of ν and E just obtained.

I hope these examples have given some idea of how to apply Thévenin's theorem. "But what," you may ask, "about the 'steady state' proviso?" Well, "steady" here does not mean d.c. necessarily. A.c. can also be steady in this sense, if it has settled down to a regular routine after any

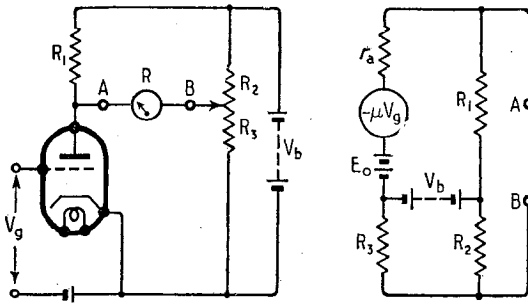


Fig. 6. A more complicated example incorporating the d.c. generator equivalent of Fig. 5.

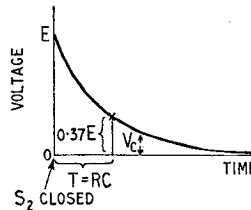
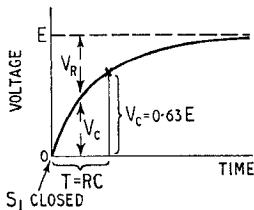
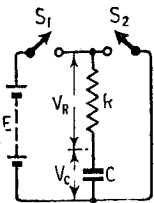
the effect of anode current agrees in both diagrams, necessitating a higher terminal voltage.

A good example of how Thévenin's theorem can be applied in this way is the valve voltmeter circuit of Fig. 6(a), in which R_2 and R_3 are provided to enable the standing current to be balanced out of the meter, whose resistance is the load resistance R. Substituting the valve equivalent from Fig. 5(b), we get Fig. 6(b). To get the Thévenin internal resistance, short circuit the sources of e.m.f., leaving r_a in parallel with R_1 , and R_3 in parallel with R_2 . So:

$$\nu = \frac{r_a R_1}{r_a + R_1} + \frac{R_2 R_3}{R_2 + R_3}$$

The open-circuit voltage (of A relative to B) can be got by adding the voltages across R_1 and R_2 , taking care to get the signs right, thus:

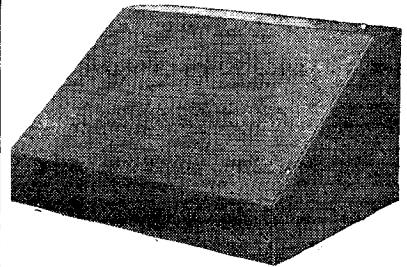
$$E = \frac{(E_0 - \mu V_g - V_b) R_1}{r_a + R_1} + \frac{V_b R_2}{R_2 + R_3}$$



(a) (b) (c)

Fig. 7. Summary of how to sketch the voltage transient curves in the familiar basic RC circuit.

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Thévenin's Theorem —

of E falls across it, and none across R , because there is no charging current. The so-called exponential curve in Fig. 7(b) marks this shifting division of E between R and C . With practice one soon becomes able to sketch a reasonably good exponential curve, given one point on it. And it is a well-known fact that the point where V_C is 63% of E occurs at time $T = RC$, this quantity RC (in ohm-farads or megohm-microfarads) being called the time constant. So that provides the point.

Similarly, when C is fully charged, S_1 opened, and S_2 closed, it discharges as shown by the same curve inverted, Fig. 7(c). And the same curve applies to the growth of current in an inductive circuit, the time constant being L/R .

That is all familiar stuff. What may not be quite so well known is how to tell what happens in more complicated circuits such as Fig. 8(a). (In case the switching of batteries on to these circuits seems of little practical interest, may I point out that the switch plus R_2 may represent a valve suddenly made to conduct by a pulse applied to the grid circuit, as for example in certain radar time-base systems?)

Assuming again that before the switch is closed the capacitor is uncharged, we know that the

that it rises exponentially, and that the time constant (as well as the value of the final voltage) can be obtained by applying Thévenin's theorem.

The open-circuit voltage (i.e. the voltage across the terminals when S is closed and C is disconnected) we have already found,

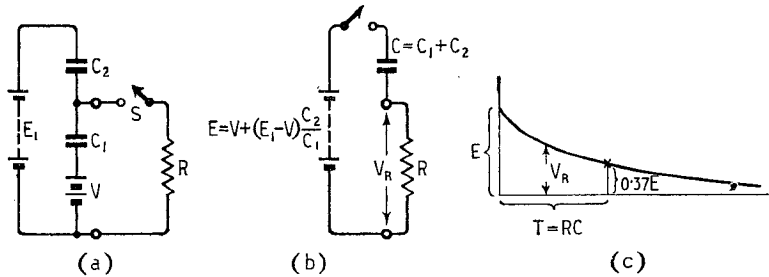


Fig. 9. Another example, in which C_1 starts with an initial charge of V volts. Like Fig. 8 (a), it can be reduced by Thévenin to the basic circuit of Fig. 7.

and of course it is the same as by Thévenin. The "generator" resistance R is R_1 and R_2 in parallel, so the Thévenin equivalent is as shown in Fig. 8(c), reducing the problem to the familiar Fig. 7 case. The time constant RC is therefore $R_1 R_2 C / (R_1 + R_2)$, and the curve can be sketched into Fig. 8(b) as easily as before.

If there were two (or more) capacitors and one resistor, then the same principle would be followed for finding the resultant C

volts, so the Thévenin voltage across the terminals is V plus the part of $E_1 - V$ which falls across C_1 . Since voltages across capacitors in series are in proportion to the reciprocals of the capacitances, this part is $(E_1 - V) / C_1 \cdot 1 / (1/C_1 + 1/C_2)$,

which simplifies to $(E_1 - V)C_2 / C$. C , of course, is the Thévenin capacitance, looking from the point of view of R ; so is C_1 and C_2 in parallel, or $C_1 + C_2$. The equivalent, Fig. 9(b) is just Fig. 7(a) again. V_R in Fig. 9(c) therefore varies in the same manner as in Fig. 7(b).

And so one could go on. Anybody who finds this easy and would like to pursue the matter further should go on to the alternative method, in which the resistanceless constant-voltage generator with e.m.f. E in series with r is replaced by a constant-current infinite-impedance generator in parallel with $r^{(3)}$, and one works in currents and admittances instead of voltages and impedances.⁴ It will be found that in certain circumstances this approach suits some circuits better.

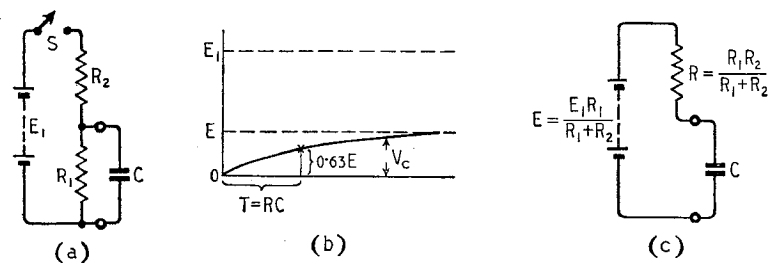


Fig. 8. The method of Fig. 7 can be extended to more difficult circuits like this by applying Thévenin's theorem.

starting condition is the same as in Fig. 7(b). And it is easy to see that in the final condition C is charged to the voltage which would exist across R_1 if C were not there, namely $E_1 R_1 / (R_1 + R_2)$. So the curve rises only to the lower of the two dotted lines in Fig. 8(b). The problems are: how does it rise, and how long does it take? The answers are

to multiply by R for giving the time constant. And if there are initial charges on capacitors when the switch is closed, they can be taken care of in the Thévenin manner by inserting a battery of appropriate voltage and sign in series with each capacitor concerned.

Take Fig. 9(a), for example. Here C_1 has an initial charge of V

³ "Admittance," *Wireless World*, January, 1949, p. 30, Fig. 1c.
⁴ *Wireless Engineer*, July, 1943, p. 322.

NEW UNIVERSAL METER

A REVISED version of the Model 70A meter made by Taylor Electrical Instruments, 419-424, Montrose Avenue, Slough, Bucks, is announced. The modified design, which will be designated Model 70B, makes use of a 1,000 ohms/volt moving-coil meter with knife-edge pointer and mirror scale. There are 50 ranges for a.c. and d.c., including six decibel ranges. An internal buzzer is provided for quick continuity tests. The price will be £14 14s.

CLASSIFICATION OF BROADCAST AERIALS

Findings of the R.C.M.F.

HITHERTO the random nature of aerials used for broadcast reception has precluded any attempt at classification, but now that the vertical rod aerial, supported at the base and designed for mounting in a particular position, is becoming more popular, a broad classification based on the expected per-

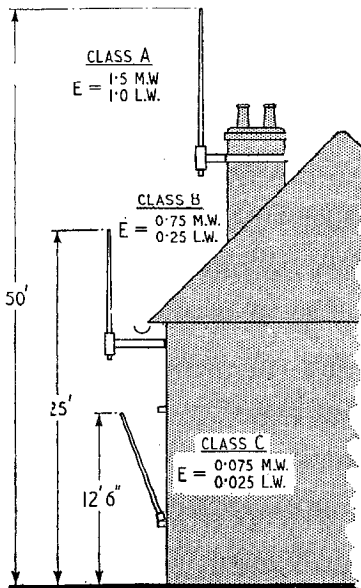
formance can be formulated. Indeed, this has now been carried out by the Radio Component Manufacturers' Federation at the request of the British Radio Equipment Manufacturers' Association and the B.B.C., which organizations have accepted and endorsed the findings in principle.

Class A aerials are of from 10 to 20ft in length, class B are usually under 15ft and class C rarely exceed 10ft in length. From a number of measurements made in typical residential districts a "figure of merit" or performance factor E has been assigned to each class. This is defined as the ratio of the aerial signal output to the prevailing field strength produced by selected B.B.C. medium and long-wave transmitters.

It is pointed out that while this E factor represents the average performance for a comparatively small number of sites only, those chosen were representative of average domestic conditions. If an aerial input of 1 millivolt is taken as the minimum signal for good reception the class of aerial required for different local field strengths can be selected with reasonable certainty. For example, on the medium waves with field strengths over 13.3 millivolts per metre class A, B, or C aerials are satisfactory; with between 1.3 and 13.3 mV/M class A or B should be used and from 660 to 1,300 μ V/M only class A aerials are likely to be really effective.

On the long waves any of the three classes suffice for field strength over 40 mV/M while for between 4 and 40 mV/M class A or B should be used and for from 1 to 4 mV/M class A are advised for best results.

The classification of indoor aerials would seem to be impracticable owing to the widely different forms of building involved and the desire to camouflage the aerial. The R.C.M.F. panel investigating this matter strongly deprecate the use of mains aerials of any kind.



Suggested R.C.M.F. classification of vertical rod broadcast aerials based on design and mounting position. A "figure of merit" E is applied to each.

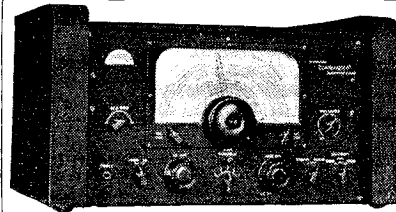
The three classes into which these are divided are shown in the accompanying illustration reproduced from the Federation's *Technical Bulletin* for December, 1948.

DESIGNED to fit the majority of television receivers, a new television magnifier has been produced by the Dulci Co., 95/99, Villiers Road, Willesden, London, N.W.2. The size is 14in x 9in and the price is £5 5s.

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Hats Off to Mr. Gaitskell

I AM all for this 'ere eddication and it is for this reason that I support the B.B.C.'s efforts to improve our minds. On the whole they make a good job of it; they do not at any rate drop so many bricks as the American film magnates. Those responsible for a recent film seemed to forget that ancestors who came over with Norman William in 1066 did not come as wanton invaders



"1066 and All That."

but as supporters of the rightful heir to the throne who had been so named by Edward the Confessor, the law of succession by primogeniture being by no means the universal rule in those days.

There are occasions, however, when the B.B.C. might do better. One such instance was a recent series of talks intended to instruct women in the ways in which science aids them in their homes. Now I am not going to cast doubt on the accuracy of the statements made by the learned scientists whom the B.B.C. brought to the microphone, although I cannot refrain from saying that I would rather trust the local plumber to instruct me in the niceties of adjusting a ballcock than the sanitary savant who insisted on calling it a float-operated hydrostatic valve.

When the turn of the electrical expert came to tell us how the current which operated our wireless sets reached our homes, I soon realized that my education had been seriously neglected. We were told quite rightly that two cables are used to connect our houses to Mr. Gaitskell's cut-off system, and were asked rhetorically whether we did not wonder why there were two conductors and not one as in the case of the water supply. The lecturer did

not long leave us guessing, but told us that one conductor was to enable the current to get back eventually to the generator and said that the water supply also had a return conductor; namely, the drains. Just as the same electric current goes round and round so also does the same water except that "the circuit" is a little more complicated as the water is purified, discharged, evaporated as clouds, and then returned once more to the reservoir as rain.

This seemed such an extraordinary analogy that I was lost in admiration at its daring nature. My admiration increased when the lecturer went on to tell us that, just as the water sometimes gets back not by the drains but by an unofficial route—such as when we watered the garden—so too does electricity sometimes find an earth return.

It was not, however, until the end of this talk when the lecturer, after informing us that 740 watts represented 1 h.p., proceeded to point out that our electric cookers were equal in power to a motor car that I saw the masterly hand of Mr. Gaitskell. It did not altogether surprise me, therefore, when the lecturer finally threw off the mask and gave us a stern warning to switch off our cookers.

Whither Radio?

MARCONI'S prophetic remarks about radar made before the American Institute of Radio Engineers in 1922—to which reference was made in this journal last November—are not, of course, the only instance of an early forecast of an outstanding radio development. Another notable example was Campbell Swinton's description as long ago as 1908 of the broad outlines of our present system of television.

Thinking of this has made me cast about in my mind to see if I cannot here and now forecast some major development of radio which will not be realized for fifty or even a hundred years—long after I have embarked on what the poet calls "the Great Adventure." I do not mean simple and obvious developments like broadcast receiving sets capable of bottling any particular programme so that we can hear it at a time more convenient than that at which it is broadcast. Such a receiver could, in fact, be made today with little or no difficulty.

Within the last quarter of a century vision has been added to aural broadcasting, and sound has been added to sight in cinema films. It cannot be very long before we think as little of going to "the smellies" as we do to "the talkies" today, while "the feelies" will be an added attraction a little later on. Once the film industry has solved the recording and reproduction of these particular sensory impressions it won't take long to work out a way of making them ether-borne. But these will hardly be major developments in the same sense as television and radar most certainly are. I shall have to think of something far more outstanding if I want a future Editor of *Wireless World* to unveil a plaque to my memory and I rather think that I have it.

My prophecy is that radio will go up and up in the frequency scale far beyond that of light and other known radiations until somewhere among the micro-angstrom units it will find itself all mixed up with sub-electrons (satellites of electrons yet to be discovered). When this has been achieved we shall probably find that the perception centres of our brains are directly responsive to these very high frequencies and are also capable of generating them. Any intermediate apparatus will be redundant, so that the radio industry, as such, will come to an end and telepathy will have really come into its own.

I have held these opinions ever since I first read the learned review of modern scientific researches into telepathy written by "Radiophare" in *Wireless World* in July, 1945. But there is a lot of ground to be covered before "Madame Estelle"



A.D. 2049.

takes her place in the *W.W.* Editorial chair; but when this does eventually happen, it is my intention that the first thing she sees is myself in spectral form.

LETTERS TO THE EDITOR

Legalized Interference Suppression ♦ Television Receiver Upkeep Costs ♦ Test Oscillator Modifications ♦ Broadcast Frequency Allocations

Compulsory Interference Suppression

ALTHOUGH it is quite natural for radio engineers to acclaim the Bill for the suppression and reduction of man-made interference to radio and radar reception, it is obvious, after some reflection, that the whole thing had better be left alone. For if it is implemented by examination of domestic appliances it will only result in an infinitesimally small reduction in noise and this in itself will cost a lot of money which the community will eventually have to find. Disturbances which seriously annoy listeners can usually be suppressed by a friendly arrangement between the offending and offended parties, without Government intervention.

As the result of some recent observations I am of the opinion that a very great deal of the disturbances annoying the broadcast listeners originate from the mains intake; i.e., the main switch and fuses. These are frequently installed in damp parts of a house and so become corroded, resulting in bad contacts and arcing and hence noises, especially under load. It is now the responsibility of the British Electricity Authority to keep them in noise-free condition.

In the discussion which preceded the launching of the Bill, great capital was made out of the fact that suppression was required in order to prevent interference to radio and radar navigational aids. I can only surmise that those responsible for the statements were ill-informed. During many hundreds of hours of radio experiments in aircraft I can call to mind no single instance in which man-made interference from the ground has caused interference to reception, and I am therefore very doubtful that a faulty domestic appliance can jam any radio or radar navigational aid. C. B. BOVILL.

Paris.

WHAT will be the position of the man who fiddles about with junk lash-ups, under the coming anti-interference laws? Unless there is either mercy or a special clause to protect them, electronic engineers fooling about in the interests of science with temporary

hook-ups made with twisted connections, to the accompaniment of the ferocious interference they cause by disturbing the gear whenever they walk across the room or by applying a soldering iron or by trying out oscillators, may find themselves obliged to choose between prison or giving up wireless. Bunyan may have written "The Pilgrim's Progress" in Bedford Gaol, but it is doubtful if a term in Pentonville will ever produce anything as good as radar.

W. H. CAZALY.

Seeing's Believing?

MOST of us have heard of commercial receivers being used without significant changes of valves for upwards of ten years or more, and the proud owners almost invariably boast that reproduction leaves little to be desired. In fact, until an actual breakdown occurs, renewal is nearly always postponed. Quite apart from the economic angle this is also, of course, a tribute to that very tolerant mechanism, the ear.

With the increase in popularity of television, taking into account the much larger numbers of valves involved and the fact that the eye is a very critical device, is it possible the cost of replacements is going to give the public a shock?

The manufacturers obtain their valves at very low prices and are in effect subsidized by most other users. It will be very interesting if the B.V.A. have to put the machine in reverse so that the public can afford to make the necessary replacements. L. C. IRVINE.

Seaford, Sussex.

Simple A.F. Oscillator

I RECENTLY built the single-valve i.f. oscillator described in the March, 1948, issue of *Wireless World*, and found it extremely difficult to obtain good waveform throughout the whole frequency range.

You may be interested in the modified circuit, given in the accompanying diagram, which finally solved the problem.

The bias developed by the voltage-doubling rectifier circuit exceeds the peak input to either half

COMBINED "EXSTAT" AND TELEVISION AERIAL

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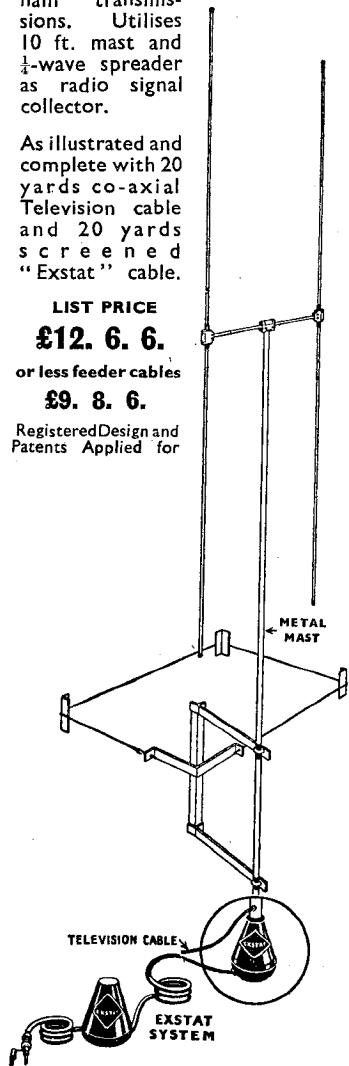
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A14

Letters to the Editor—

of the valve, thus preventing distortion due to grid current. The 250,000-ohm resistance in the input to the rectifier circuit keeps the input resistance high, thus preventing distortion when the rectifier conducts on the peaks. The left-hand half of the valve has a low anode load resistance and receives the full bias; owing to the curvature of its characteristic the gain is controlled

the right-hand valve is returned to earth, and a bias resistor (unbypassed) inserted in the cathode lead. A further improvement would probably be obtained by using a variable- μ r.f. pentode as the first valve.

comparatively compact country like Belgium are more favourable (lower in frequency) than those for the Netherlands.

On the political side Spain is not allocated a single clear channel, whilst Great Britain, considerably smaller in area, is allocated three. It is interesting to reflect that Spain was allocated two completely clear channels (589 and 997 kc/s) in the Montreux Plan which should have come into operation in March, 1940.

In addition to Great Britain, France and the U.S.S.R.—especially her Western and Baltic provinces—have been allocated particularly favourable low frequencies as clear channels.

Although not directly connected with the subject under discussion I suggest that manufacturers should standardize the frequency coverage provided by new receivers. The long-wave band should be 140-400 kc/s and the medium-wave band 515-1,650 kc/s.

These coverages are considerably greater than those provided by present-day sets, and will allow for any future expansion beyond the Copenhagen allocations.

P. BATHAM JONES.

Watford, Herts.

Television Shocks

SOME manufacturers of modern a.c./d.c. television receivers connect one side of the mains supply to the chassis and make no provision for the mains lead to be terminated in a plug that cannot be reversed in the mains socket, therefore the chassis can be alive in respect to the earthy side of the mains.

This is dangerous practice and I doubt if it conforms with the Board of Trade Regulations, for not only is the chassis alive, but the screening of the coaxial cable and one arm of the aerial are alive also.

Is there any need for this dangerous practice to continue? Perhaps someone can defend this method of connection, for in my opinion it is decidedly bad engineering.

STANLEY E. HUSON.

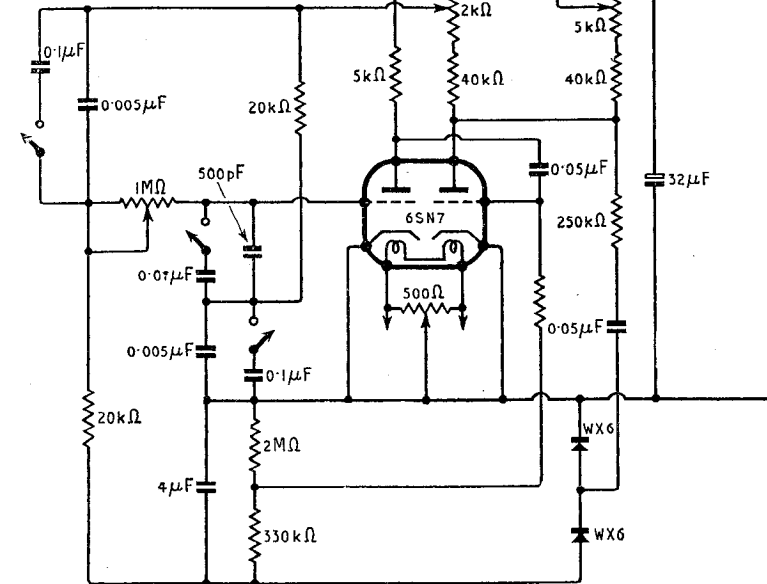
Bexleyheath, Kent.

“THE WARNING WINKER”

A Correction

WE regret that there was an error in Fig. 2 of this article in our last issue. The author writes:

“I have no excuses to offer for presenting a circuit which (a) would keep the neon continuously winking, even with the switch open, since there is a return path to h.t. negative by way of the chassis and valve filaments, and (b) would burn out



by the bias, but the input signal is small and there is very little distortion. The right-hand half of the valve has a high anode load resistance which linearizes the characteristic, and operates as a straight amplifier.

The best waveform is obtained with the gain control at the minimum setting which will sustain oscillation throughout both frequency ranges, but the setting is not at all critical. The waveform at all frequencies is then an almost perfect sine wave—just a little second harmonic, perhaps, but not the slightest sign of “sharp corners.” If oscillation does not commence shortly after switching on, momentarily earthing one of the anodes two or three times will start things moving.

Using an ex-R.A.F. valve, Type VT61A, an amplitude of about 10 V r.m.s. was obtained at the second anode. Almost any other double triode should prove satisfactory; if any trouble is experienced, the anode load resistors or the bias rectifier input resistor may need to be altered. If the valve has separate cathodes, or if separate valves are used, greater stability of operation is obtained if the grid leak of

The greatest snag of this circuit is mains hum, which at low frequencies causes a periodic variation in the amplitude of oscillation. A certain amount of screening is desirable, and the hum-dinger is essential.

HOWARD BOOTH.

London, S.W.9.

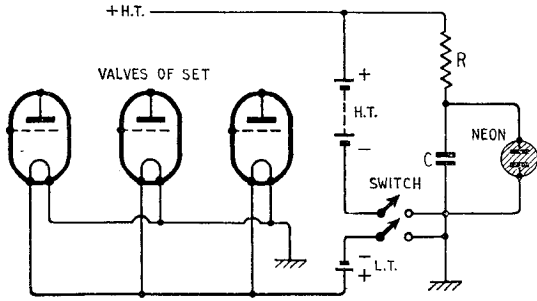
Copenhagen Comments

MAY I offer a few belated observations concerning the Copenhagen frequency allocations published in *Wireless World* for November, 1948.

Whilst accepting as an unfortunate necessity the preservation of a 9-kc/s channel separation, I cannot help feeling that the new plan is based too much on the frequencies in use today and/or political considerations instead of an equitable scientific distribution of the limited facilities available.

An example of the first point is provided by the allocation of clear channels to Belgium and the Netherlands. Belgium is allocated 620 and 926 kc/s and the Netherlands 746 and 1,007 kc/s. Each of these frequencies is substantially a clear channel, allocated presumably for national coverage, yet those for a

all valve filaments if, with the switch open, a short occurred between h.t. positive and chassis.



"What I meant to draw—and did in fact draw in my rough notes—was the accompanying circuit.

There are several possible variations on the theme; but one thing essential to all is that in the 'off' position of the switch neither h.t.—nor l.t.—must be connected to chassis, either directly or through a path furnished by the filaments. May I ask any reader who made up the device to rest assured that when given a proper chance in the correct circuit the 'Warning Winker' leaves nothing to be desired as a winker and as a warner?"

The experimental verification of Mr. Millington's theory involved a technique not previously used in such measurements. This work was organized by G. A. Isted (also of Marconi's) and carried out by him and his assistants.

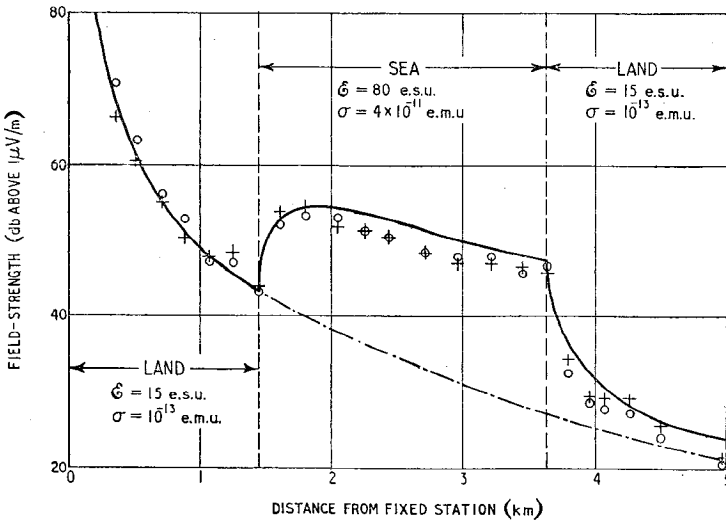
PROPAGATION OVER COASTLINES

IN a letter to *Nature*, G. Millington, of Marconi's W.T. Co., describes an interesting phenomenon which occurs when radio waves cross a boundary between land and sea. Over land the field strength of the ground wave falls off in accordance with well-known laws but at the boundary there is a sudden rise of field strength and for a short distance it actually increases with distance. After reaching a peak of some 12 db above the normal value, the field strength falls off again, but more slowly than above land. On again reaching land, there is a sudden drop, but for some distance inland the field is stronger than if the whole path were over land.

The accompanying graph shows

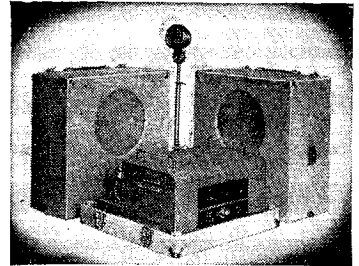
by the solid line the theoretical variation of the field and by the circles and crosses the results of measurements at a wavelength of 3.9 m. These measurements were carried out with a Marconi 10-W transmitter across the Blackwater, Essex. The phenomenon is more fully discussed elsewhere*.

* "Ground-Wave Propagation Over an Inhomogeneous Earth," by G. Millington. *Proc. Instn. Elect. Engns.*, January, 1949, Vol. 96, Part III, p. 53.



The solid and chain curves are theoretical ones indicating the field strengths respectively for a land/sea path and land only. Measured results at a fixed receiver with a mobile transmitter are indicated by crosses and those at a mobile receiver with a fixed transmitter by circles. Vertical polarization was used.

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RANDOM RADIATIONS

By "DIALLIST"

Age and Loudness

AN ARTICLE in the latest issue of the *B.B.C. Quarterly* provides food for quite a bit of entertaining thought. It describes the results of tests designed to discover the sound levels at which listeners prefer to receive the broadcast programmes. I gather that the tests were originally instituted to find out whether those engaged in monitoring programmes had the same ideas about loudness as "the average listener." It soon emerged that the professionals at the transmitting end like their reproduction very much louder than did the amateurs in their own homes. With a reference to zero level of 10^{-16} watt per square centimetre tests showed that for symphonic music the "pros" plumped for levels of 88 db (musicians and transmitting engineers) and 90 db and 87 db respectively for men and women programme engineers. The levels apparently preferred by the listener, however, were 78 db for both men and women. This led to a more detailed investigation of the preferences of the listening public. A large and representative section of the public is always available in the personnel of the Listener Research Panel. The results obtained here are quite remarkable. What intrigues me most is the big fall in the preferred sound level with advancing years. Take speech. At 15 years the preferred level is about 73 db; at 30 years it falls to 72 db; at 45 years to 70 db; at 55 years to just over 68 db; and at 65 years to 66 db. Offhand, one might have expected rather the opposite. The young are supposed in the ordinary way to have very acute hearing and there is no doubting the falling off that takes place as people grow older. I have sometimes wondered, though, whether sounds in general convey quite so strong a stimulus to the young brain as to the older one. If they concentrate on listening, young people certainly hear better than their elders; but is this true when they are not concentrating in that special way? I doubt it. Even if they are only a few feet apart, small children invariably speak to one another at the top of their

voices. And at a rather later age a party of young folk conversing together produces a sound level many decibels above that due to a similar number of their fathers and mothers.

Sun Spots

AS I WRITE, the rather hazy state of the atmosphere is giving all who care to cast their eyes skyward first-rate views of an outside in sunspot groups. By the time that this appears in print the spots will have passed to the side of the sun that is then invisible; but they should reappear within a few days. If you haven't seen them already, it's worth while to take a look. Use a piece of smoked glass or the dark part of an old photographic negative if the sky is clear; but you may get an excellent naked-eye view on a misty day, particularly at sunset time. These big spots are centres of intense activity, the effects of which normally make themselves manifest on this earth of ours in two different ways. When the spots reach a position which brings them bang opposite to us electro-magnetic radiation from them is poured upon us. The spots also emit streams of particles. The radiation reaches us at the speed of light in under ten minutes; but the particles travel more slowly and don't get here until over a day later. Hence the day's delay usually observed between radio blackouts and the appearance of the Aurora Borealis.

Trouble-savers

A COMMON FEATURE of the descriptions of new inventions nowadays is the stress laid on their trouble-saving qualities. A large proportion of the practical products of applied science promise poor toiling man emancipation from one kind of drudgery or another. You'll find illustrations of this here, there and everywhere in the advertisement sections of daily, weekly and monthly publications. This gadget enables fires to be lighted in half the time; this one does the housewife's washing-up for her while she sits and reads at her ease; a third offers her alleged lord and master

a means of getting rid of the weeds in his garden without the bother that gardeners since Adam have had of hoeing them up, digging them in or pulling them out by hand, a fourth . . . but I can do a little personal trouble-saving here by means of those dots. You can think of other trouble-savers for yourself and save me the drudgery of writing them down! Yet, for all the toil that we are told we have been saved by automatic thises or finger-tip that, it doesn't seem to me that life on the whole is easier than it was before this trouble-saving business began. I don't find that I have to do less work than I had to do twenty-five years ago. The majority of so-called trouble-saving devices are, I believe, misnamed: they should be termed "ginger-uppers," for what they do is to make it possible for you to get through far more work in the same amount of time.

It's Up to You

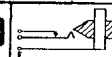



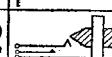

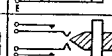



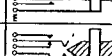

Such were my thoughts when I spent a recent day in some busy research laboratories whose activities are largely devoted to the development of devices which make the electron do for us jobs that our fathers and grandfathers had to slog through by their own unaided efforts. Are we harnessing the electron?—or is it truer to say that we are busily engaged, without realizing the fact, in discovering more and more ways for it to harness us? I'm not going to offer an answer to these questions, preferring to give the reader the trouble of finding his own. Though I have the most profound respect for the almost formidable I.Q. of *Wireless World* readers, I can't resist mentioning the old Army saying: "The subaltern officer is not infrequently asked to give his reasons in writing for doing this or that. It is recognized that he has in fact no reasons; but the question provides an exercise for his otherwise sluggish brains." One electronic device which particularly interested me was a compact little apparatus for counting pills. When you plank down your one-and-fourpence, or whatever the price is nowadays, including purchase tax and entertainment tax, for a box or tube of, say, Rich Red Pellets for Pale Green Sailors you find that the tube, box or carton contains invariably twenty-five of these safeguards against sea-sickness.

Were they counted by hand into the container? They were not. The photo-electric cell and the thermionic relay did the job. Half a century ago boxes or what not would have been used which were designed to hold about twenty-five pills. Some manual counting may have been done; but you were just as likely to find twenty-three as twenty-four, twenty-five or twenty-six pellets in the container. I know that the unvarying twenty-five, electronically dished out, signify progress; but somehow I can't help wondering in my heart of hearts whether we're altogether sane in applying expensively trained physicists to developing things of this kind.

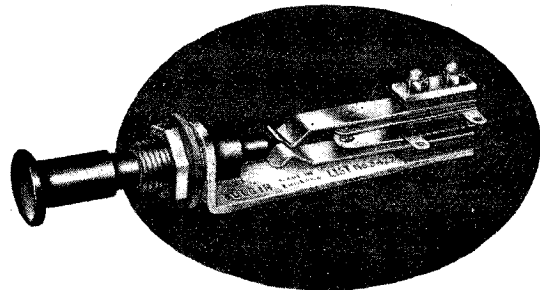
Bigger Tuning Range Needed

ONE RECENT BIG IMPROVEMENT made in American "TV" receivers is the introduction of a new type of tuner, which gives continuous coverage of the whole band of frequencies assigned to television broadcasting. Something of the kind is needed here, for, as I wrote a while ago, the purchaser of a television should certainly feel assured that it will work in any service area into which he may happen to move. It would be no bad thing, too, if receiving dipoles were made with telescopic end pieces. Dipoles of this kind were used in the GL1 and GL2 radar sets during the war and they enabled the receiver to be tuned to any frequency between 55 and 84 Mc/s. The idea should be useful to makers of television aeri-als: with telescopic end-pieces only one type of dipole and reflector array would need to be made for the whole country, instead of a separate type for each area. There's another point, too. It is quite conceivable that carrier frequencies will have to be altered from time to time, just as sound carrier frequencies are. You can cut bits off a dipole with one-piece arms if the new frequency is higher, but it's not so easy to lengthen it to suit a lower frequency. The sliding part of the GL dipoles had numbered divisions engraved on them and a table showed you just how far to push in or pull out when setting them up for any required frequency. Probably the television aerial makers had thought of that one already. If they hadn't, I make them a present of the idea.

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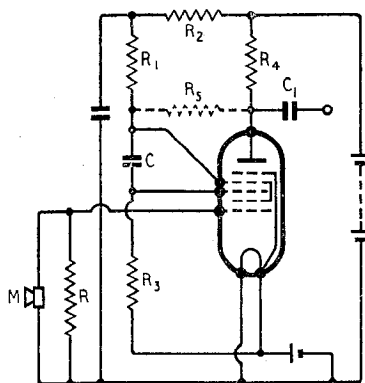
A Selection of the More Interesting Radio Developments

Multi-grid Amplifiers

A SINGLE heptode valve is arranged to operate as a two-stage amplifier, the high overall gain so secured being particularly advantageous as applied to hearing-aid appliances.

As shown, the pick-up signal from a crystal microphone M is fed to the innermost grid, which is shunted by a resistance R. The next electrode is connected to the h.t. supply through load and decoupling resistances R_1 , R_2 . It serves both as an anode to the first electrode, and as a control grid for the second amplifier stage, which is thereby coupled in cascade with the first. The third grid is connected to the positive side of the cathode through a resistance R_3 , and is coupled through a condenser C with the screen grid, which is followed by the usual suppressor grid.

Stability is increased by applying negative feedback from the main anode to the grid anode through a resistance



Heptode two-stage amplifier.

R_5 , though this is stated to reduce an average voltage gain of 400 to about half that figure.

O. B. Sneath. Application date, November 21st, 1945. No. 600884.

Air Traffic Control

TRAFFIC or other local conditions sometimes make it necessary for the pilot of an incoming plane to circle around the aerodrome under the instructions of the Control Officer, before coming down to land.

In such circumstances the machine can be guided, either through visual signals or by the same signals applied to an "automatic pilot," in a circular course, and at a predetermined distance from the landing point by navigational equipment of the radar type. The plane carries an "interrogator" set which co-operates with a "responder" beacon at the aerodrome to develop a direct current which depends upon the time interval between the two

signals and therefore represents the distance or range of the craft. This is fed to a centre-zero meter.

A second current, calibrated to represent the flying distance allotted by the Control Officer, is taken from an independent source and is fed to the same meter, in opposition to the first current. The resulting indication not only shows when the machine is on the set course, but also how to correct for any deviation. A variable strobe is used to search for and interlock with the responder signal, thereby automatically stabilizing the first-mentioned current at its correct range-indicating value.

L. C. Barber. Application date September 5th, 1945. No. 601401.

Pulsed Signalling Systems

ENERGY radiated in the form of short pulses can be used in various ways as a substitute for ordinary carrier-wave signalling. The modulating voltage can, for instance, be applied to vary the width, or amplitude, or relative phasing of the pulses about some mean value of these characteristics, which always represents the no-signal condition, or zero modulation. In all these known systems, the average number of pulses radiated per second remains constant.

According to the present invention, the width, height and phase position of the pulses are kept constant, and signal voltages are conveyed by varying the number of pulses above and below a given mean number transmitted in a set period of time. For instance, taking the unit of time as 1/6,000th of a second, three equi-spaced pulses, sent in equi-spaced groups, correspond to the no-signal condition, leaving a possible variation of three pulses either way, i.e., from zero to six, to represent maximum modulation in the negative and positive directions respectively. The latter corresponds to a continual train of equi-spaced pulses emitted at the rate of 36,000 per second.

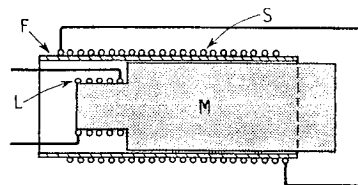
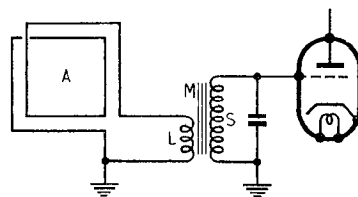
Marconi's Wireless Telegraph Co., Ltd. (assignees of H. O. Peterson). Convention date (U.S.A.), January 8th, 1944. No. 605178.

Frame Aerial Couplings

A HIGH-FREQUENCY transformer of the permeability type is used to couple a frame aerial A to the first amplifier of a radio receiver; in addition, the moving core M serves to control the tuning of the input circuit without

appreciably affecting the inductance of the aerial.

To secure this result, the primary windings of the transformer are kept few in number, to reduce capacity coupling with the secondary, whilst their inductance is made equal to that of the frame-aerial turns, this balance favouring the gain factor of the coupling. In a suitable design of transformer, shown enlarged, the secondary, S, is wound on a dielectric former F, whilst the primary L is wound over a shoulder or projection on one end of the moving core, so that the primary inductance remains the same for all positions of the core. That



Frame aerial coupling circuit.

arrangement also ensures a constant coefficient of coupling over the whole of the tuning range.

The British Thomson-Houston, Ltd. Convention date (U.S.A.), January 19th, 1945. No. 606599.

Range Selectivity

MODULATED pulses are used to limit and select the range of distances over which point-to-point communication can be carried out, without interference from stations at other distances. For instance, stations A and B are each provided with repeater installations which transmit pulses to and fro, so that the stations are locked together at a repetition rate which depends upon the distance separating them. Both stations are equipped with modulating and detecting circuits, which are intermittently coupled to a common aerial in known manner, for two-way signalling.

Adjustable gating circuits are also provided to enable the operator at Station A to accept messages from stations other than B, situated at selected distances varying from a quarter of a mile to 50 miles away. With sharply directive aerials a further discrimination can be made between stations at equal range but with different orientation. It is desirable to use pulses of the order of one micro-second or less, since the distance-selectivity obtainable, and the minimum working range, are both inversely proportional to the duration of the pulse.

Marconi's Wireless Telegraph Co., Ltd. (assignees of W. Hansell). Convention date (U.S.A.), September 16th, 1943. No. 604438.

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