Wireless World

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Television Standards for Europe

AT the risk of wearying our readers, we feel impelled to return to a subject that is fundamental to the healthy growth of television: the standardization of European transmission systems. It is generally admitted that the cost of good television programmes is high; obviously, without good programmes, the service cannot grow, and so any country embarking on television is in danger of the vicious circle. In Europe, a continent of relatively short distances, there is a real technical possibility of exchanging programmes between countries and so the high cost can be shared. Up to a point, exchanges of "canned" film programmes can be made without regard to the technical standards adopted by the various nations, but the exchange of living "actuality" items becomes impracticable unless there is uniformity of transmitting systems.

The present time is particularly opportune for again drawing attention to this matter. As reported on another page, an international study group of the C.C.I.R. is now visiting this country with the object of investigating our television practices from many different aspects. We hope and think the members will gain a favourable impression of the practicability of our 405-line system as an international standard. The arguments in favour of it are already well known; economy in bandwidth and economy in receivers are the principal factors. It happens that the bandwidth required is just within the capacity of existing European telephone cables, which could, therefore, be used for programme exchanges at off-peak hours. Receivers for a 405-line system can be produced cheaply by manufacturing methods that do not differ in essentials from those used in making broadcast sound receivers.

As to whether the picture quality produced by our system is good enough is a question for the members of the study group themselves to decide, but it may be pointed out that the quality at present obtained, good as we believe it to be, does not represent the ultimate possibilities of 405-line transmission.

Another argument in favour of 405-line transmission is presented in a letter, printed elsewhere in this issue, from a Dutch reader who is out of sympathy with the present European devotion to the idea of 625 lines. He contends that the next development will be in the direction of colour rather than in increase of definition, and so any monochrome system is to some extent a temporary expedient. Therefore, he argues, it behoves the war-impoverished continent of Europe to make a start with the cheapest practicable system.

A similar plea was recently made by O. S. Puckle, Chairman of Council of the Television Society, who went so far as to urge that "at least the Benelux countries" should adopt our standards. An official statement of the Radio Industry Council also stresses the advantages of standardizing on 405 lines. At first sight, this British advocacy of the British system may, to our continental neighbours, savour of commercial propaganda. Of course, British television firms would stand to gain from the rapid international growth of television, and to that extent would doubtless welcome the adoption of that system which, as many of them believe, would be most suitable. But this advantage would be shared by their continental competitors: further, British manufacturers have proved that they can design and make both transmitting and receiving equipment of any standard that their customers may require, and on this score it hardly matters to them what system may be chosen.

So far at least as *Wireless World* is concerned, there is nothing sinister, subtly propagandist or nationalistic in our advocacy of 405 lines: for reasons we have given, it is thought to be the best compromise between conflicting requirements for use as a European standard.

Television Camera Tubes

The Manufacture of Image Orthicons

ONE of the outstanding advantages of the Image Orthicon is its ability to operate under conditions of very low light intensity. It is even possible to obtain a reasonably good picture by the light of a single candle.

Since the Marconi Company first decided to rely mainly on these tubes for use in television cameras, considerable improvements in performance and manufacturing technique have been made. The latest type of tube is now being manufactured by the English Electric Valve Company at Chelmsford.

The electrode arrangement is shown diagrammatically in Fig. 1 and it consists of four basic sections—photo-cathode and image section, target group, electron gun and electron multiplier.

The optical image is focused on to the semi-transparent photo-cathode which is deposited on the optically-worked flat face of the tube. The resulting electron emission from the photo-cathode may be considered as constituting an electron picture which in turn is imaged by means of a longitudinal magnetic field on to the target plane. (This electron imaging is of the long-field unity-magnification variety.)

The target consists of an extremely thin sheet of glass of definite conductivity. Electrons bombarding the target (at a velocity of approximately 300 V) cause the release of secondary electrons. The secondary-emission coefficient being greater than 2, a net gain is achieved at this stage as well as a reversal of "polarity"; that is to say, illuminated picture points *lose* electrons and so appear on the image side of the target as a *positive* charge. All the secondary electrons are collected by the "target screen" which is an extremely fine gauze located parallel to and extremely close to the glass target on the image side.

The finite resistance of the glass target allows it to function as a two-sided target; that is, it can be scanned on the side remote from the image. As always in an Orthicon the electron velocity of the scanning beam is reduced substantially to zero at the plane of the target. This process involves a number of problems all of which had, however, previously been solved for the case of the straight Orthicon. The principal problem is to arrange for orthogonal landing of the scanning beam in a sharply focused condition. This is achieved by use of magnetic deflection fields superposed on a long focusing field and

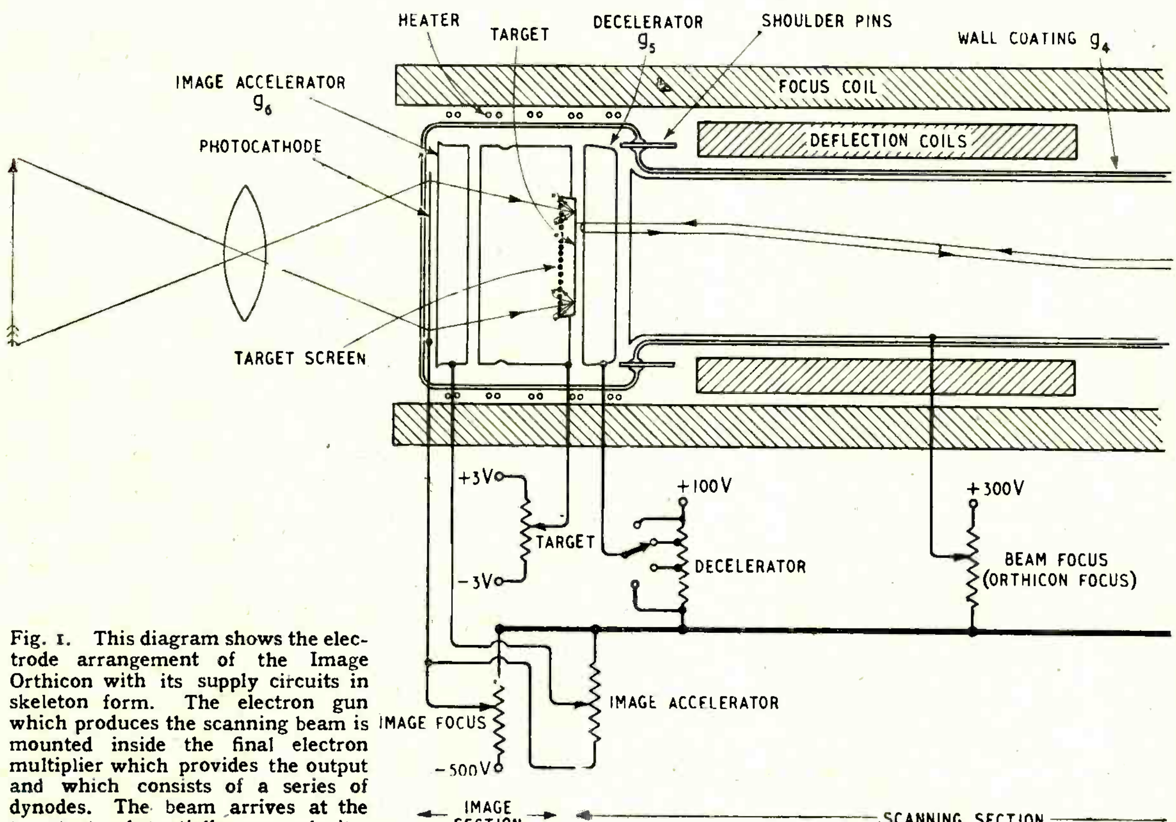
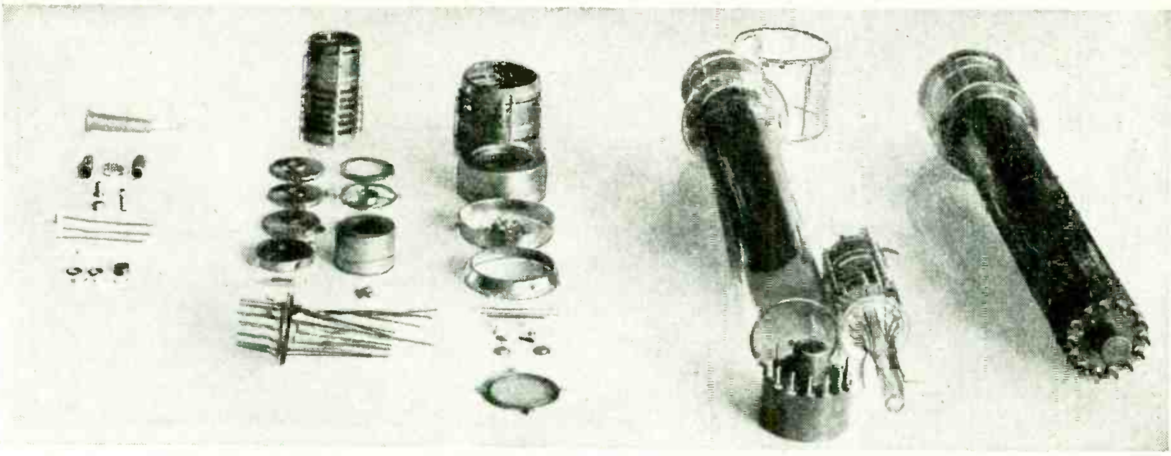


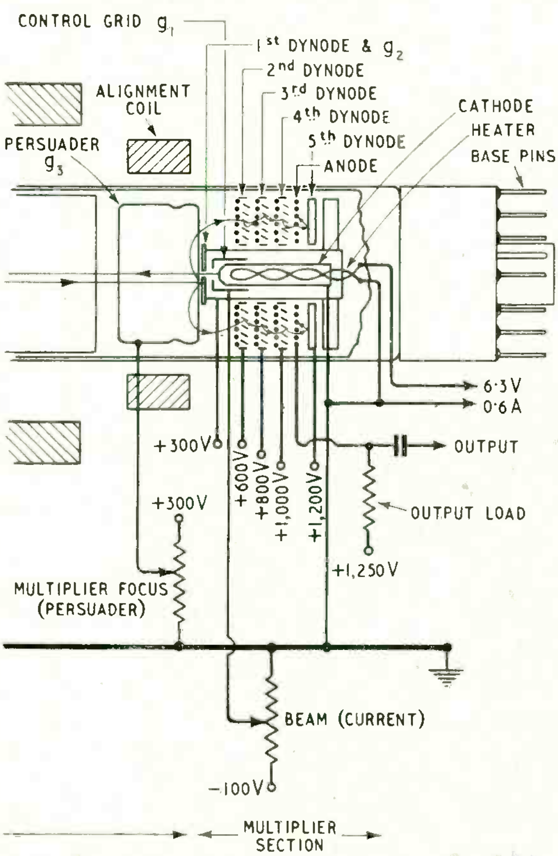
Fig. 1. This diagram shows the electrode arrangement of the Image Orthicon with its supply circuits in skeleton form. The electron gun which produces the scanning beam is mounted inside the final electron multiplier which provides the output and which consists of a series of dynodes. The beam arrives at the target at substantially zero velocity.

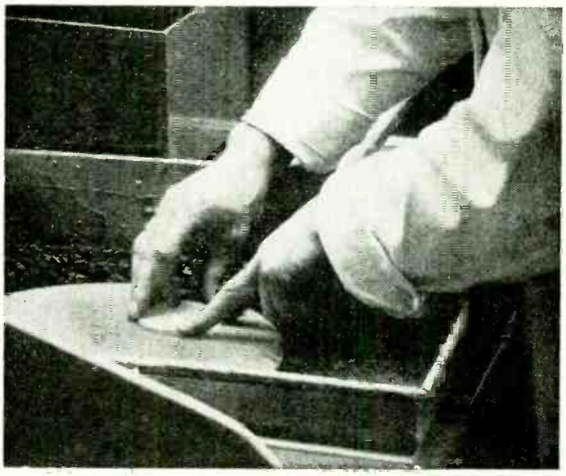


Component parts of the Image Orthicon with the completely assembled tube shown on the extreme right.

by the use of auxiliary electrostatic lenses constituted by the various electrodes g_4, g_5 and the target screen.

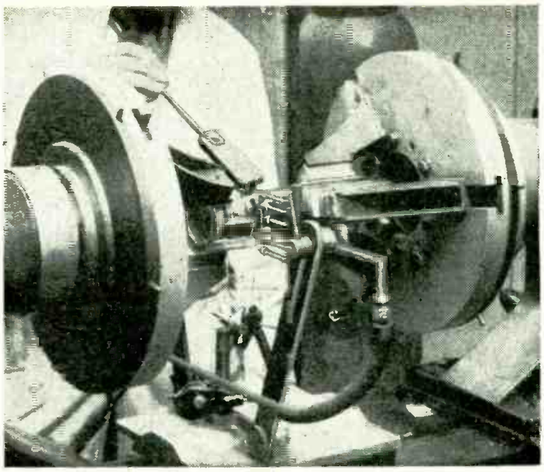
The mode of operation of the tube can conveniently be illustrated by considering the case of a picture consisting of a single white picture-point on a uniformly black background. In this case only one picture-point of the target is electron-illuminated. When the scanning beam scans the target, electrons will land on the dark portions until a target potential is established (near to zero or cathode potential) for which no further landing is possible. The whole





Two of the processes involved in manufacture. Optically working the flat face of the tube and (below) assembling the gun mount and electron multiplier on a jig.

Assembling the image mount and stem tube on a jig.



Sealing the bulb to the stem on a glass-working lathe.

of the scanning beam is returned, and does in fact return to the gun structure in the immediate vicinity of its starting point, which is the "defining aperture" in electrode g_2.

In the case of the white picture-point, however, electrons are continuously being lost on the image side of this part of the target and electrons are deposited to neutralize the resulting local positive charge. If the resistivity of the glass target were infinite, this situation would be a transient one and an equilibrium condition would be built up in which the scanning beam became non-cognizant of the white picture point. However, owing to leakage through the target, the landed electrons on the scanning side leak through to the positive charge on the image side so that a fresh landing is made on every scan. This results in the reduction of the return-beam current which constitutes the signal from the tube.

To realize the full potentialities of this scheme it is necessary to apply a considerable amount of electron multiplication to the return-beam current before taking it as signal to the normal amplifier. This is accomplished by a series of annular multiplier discs of the pin-wheel variety (dynodes d_2, d_3, d_4 and d_5) which are built concentrically around the electron-gun structure. The role played by the target screen must now be clarified. It is normally set some 2-V positive of the "non-landing potential." Now it is impossible for a white-picture point to go substantially more positive than this 2-V value because, if this were to happen, the secondary electrons would be unable to reach the target screen and have literally nowhere else to go. This voltage defines the range of linear operation of the tube and it would be expected that if the illumination were sufficient to allow a white-picture point to reach this voltage in a time less than the picture repetition time this would result in "saturated whites." In fact this phenomenon is not observed. On the contrary, a new regime sets in which may be described as "electron redistribution." The white-picture points proceed to rain electrons on to the darker picture points and so maintain picture contrast. This phenomenon plays at least three very useful roles:

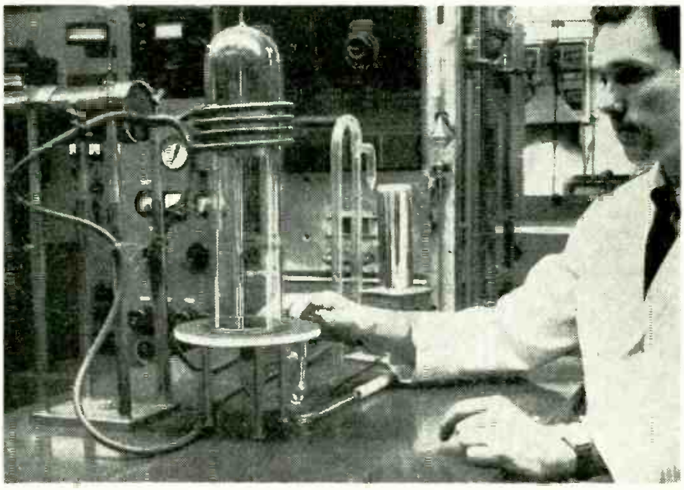
1. It allows the tube to operate over an extraordinarily wide range of illumination.

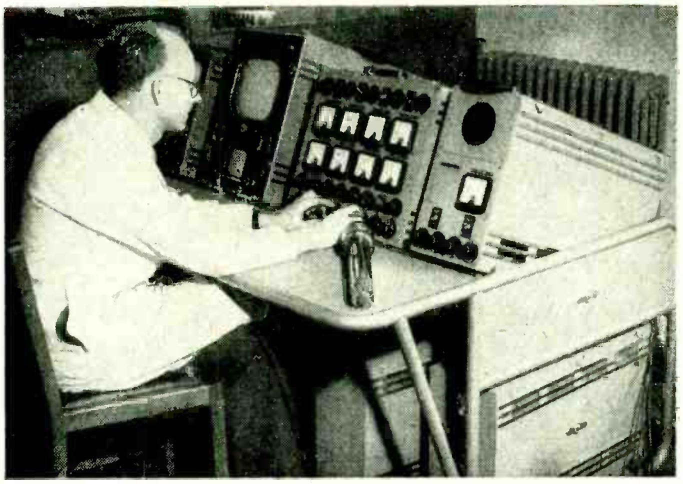
2. It produces a desirable reduction in the gamma of the picture.

3. It reduces the effective storage time of the tube and so eliminates the appearance of "smearing" on moving objects.

As can be seen from Fig. 1, the scanning beam originates from the cathode and emerges through a hole in the centre of the electrode labelled 1st dynode and g_2. The latter is its initial role for, being 300-V

Vacuum r.f. heating is used in the preparation of the target mesh.





Test gear used for checking the characteristics of the finished tube.

positive to cathode, it acts as the anode of the electrode gun. The return beam lands on it away from the hole, being persuaded to do so by the deflecting system g_3, which is aptly termed the "persuader," since its object is to ensure that the return beam lands on the electrode clear of the emergent beam.

To the return beam the electrode acts as the first dynode of the electron multiplier. Secondary emission is produced and the paths of the secondaries are to the so-called pin-wheel 2nd dynode at which more secondary electrons are produced, and thence to d_3, d_4, d_5 and the anode from which the output of the tube is taken. These pin-wheel dynodes are mounted concentrically with and outside the electron gun and comprise inner and outer rings holding a series of radial slats—somewhat like a radial Venetian blind.

Manufacturing Problems

Not the least of the difficulties of tube manufacture arises from the fact that the tube comprises virtually four distinct sections, so that a fault in any one renders the complete tube useless. This is, of course, unavoidable since all four sections must necessarily be in a common evacuated envelope.

The parts of the tube which have produced the greatest manufacturing problems are:—

The Photo-cathode. A cæsium cathode is used and the difficulties arise because some of the processes needed for obtaining the best cathode conditions are in conflict with other requirements, notably that of avoiding leakage to other electrode surfaces.

The Target Mesh. In order to avoid limiting the resolution of the tube the target screen has to be of extremely fine mesh; in the present instance 500 per linear inch. Also a high degree of "transparency" is required. These screens are made by an electrolytic process from a ruled-glass master. This master is sputtered with palladium which is then wiped off the high spots to leave a palladium grid in the troughs of the rulings. The electroplating deposits copper on the palladium which is peeled off under water to form a copper mesh.

The Target Proper. This is a sheet of glass approximately 0.0002-in thick and 1½-in diameter. To obtain the necessary rigidity of mounting and high degree of flatness it is stretched in drumhead fashion on a metal ring. Natural surface tension processes of a delicate character are involved in producing this unit.

The Target Assembly. The problem here is to obtain highly uniform target to mesh spacing of the order of 0.001 in. In view of the extremely delicate nature of both elements this calls for special technique.

Electron Gun. This is in many respects of normal construction but involves the use of a defining aperture which is of the order of 0.001-in diameter.

Electron Multiplier. This structure, which is realized in magnesium-silver alloy, consists of five stages of multiplication and has to show a gain in the region of 200 total.

Under good conditions, the standard 3-in Image Orthicon can do justice to a 500/600-line picture resolution. Its contrast reproduction is also entirely satisfactory under proper lighting conditions.

The unique feature of the tube is its sensitivity and it is this, taken in conjunction with a number of important practical features, which renders it an outstanding camera tube for outside broadcast work.

British Industries Fair

MORE than fifty radio and electronic manufacturers are among the 3,000-odd exhibitors at this year's B.I.F. which opens simultaneously at Castle Bromwich, Birmingham, and Earls Court and Olympia, London, on 8th May. Generally speaking the "heavy engineering" side of radio is concentrated at Birmingham, where B.T.H., G.E.C., Marconi's, Westinghouse, B. I. Callenders, British Electric Resistance, Brush Electrical, Chloride, English Electric, Londex, Morganite Resistors, Plessey and Telegraph Construction & Maintenance are exhibiting.

Radio is well represented at Olympia where some forty stands in the Radio and Scientific Instrument Sections are occupied by manufacturers of domestic receivers, valves, test and measuring equipment, communications gear, sound reproducing equipment and hearing aids. The exhibitors at Olympia include:

Airmec Laboratories.
B.T.H.
Baldwin Instruments.
British Electronic Products.
British Vacuum Cleaner.
Brown, S. G.
Cinema-Television.
Compton Organ.
Cooper Teleprinter.
Dallas, John E.
Dawe Instruments.
Ekco.
Electronic Developments.
Elliott Bros.
Everett, Edgcumbe.
G.B. Equipments.
General Acoustics.
Hadley Sound Equipments.
Imhof.
Johnson, Matthey.
Lectron Hearing Aid.
Lee Products.
M.S.S. Recording.
Magneta.
Measuring Instruments.
Megatron.
Metro Pex.
Mullard.
Ossicaide.
Pifco.
"Q-Max."
Sangamo Weston.
Scophony-Baird.
Shipton, E.
Simon Sound Service.
Southern Instruments.
Standard Telephones & Cables.
Taylor Electrical Instruments.
Truvox Engineering.
Twentieth Century Electronics.
Whiteley Electrical.
Woden Transformer.

The Fair, which lasts until 19th May, will be open each day except Sunday, from 9.30 to 6.0. Admission is by Trade Buyers' Badge which is obtainable at the entrances price 2s 6d on presentation of a trade buyer's business card. The public will be admitted on the 13th and 17th on payment of 2s 6d.

Wireless World and *Wireless Engineer*, with the technical books in each of the specialized fields covered by sixteen of the thirty-two journals in the Iliffe group, will be featured on a stand at Castle Bromwich.

Transients and Loudspeaker Damping

Experimental Investigation of Some Conflicting Theories and Beliefs

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

VERY widely divergent opinions appear to be held among high-quality reproduction enthusiasts on the subject of amplifier output impedance, and after hearing a recent discussion the writer decided to try to produce some experimental evidence on the problem. First, let us attempt a recapitulation of the views of both (or is it three?) sides. Those "in favour" claim that a low output impedance increases the magnetic damping of the motion of the moving coil and thereby improves the transient response, while those "against" claim that low output impedance definitely impairs the h.f. response of the speaker and therefore degrades the transient response. A sub-section of the "against" claim that no improvement is to be obtained by reducing the output impedance below, say, 10% of the voice coil impedance. These viewpoints will be examined, first to see what might be expected and then to see what actually happens.

As a typical transient, a square pulse of voltage will be applied to the speaker, in the expectation (ill founded) that a square wave of air pressure will result. A square wave of this kind can be a severe test for a loudspeaker, or indeed any mechanical device, and it can be assumed that if it deals faithfully with this pulse, speech and music will not represent a serious problem. A square pulse also has the advantage that one can visualize the result without much difficulty.

Before proceeding further it is probably advantageous to clear the air a little over the meaning of amplifier output impedance, and magnetic damping.

The output impedance is the value of Z given by applying E volts (a.c.) to the amplifier output terminals, the amplifier being alive and working, and obtaining a current of I amps flowing through the amplifier output circuit, Z being E/I. This can be measured with a voltmeter and ammeter or more elegantly by a bridge method. Z varies with frequency, a typical sort of result, obtained on an amplifier employing two Pen 44 valves in push pull, being shown in Fig. 1. Without feedback the value of Z obtained over the middle frequency region, say 250/1,000 c/s, would generally be about half the "optimum load" for the amplifier, but given the freedom of applying feedback, the designer can make the output impedance almost anything he requires without altering the "optimum load" to which the amplifier must be connected if maximum undistorted power is to be obtained. Given a "perfect" output transformer without losses, the impedance that is measured is that of the output valve divided by n^2 where n is the ratio of the output transformer, and it is a pure resistance at all frequencies. A practical transformer introduces additional losses and also introduces various reactances that make the impedance change with frequency as shown in Fig. 1; but for simplicity the amplifier impedance will be assumed to be a pure resistance.

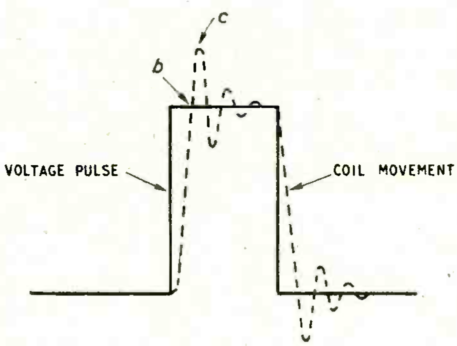
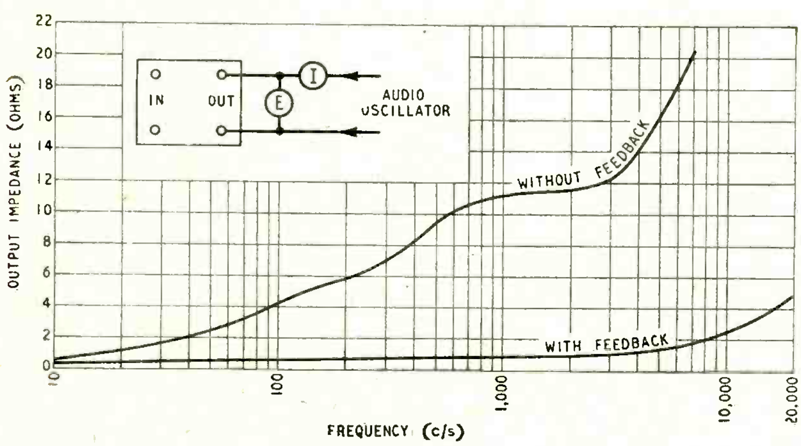


Fig. 2. Applied voltage and coil motion.

Fig. 1. Variation of output impedance with frequency in a typical amplifier.



It should also be noted that it is the ratio of speaker impedance to amplifier impedance and not the absolute value of output impedance that is of consequence; a speaker of 100 ohms and amplifier of ten ohms will produce (to a first approximation) the same results as a speaker of 10 ohms fed from an amplifier of 1 ohm, i.e., the damping factor is 10 : 1 in both cases.

$$\text{Damping Factor} = \frac{\text{Loudspeaker Impedance}}{\text{Amplifier Impedance}}$$

Now for magnetic damping. If a coil of wire, or even a single turn is moved in a magnetic field, a voltage is induced into the coil, and if the ends of the coil are connected to a resistance, current will flow through the coil and resistance, power will be dissipated and extra effort will have to be exerted to move the coil through the field, or if the coil is swinging freely in the magnetic field it will be brought rapidly to rest.

With this preliminary excursion let us consider how the coil and cone might be expected to move when a square wave of voltage is applied, Fig. 2.

As the coil (and cone) possess mass they move off slowly from the position of rest, lagging behind the voltage, but on reaching the position *b*, corresponding to the applied voltage, they overshoot to a point *c*, where they are brought to rest by the restraining influence of the surround, and the kinetic energy stored in the moving mass becomes potential energy stored in the "springiness" of the surround. The coil then reverses direction, swings back through the mean position, oscillating about its final position until the energy stored in the moving mass is dissipated in frictional losses, and the coil comes to rest displaced from the unenergized position by an amount corresponding to the applied voltage. When the voltage pulse is removed, the coil returns to the "off" position lagging behind the current, overshoots, oscillates several times just as before, finally coming to rest ready for the next pulse.

Without any doubt it will be agreed that as the oscillations were not part of the original waveform they should not be inserted by the loudspeaker. The energy appearing in the oscillation was part of the signal energy, the loudspeaker only acting as a frequency converter and rearranging the frequency spectrum of the square pulse to emphasize the frequency corresponding to the natural frequency of the mass of cone and coil on the "springiness" of the surround.

After each pulse the coil is finally brought to rest due to the energy stored in the moving mass being dissipated by the various losses in the cone and surround, the air friction (viscosity) losses due to the air trapped in the narrow gaps between coil and pole pieces, the energy dissipated as sound, and, most important of all from our point of view, the electrical losses in the moving coil—amplifier output circuit. When the coil overshoots its final position the voltage generated in the coil exceeds the driving voltage, circulating a current back through the amplifier output impedance and introducing an I^2R loss.

The reality of these oscillations is indicated by Fig. 3(a) an oscillogram of the voltage across the voice coil terminals when a d.c. voltage pulse is applied. The rate of rise and fall of voltage is too great to be shown on the photograph but the oscillation at the top of the pulse and end of the pulse is clearly shown. In this case the effective resistance of the amplifier feeding the speaker was roughly twelve times the d.c. resistance of the coil. It will be appreciated that though these are records of the transient voltage across the coil; this voltage is produced by the motion of the coil and they are therefore records of the coil motion.

The effects of amplifier output resistance on the coil damping were directly measured in the following way. A small piece of aluminium foil was fixed to the voice coil and provided with a thin flexible connection. Across the speaker frame, a micrometer was supported so that it could be screwed in to touch the foil strip on the voice coil, contact being indicated by the flashing of a small neon lamp in series with the foil and micrometer head. The voice coil was deflected inwards by passing a direct current through the coil and on switching this "off" the coil

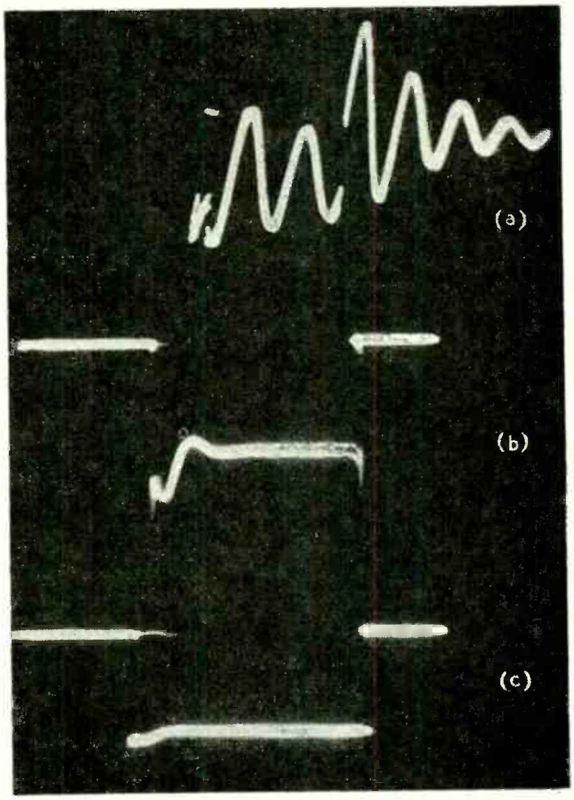
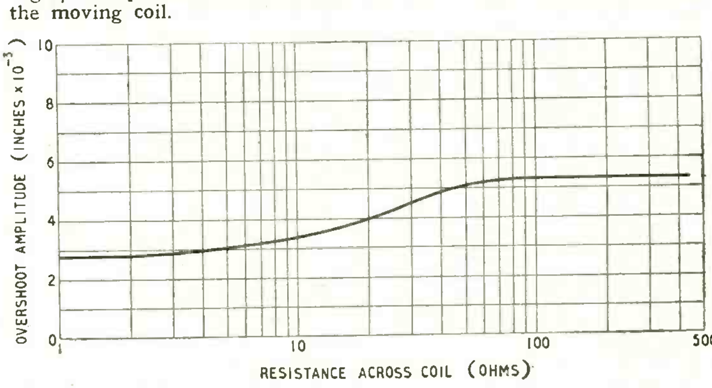


Fig. 3. Oscillations of voice coil supplied from source of adjustable resistance, (a) 100 ohms, (b) 10 ohms, (c) 2 ohms.

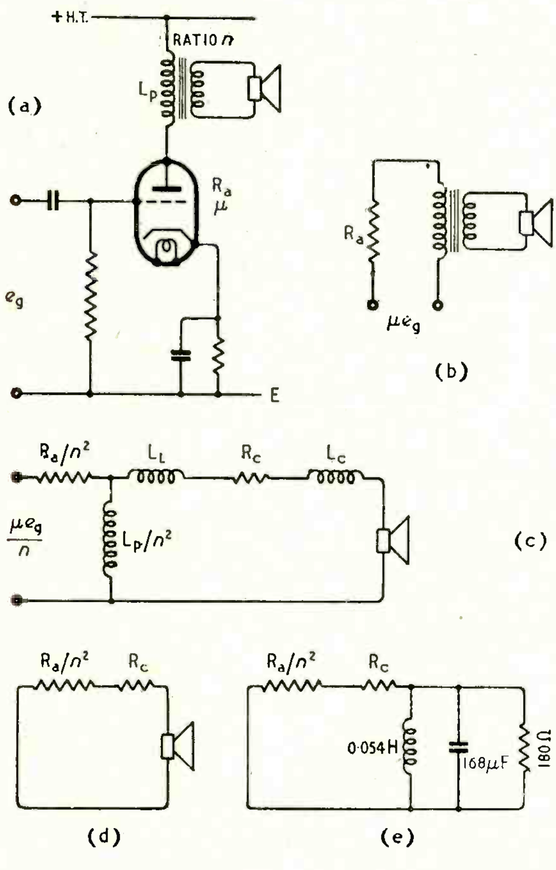
Fig. 4. Amplitude of first overshoot as a function of resistance across the moving coil.



and cone swing out, pass through the unenergized position, overshoot, oscillate about the mean position, and finally come to rest in the centre. The micrometer served to measure the amplitude of the first overswing and this was checked for a range of values of resistance shunted across the coil. The results are shown in Fig. 4. It will be seen that the overswing continuously decreases with decrease of R down to a value of about 2 ohms and then becomes constant. This is significant as it indicates that in this case there is no advantage in using an amplifier having an output resistance less than half that of the loudspeaker.

It was believed that a direct mechanical measurement of the overshoot would perhaps be a more convincing indication of the results than would a measurement of the voltage across the voice coil, but it is simpler to make the electrical measurement. By making the applied pulse repetitive and using a variable resistance across the voice coil, the oscillation of the voice coil can be adjusted to the point at which no overshoot is observable on the oscilloscope. In this instance, a resistance of 3 to 4 ohms was necessary to obtain a unidirectional return to

Fig. 5. (a) Practical amplifier circuit, (b) Equivalent circuit with resistor substituted for valve, (c) Values referred to transformer secondary. Leakage inductance L_L, and moving coil inductance and resistance L_C and R_C. Loudspeaker assumed "perfect" with no resistance or static inductance. (d) Primary inductance of transformer and static inductance of coil removed. (e) Equivalent circuit (including loudspeaker) at frequencies below 100 c/s.



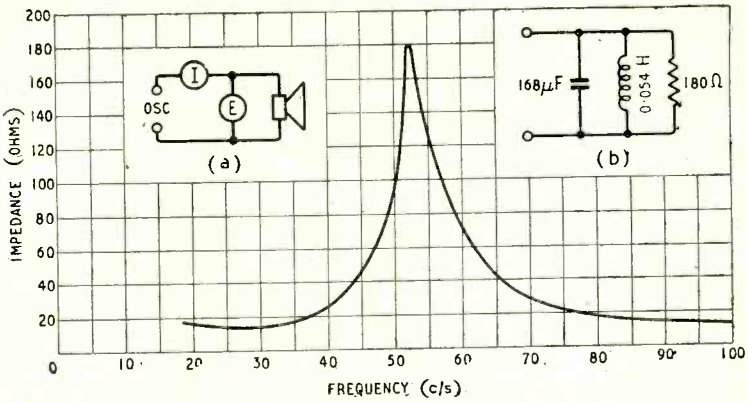
the central unenergized position, but the actual value is not highly critical. Figs. 3(b) and 3(c) indicate the voice coil motion for values of 10 ohms and 2 ohms respectively and it will be observed that a resistance equal to the voice coil impedance produces a marked reduction in the amplitude of oscillation when compared to the result shown in Fig 3(a). The circuit used to provide the repetitive pulses for Figs. 3(b) and 3(c) leaves the coil connected to the battery (of very low resistance) at the peak of the inward swing effectively removing any trace of oscillation of the voice coil at the top of the pulse.

The effects to be expected from shunt resistance on the voice coil can best be decided by considering the equivalent electrical circuit of the loudspeaker and driving amplifier. In Fig. 5(a) is the practical amplifier circuit and in 5(c) the equivalent circuit with all values referred to the secondary. In the low-frequency region the transformer leakage inductance and moving coil inductance (measured with coil held stationary) are too small to be of significance and can be ignored. The transformer primary inductance L_p is too high to be of interest if the transformer is a good one and of no interest if it is a poor one because no quality enthusiast would use it. The circuit as seen by the moving coil thus becomes that of Fig. 5(d). To define the equivalent electrical circuit of the moving coil itself the impedance/frequency characteristic was obtained using the measuring circuit of Fig. 6(a). This produced the curve shown, characteristic of a parallel resonant circuit from which it may be deduced that the coil in motion is equivalent to a perfect inductance of 0.054H in parallel with a condenser of 168 μF and a resistance of 180 Ω. The values may appear somewhat surprising, but L and C have no physical existence, the effect of L and C being produced entirely by the motion of the voice coil in the magnetic field. The frequency of resonance, 52.5 c/s, is that of the mechanical system comprising the mass of the cone and coil supported on the "spring" formed by the cone surround and centring. The shunt resistance represents the energy loss due to internal friction in the cone and surround, the viscosity loss is the air in the narrow gaps between the voice coil and magnet and the regrettably small amount of energy dissipated as sound.

These values can now be added to the equivalent circuit of Fig. 5(d) to give 5(e). Over the low-frequency range considered the performance of this LCR combination will be exactly the same as that obtained from the circuit of Fig. 5(a) with the actual speaker, but the equivalent circuit has the great advantage (at least to an electrical engineer) of rendering the performance more susceptible to calculation.

For a circuit of this type there is a critical value of shunt resistance below which the circuit is non-oscillatory. This is given by $R=\frac{1}{2}\sqrt{L/C}$. Substituting the values of L and C obtained from the electrical circuit it is found that $R=9$ ohms.

Let us see just what is meant by the expression "a critical value of resistance which will make the circuit completely non-oscillatory." In Fig. 7 the equivalent circuit of Fig. 6(c) is redrawn to add a battery, high resistance and switch. In the position shown the battery charges the condenser through the high resistance and on closing the switch the condenser is discharged through the parallel combination of L and R. With values of R well above



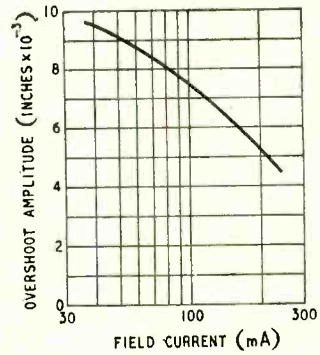


Fig. 8. Effect of field current on voice coil oscillation.

Fig. 6. Impedance/frequency characteristics of a moving-coil loudspeaker measured with circuit (a). The curve approximates to the response of a parallel resonant circuit with the values given at (b).

the critical value the voltage across the circuit will oscillate for several cycles as shown in Fig. 7(d), the amplitude of oscillation gradually decreasing as the energy, originally stored in the charged condenser, is dissipated in the resistance R. If the process is repeated with a decreased value for R the number of cycles of free oscillation will decrease as R is decreased. For the critical value of R no oscillation will take place, the voltage falling to zero without overshooting. Further decrease in R will merely make the voltage fall to zero more quickly. The critical value of resistance is that value which just prevents the current reversing in direction, i.e., the current approaches its final value from one side only.

The process is identical with the mechanical motion of the coil and cone; above a critical value for the damping the coil will oscillate several times before coming to rest; at a critical value of damping it will just not oscillate at all, but return to the final position without overshoot; below this value it will merely return more quickly than for the critical value.

In this particular speaker it will be seen that the critical value of resistance is calculated to be 9 ohms whereas the value below which no overshoot (oscillation) occurs is about 2.5 ohms, the difference being due to the 8 ohms effective resistance of the voice coil below which the damping circuit resistance cannot be reduced *because the external resistance is always in series with the voice coil's own resistance.* Short of introducing an amplifier having a negative output resistance there appears to be little or nothing to be gained by reducing the output resistance below 10-20 per cent of the d.c. resistance of the voice coil.

Something can, however, be achieved in a different direction; if the damping current that flows cannot be further increased by decreasing the circuit resistance, it may still be increased by increasing the voice coil circuit voltage. The voltage generated by the voice coil moving in the field is given by $E = vlB$, where B = gas flux density, l = length of wire, and v = coil velocity.

For a given gap volume l the length of wire cannot be increased, v, the coil velocity, is fixed by the frequency of the oscillation, leaving only the gap density B to be increased. This is a parameter that is at the designer's disposal (though gauss cost money), and Fig. 8 is a plot of the measured amplitude of oscillation of the voice coil for a fixed shunt resistance of 10 ohms (plus coil resistance) and a range of field currents known to be below the saturation value. It will be seen that, roughly speaking, a fourfold increase in gap density (field current) reduces the amplitude of overshoot oscillation by a factor of two.

This would appear to dispose of the suggestion that feedback amplifiers can introduce too much damping

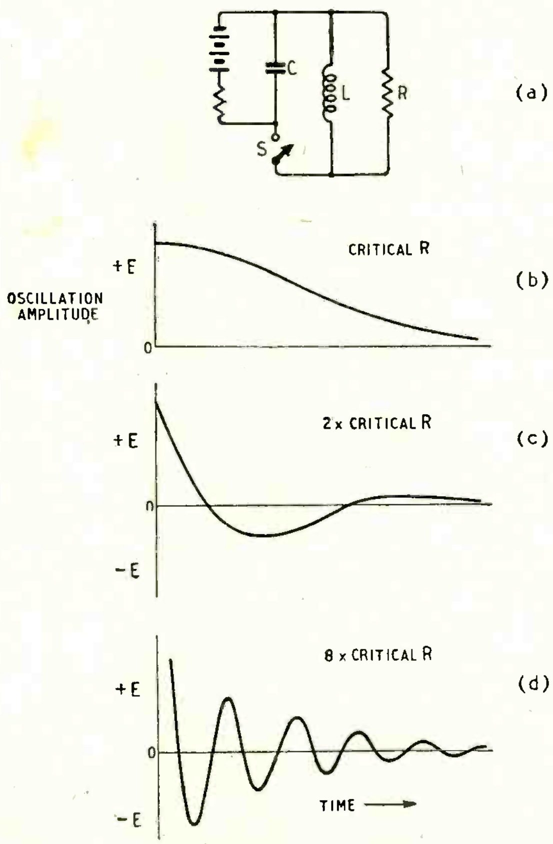


Fig. 7. Equivalent electrical circuit of moving-coil loudspeaker with the addition of a battery. Voltage fluctuations on closing the switch S are shown at (b), (c) and (d).

as it will be seen that the obtainable damping is severely limited by the voice coil resistance. Incidentally, the suggestion that too much negative voltage feedback can make an amplifier unable to deal with fast transients is also unsound. Excluding tricks, the addition of feedback makes the characteristics of an amplifier approach more and more closely to the characteristics of the components of the feedback network, i.e., the two resistors which determine the amount of feedback, and resistors at least are like Cæsar's wife.

Finally, the question of "too much feedback reducing the h.f. response and thereby degrading transients." This is a point so obscured by side issues that no precise answer can be given, but some indication of the result may be helpful. The voice-coil impedance of almost all speakers increases with increase of frequency due to the coil inductance, thus reducing the driving current and the acoustic output at high frequency. If the speaker is driven from a high-impedance source, this current decrease, being a function of total circuit resistance, is not so serious as when a low-impedance source is used. Thus it can be said that the relative h.f. output will always be greater when a high-impedance source is used. However, if the overall response is "flat," with the usual sort of "non-feedback" output impedance ratio of amplifier/speaker = ½, increasing the output impedance will increase the transient distortion by over-emphasizing the h.f. components of the pulse. Whether change of output impedance improves or degrades the transient response always depends upon where you start from, but it has been shown that an increase in output impedance always makes the transient "overshoot distortion" more troublesome, whatever it does to the high-frequency components of the transient.

Finally, do these oscillations really produce noticeable degradation in quality? Does an amplifier with a signal applied to its output really behave like a decent clean-living resistor? Can the loudspeaker be made to produce a good square acoustic signal; and if it can, what does it sound like? These and other questions must be left for later discussion.

SHORT-WAVE CONDITIONS

March in Retrospect : Forecast for May

By T. W. BENNINGTON
(Engineering Division, B.B.C.)

DURING March the average maximum usable frequency for these latitudes decreased very slightly during the day, and increased considerably during the night. These are the normal seasonal variations.

Daytime working frequencies remained high; in fact, higher on the average than had been expected. U.S.A. stations on frequencies over 30 Mc/s were not often heard, but the 28-Mc/s band held on remarkably well. 11 Mc/s was about the highest *regularly* usable night-time frequency.

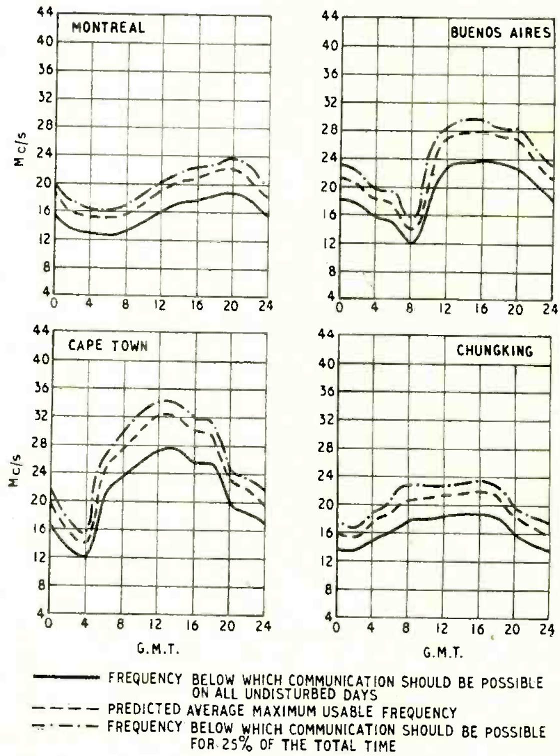
Sunspot activity was, on the average, higher than during the previous month. The giant sunspot of February 20th (now much reduced in size) crossed the sun's central meridian again on March 18th and further ionospheric disturbances followed.

Though the early part of the month was ionospherically "quiet," the latter part was subject to much ionospheric storminess, and the month as a whole must be classed as a disturbed one. The most disturbed periods were 6th-7th (minor), 13th (minor), 19th-22nd, 24th-25th and 27th-28th. Strangely enough, no Dellinger fadeouts were reported during the month.

Forecast.—Daytime m.u.fs in these latitudes should continue to decrease during May, whilst night-time m.u.fs should continue to increase.

Daytime working frequencies on east-west circuits should therefore be considerably lower, and those on north-south circuits somewhat lower, than during April. It is unlikely that 28 Mc/s will be usable over east-west circuits at any time during the month, though it may occasionally be usable in southerly directions. Moderately high frequencies will, however, remain of use for longer periods than during April, because of the longer duration of daylight at this end of the circuits. Frequencies as high as 15 Mc/s should remain regularly usable until after midnight, and the lowest frequency really necessary at any time of night should be of the order of 12 Mc/s.

Daytime frequencies for medium-distance communication should be somewhat higher than during April because such communication will take place via the E or F_1 layers for several hours daily. There is likely to be a big increase in the rate of incidence of Sporadic E, and transmission up to 1,400 miles may be frequently possible, perhaps on exceptionally high frequencies.



The curves indicate the highest frequencies likely to be usable over four long-distance circuits from this country during the month.

Physical Society's Exhibition

Electronic Research and Measuring Equipment

The fifth post-war exhibition of the Physical Society, held in London from 31st March to 5th April, included many items of radio and electronic interest. This report opens with a description of some of the exhibits concerned with research and development rather than routine production.

RESEARCH

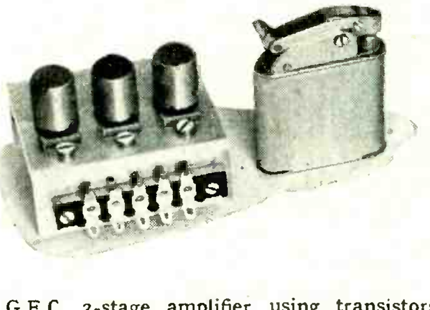
THE applications of germanium are no longer confined to the diode. The crystal triode, or transistor, is on its way to practical use. The G.E.C. Research Laboratories demonstrated its characteristics on an oscilloscope and showed experimental equipment embodying it. A three-stage a.f. amplifier with a gain of 66db and an input impedance of 1kΩ was shown.

Germanium also forms the basis of a method of measuring magnetic field strength by the Hall effect, shown by both G.E.C. and B.T.H. If a magnetic field is applied at right angles to a conductor carrying a current, a p.d. is developed across the conductor which is proportional to both the field and the current and which is at right angles to both. The effect is relatively large when the material is germanium, and a sensitivity of 1μA per 1mA per 1,000 gauss is obtainable. The germanium can be physically very small and so can be used for exploring magnetic fields.

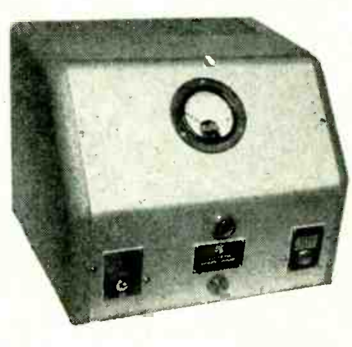
Synthetic piezo-electric crystals were shown by Standard Telephones. Ethylene diamine tartrate is easily grown and produces crystals suitable for use in line filters.

A method of transmitting telegraph signals over narrow bandwidths was shown by Marconi's W.T. Company. Signals of 66 w.p.m. can be transmitted over a bandwidth of 10c/s, using a 5-unit code. Pulse-amplitude modulation is used with 32 levels; the noise level must be 36db below the peak signal level.

The Royal Aircraft Establishment showed an electronic curve follower for feeding recorded information to a computer. The curve is drawn on transparent film and is scanned by a c.r. spot oscillating at 3kc/s with an amplitude of 1mm. A photo-cell and amplifier is used with a phase-sensitive rectifier and gives an output proportional to the displacement of the centre of oscillation from the line. This is fed back to the deflector plates and locks the centre of the spot to the line. The deflector-plate voltage forms the output of the device.



G.E.C. 3-stage amplifier using transistors compared in size with a cigarette lighter.



(Right) W. G. Pye current-stabilized power unit, designed for supplying a hydrogen lamp.

The Telecommunications Research Establishment showed locked-oscillators of the sine-wave type giving frequency multiplication in steps of 10:1, and the Signals Research and Development Establishment exhibited a number of balanced-T bridges built for impedance measurements in the 50–100-Mc/s region. One model includes a decade resistance standard.

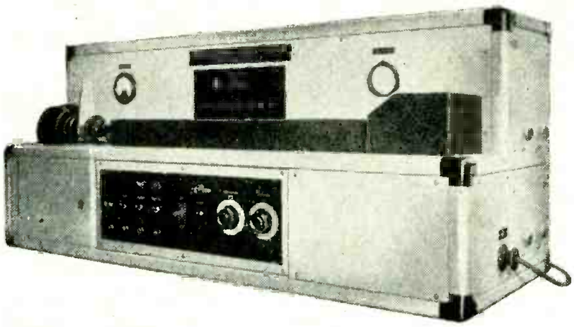
GENERAL ELECTRONICS

AMONGST the exhibitors of power supply units, one of the highest claims for stability was made by Cawkell, who demonstrated a model giving 200V at 50mA with stabilization of 0.003 per cent for mains or load variations of 15 per cent. The valve-heaters in the instrument are connected in series across the stabilized h.t. line, and a thermal-delay switch allows them to reach full temperature before the stabilizing action commences. A 300-mA current-stabilized power supply by W. G. Pye gave 0.01 per cent stability for 12½ per cent mains variations and ±100Ω variation on the normal load of 300Ω. Here again the valve heaters are in series across the stabilized line, and tappings are taken from the potentiometer thus formed to provide h.t. voltages, thereby saving extra resistors. Cinema-Television, Dynatron and E. K. Cole had stabilized e.h.t. units for nucleonic work, whilst Tinsley showed an a.c. stabilizer using a thermistor-bridge detector. A constant-current source for supplying valve heaters or filaments, using a transductor, was shown by the British Scientific Instrument Research Association, and a constant-voltage 12-V supply by Advance Components.

Several firms have been concerned with the problem of producing stable d.c. amplifiers. Southern Instruments showed a drift-corrected d.c. amplifier in which an oscillating relay continuously compares input with output so that any variation in gain is made to operate an automatic correcting circuit. Another self-balancing method was demonstrated by Electronic Instruments, for use in an electrometer, but here the correcting process was set in motion periodically by a cam-operated switching system. Two alternative methods of d.c. amplification were on view. Nagard used the d.c. to modulate a carrier frequency of 14Mc/s in an amplifier which had a flat frequency response up to 1Mc/s and a maximum gain of 15,000. Tinsley and Sunvic, on the other hand, modulated the d.c. by means of a mechanically operated "chopper," then amplified the result by normal methods and finally rectified the output.

Demonstrations of various applications of magnetic amplifiers were confined mainly to two firms. Elliott used them for amplifying signals from thermo-couples, for driving a uniselector and for speed control of a 1-h.p. motor; whilst Electro Methods showed several applications, including the integration of small signals by a low-inertia integrating motor driven by a magnetic amplifier. Thermionic amplifiers with special uses were shown by E. K. Cole, de Havilland, T.R.E. and Cawkell. The latter's exhibit was a demonstration amplifier for schools, with

Electronic apparatus for counting the red corpuscles in human blood, developed by Metropolitan-Vickers.



controls brought out on the front panel to enable circuit constants to be altered whilst the effects at the output are studied on a c.r.o.

In the field of computing, for those who find it difficult to convert decimal to binary numbers, Elliott showed a machine that will do the job automatically. An analogue computor for solving twelve similar linear equations was exhibited by de Havilland, and the N.P.L. had on view a junior model of their automatic computing engine, which is still in process of development. To reduce the tedium of designing directional aerial arrays by the trial-and-error method, T.M.C. have produced an experimental apparatus in which the trial radiation pattern is traced instantaneously on the screen of a c.r.o.

Counters and scalers were very much in evidence this year. In general they followed the conventional form of an electronic system providing either scales of two or scales of ten, together with a mechanical register to give the total count. An interesting application demonstrated by Metropolitan-Vickers was the counting of blood corpuscles. The blood is diluted by a known amount and passed down a capillary tube, an image of which is focused by a microscope on to a photo-cell; thus, the passing of a corpuscle causes the photo-cell to produce a pulse which in turn actuates the counter. Other exhibitors of counters were Airmec, Dawe Instruments, Panax, Dynatron, E. K. Cole, Lydiate Ash, Marconi Instruments, and the Atomic Energy Research Establishment, many of the instruments being designed for counting the random-pulse outputs of Geiger-Muller tubes and ionization chambers.

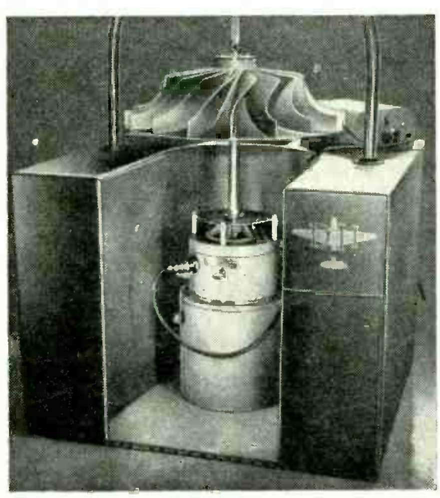
Several portable radiation monitors and detectors worked by batteries were on view, the principal exhibitors being Baldwin Instruments, Ediswan, E. K. Cole and Panax. For determining the strength of radiation in particles-per-minute, rate-of-count meters were shown by E. K. Cole and Panax.

INDUSTRIAL ELECTRONICS

ESTABLISHED methods of applying variation of resistance, capacitance, inductance or photo-emission to the control of industrial processes or production were, as usual, well represented, and some interesting new principles of control were shown for the first time.

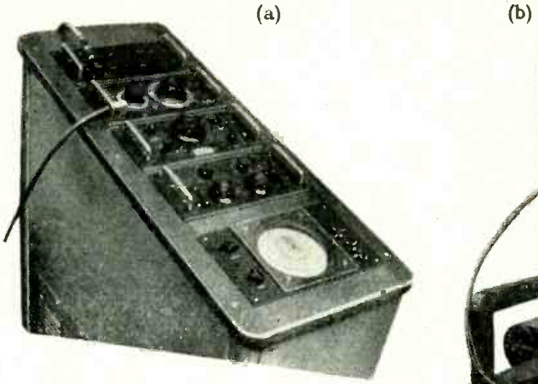
In the radioactive thickness gauge, developed by the Electronics Division of E. K. Cole, the absorption of emanations from a radioactive source is used to indicate the thickness of sheets and films; e.g., paper, plastics or even steel. A tray containing the radioactive element is placed below and an ionization chamber above the moving strip, and no mechanical contact is necessary. The output from the ionization chamber is converted to a.c. by a vibrating-reed electrometer, amplified and compared with the output from an identical reference source in which a normal specimen of the material under examination has been inserted. Assuming that the density of the material remains constant, the output indicated by the differential meter gives a measure of the variation of thickness to an accuracy of 1 or 2 per cent at speeds up to 5 or 6 ft/sec for materials such as paper and plastic. The strength of the source required under these conditions is perfectly "safe" from the point of view of health; for higher speeds and denser materials some shielding may be necessary.

Measurement of the temperature of flue and furnace gases in the region of 1,000° to 2,000° C presents many difficulties, particularly when the average temperature across a furnace 20 or 30ft wide and a few inches above the fuel is required. A solution has been provided by Lydiate Ash Laboratories, in which the velocity of propagation of supersonic waves is the underlying principle. The output from a stable l.f. oscillator, variable over a limited frequency range, provides a circular trace on a c.r. tube after passing through a network giving two signals spaced 90° in phase. It also provides pulses for firing a Trigatron which discharges an e.h.t. circuit in a spark gap with peak pulse energies of 600 kW. The sound energy of the spark is concentrated in a beam by a reflector, and is picked up by a transducer, amplified, and a suitable h.f. component above the ambient furnace noise is filtered and applied to the trace. The pulse repetition frequency is adjusted according to the length of the sound path, and a scale-of-two ensures that the received pulse coincides with the transmitted pulse at normal temperatures after two revolutions of the trace. In this way the temperature scale is expanded to give better resolution. The spot travels anti-clockwise, and as the temperature rises the received pulse arrives after shorter intervals of time and progresses clockwise under a calibrated graticule. The transducer



Ediswan portable gamma radiation monitor type 1030C, for indication of integrated dose up to 0.125 rœntgens, and (right) de Havilland moving-coil vibrator for fatigue testing. Alternating thrust 250 lb and frequency range 0 to 1,000 c/s.

(a)



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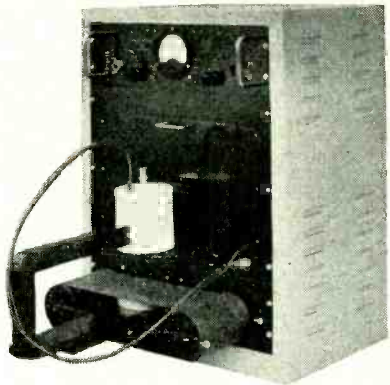

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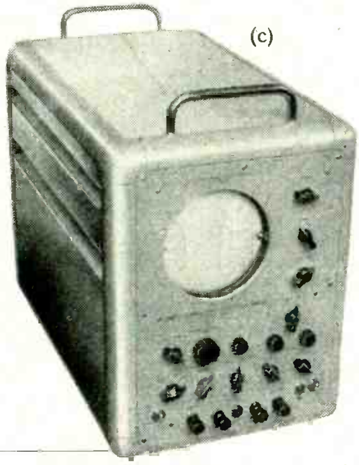


(a) Control and display unit of Lydiate Ash Laboratories' electronic high temperature indicator.

(b) Ekco thickness gauge, showing external radioactive source and ionization chamber.

(c) Portable automatic curve tracer made by Industrial Electronics, Ltd.

cannot be inserted directly in the furnace gases, and an end correction is applied electrically. Compensation is also provided for changes in the gas composition.

Fatigue testing at low and sub-audio frequencies is gaining in importance, and regenerative amplifiers are being used as self-drive units in conjunction with vibration pickups and filters to select the natural frequency at any required mode of vibration. Complete equipment for this type of work, shown by de Havilland Propellers, included a large moving-coil drive unit with many features—including cloth-loaded synthetic resin centring spiders—reminiscent of conventional loudspeaker design. The Type 1/D1 vibrator, as it is called, has an energized field taking 1 kW, and at full load exerts an alternating thrust of 250 lb with amplitudes up to 0.25 inch over a range of 0 to 1,000 c/s; the natural frequency of the unloaded assembly is 5 c/s.

Instantaneous visual indication of frequency is given by the Type 1204 "strobotuner" shown by Dawe Instruments. Twelve stroboscopic rings revolving at speeds proportional to semitone intervals on the equally-tempered scale are driven by a synchronous motor energized from a valve-maintained tuning fork. The normal fork frequency is 440 c/s, but it can be varied a semitone on either side by sliding loading weights, if pitches other than the international standard are required. The revolving discs are illuminated by neon lamps, connected in the output of a microphone amplifier so that the frequency of the sound under investigation causes the appropriate disc to appear stationary. Seven rings of segments on each disc are marked at octave intervals and the total frequency range of indication is 32 to 4,070 c/s. The equipment is designed primarily for manufacturers of musical instruments, and considerably reduces the time of adjustment and testing.

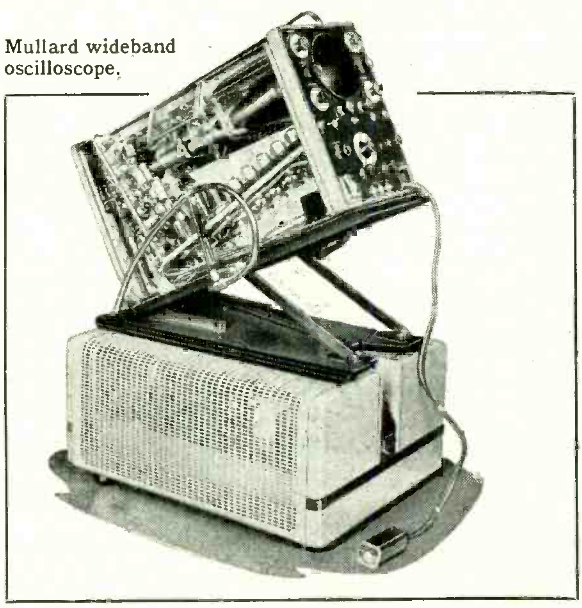
Another useful aid to the production testing of audio-frequency components such as loudspeakers, transformers, filters, amplifiers, etc., is the Type 1900 portable response curve tracer which was demonstrated by Industrial Electronics. One of the r.f. oscillators in a beat-frequency generator is controlled through a reactance modulator by a linear sweep generator giving a scanning rate variable between 5 sec and 1 minute. The output of the b.f.o. is divided, and part is fed through an R-C network, rectified and amplified in a push-pull d.c. amplifier in a give, on a c.r. tube, a horizontal deflection which is proportional to the logarithm of frequency. Feedback is applied between the deflector system and the reactance modulator gives a reasonably constant rate of deflection of the spot. Vertical deflection from the input amplifier is normally linear, but a logarithmic compression circuit, depending on the characteristics of a contact rectifier, can be switched in when desired. Special precautions have been taken to ensure the stability of frequency calibration and the scale is checked at one end against mains frequency, and at the other against a stable resonant circuit.

Many industrial control devices depend on the accurate measurement of displacement, and the proximity switch and proximity meter shown by Fielden (Electronics) are examples of the sensitivity obtainable when using balanced capacitances for this purpose. The principle has been extended to graph recorder mechanisms in which the movement of the pointer of a 0-50 μA meter is followed at a distance, depending on capacitance, by a servo-operated moving vane to which the pen mechanism is connected.

OSCILLOSCOPES

THE cathode-ray oscilloscope is as ubiquitous as ever and many different types were shown. The Duddell string oscillograph is still used, however, and the Cambridge Instrument Co. showed 6- and 12-channel models having a frequency response up to 1,400c/s. Clifton Instruments also showed an electromagnetic type.

Mullard wideband oscilloscope.



A. E. Cawkell Electronic Engineers had a c.r. type for 0.5-100c/s with a sensitivity of 50mV/cm. It is a double-beam type with an electronic switch.

The Industrial Electronics A.F. Response-Curve Tracer is designed for checking a.f. apparatus and draws a frequency-response curve on a long-afterglow screen.

On oscilloscope with an amplifier calibrated to 5 per cent in volts was shown by Nagard. It is in two units and covers zero to 10Mc/s. Furzehill Laboratories showed general-purpose oscilloscopes. The 1684D has an amplifier providing a sensitivity of 7mV/cm over the range 0-1.2Mc/s or 21mV/cm up to 3Mc/s. The time-base has a range of 2c/s to 150 kc/s. The 1684N is designed for low-frequency use and has an upper limit of about 50kc/s. It includes 10:1 sweep expansion.

Airmec Laboratories had an oscilloscope with a Y amplifier operating from zero to 5Mc/s and a timebase giving sweeps from 0.5sec to 1μsec. Mullard showed a wideband oscilloscope with X and Y amplifiers with a response from zero to 20Mc/s for —3 db. The sensitivity is 100mV/cm and a probe input is available.

An elaborate oscilloscope was exhibited by Metropolitan-Vickers. It is of the continuously evacuated type and operates at 100kV.

Cameras for recording oscilloscope traces are available in many types, but a special display was made by Avimo. This firm showed continuous film-recording cameras. With a film capacity of 200ft and film speeds between 2.5in/sec and 300in/sec operation is from a 24-V power supply.

SIGNAL SOURCES

AN interesting feature of the newest types of signal generator is the provision of both frequency and amplitude modulation from internal sources. The Marconi Instruments Model TF995 typifies the trend as it provides internal f.m. at 1,000c/s with deviations variable from 25kc/s to 600kc/s, and a.m. up to 50 per cent. The r.f. oscillator is variable over 4.5 to 9Mc/s only, but by using cascade harmonic multipliers an effective frequency range of from 13.5 to 216Mc/s is obtained. Included also is a crystal calibrator. A more ambitious model is the TF948, covering 20-80Mc/s, and with internal modulation by four frequencies with f.m. deviations up to 600kc/s and a.m. up to 80 per cent. It has a crystal check circuit, f.m. and a.m. monitoring and a tuning scale giving about 7 feet for each of the two frequency bands.

An f.m. signal generator intended primarily for testing receivers in the 90-Mc/s region was shown by Mullard. Known as the Model E7572, the final f.m. signals are obtained by mixing the output from a fixed frequency f.m. oscillator with that from a variable c.w. oscillator and using high- and low-pass filters to select the difference and summation frequencies. Ranges of 3-15Mc/s and 80-100Mc/s are thus obtained with a single variable oscillator. Two forms of modulation are provided, a 500-c/s sine wave with variable deviation up to ± 100kc/s and a 100-c/s repetition saw tooth.

A new Advance audio generator (type H1) is notable for its wide coverage, 15 c/s to 50 kc/s, and the provision for either sine-wave or square-wave output. Heavy negative feedback ensures low distortion and the output is variable from 200μV to 20 V.

METERS

TYPICAL of the modern trend in design of mirror galvanometers is the Pye "Scalamp," a new self-contained model with galvo unit, scale and lamp in one case. In addition to other novel features it has switchable shunts to vary the sensitivity and a shock-proof mounting to absorb bench vibration.

A number of new models with shortened suspension, to reduce the height of the case, were shown by Tinsley, and further examples were seen among the exhibits of Hilger, Pullin and Turner.

Pointer instruments have undergone little change, save that meters with a sensitivity of 10μA full scale are now more plentiful. A meter of this sensitivity was included in a new Series 30 (3-in scale) made by Pullin.

A tropical version of the Avo Electronic Test Set is now available, and there is also a valve-voltmeter conforming to B.S. standards for first-grade moving-coil instruments. It is the Model 26, made by Electronic Instruments, and is usable up to 200Mc/s.

BRIDGES

WIDE-RANGE self-contained bridges for the measurement of small values of inductance and capacitance figured among the exhibits of Cinema-Television. One, covering 0.005μH to 30mH in 12 ranges, gave direct readings of mutual and self-inductance with an accuracy of ±1 per cent of the half-scale reading on all ranges, and this also had facilities for measuring resistance of from 0.0001Ω to 3kΩ in 12 ranges also. Another covered, in 36 ranges, 0.002pF to 100μF and 1Ω to 30,000MΩ.

A feature of these bridges is the employment of inductively coupled ratio arms and circuits that cancel out the inductance, capacitance and resistance of external connecting leads, thereby enabling measurements to be taken with the components *in situ*.

Wayne Kerr showed some bridges of exceptional interest; the B401 impedance bridge, for example, gives *in situ* measurements of capacitance, resistance and inductance over the ranges 0.1pF to 10,000μF respectively. Measurements can be made at either 5kc/s or 50.5kc/s

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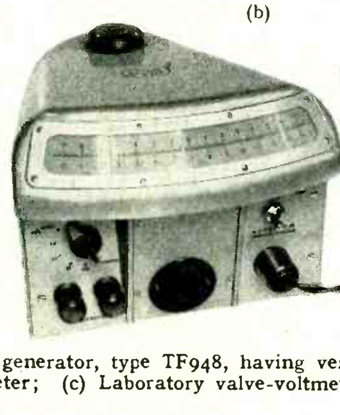
(b)



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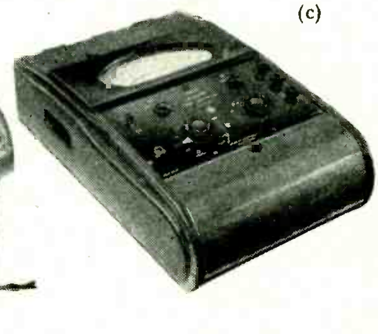
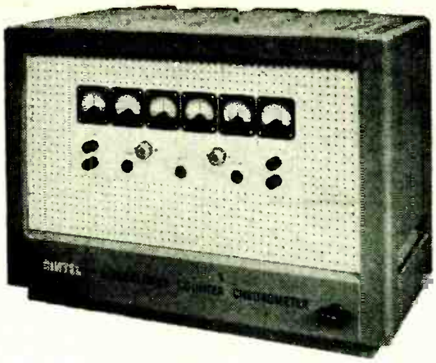


(a) Marconi Instruments f.m.-a.m. signal generator, type TF948, having very long frequency scales ; (b) Pye "Scalamp" self-contained mirror galvanometer; (c) Laboratory valve-voltmeter made by Electronic Instruments.



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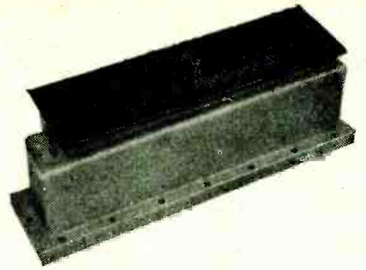


(b)

(c)

(a) Cinema-Television electronic stop-watch (microsecond counter chronometer); (b) Standard Telephones push-button h.f. attenuator; (c) 20th Century Electronics c.r. tube.

from an internal oscillator or with an external generator over 50c/s to 20kc/s. The accuracy is ±1 per cent. Another, the type B901, is designed primarily for measurements of susceptance and conductance of v.h.f. aerial systems over the frequency range 50 to 250Mc/s.

MISCELLANEOUS TEST EQUIPMENT

An instrument for measuring very short intervals of time, described as the Millisecond Counter Chronometer, was shown by Cinema-Television. Its range is 1μ sec to 1 sec, calibration being in steps of 1μ sec. A starting pulse activates circuits which continue to record the number of cycles of an interval oscillator until the arrival of a stopping pulse. Another microsecond counter, the Chronotron, was included among the exhibits of Electronic Instruments.

A wavemeter of unusual accuracy, 1 part in 10^5, was shown by Plessey. It incorporates several reference oscillators, one being crystal controlled, and covers a range of 15 to 10,000Mc/s.

For analysing complex waveforms Muirhead have developed a high-precision type wave analyser, Model D489A. Resistance-capacitance tuning is employed, and the exploratory range is 19c/s to 21kc/s. It is not a heterodyne type.

Dawe had a v.h.f. "Q" meter, range 30 to 200Mc/s, and an improved sound level meter, the new model being about half the size of the older, but providing the same facilities.

VALVES AND C.R. TUBES

An unusually small number of valves and tubes were shown at this year's exhibition. Standard Telephones had a reflex kylstron for 6–7cm with an output of 0.65–1W, and capable of being frequency-modulated 0.8–1Mc/s per volt. A frequency shift of 400Mc/s is possible by mechanical tuning.

20th Century Electronics exhibited precision c.r. tubes. There are two single-beam types, 4in and 6in. and a 6-in double beam, all with flat faces. The last has two separate guns, and it is claimed that there is no interaction between them; the X-plates are common.

A range of cold-cathode valves and electrometer valves was shown by Ferranti.

COMPONENTS

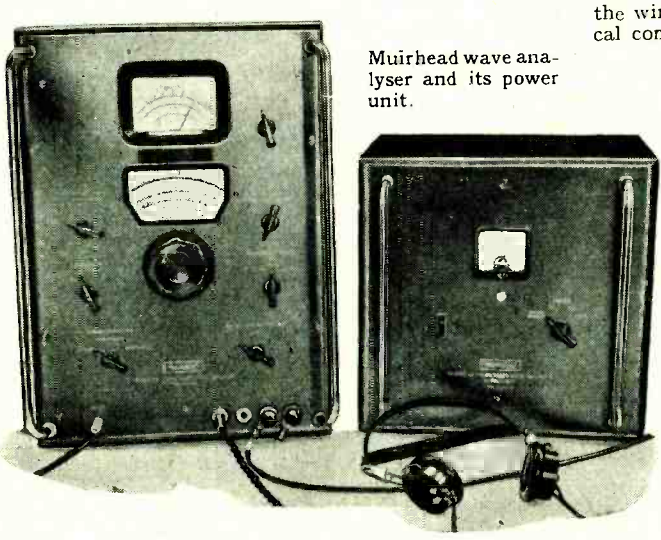
Standard Telephones showed a range of swaged-seam capacitors for tropical purposes. Both paper and mica-dielectric types are made, and the terminals and mounting are on the same face of the component.

Variable transformers and wire-wound resistors were exhibited by Zenith, while Gambrell showed 50-MΩ standard resistors and had an interesting precision slide-wire, comprising 50ft of wire wound as 100 turns on a drum.

Westinghouse, in addition to the well-known ranges of metal rectifiers for h.t. and e.h.t., were showing new types designed for use as "damping diodes" in television line-scan circuits. They range up to the 14D36 with a rating of 3.47kV peak inverse and a mean current of up to 100mA. Types with cooling fins can be supplied for higher currents.

Standard Telephones also showed selenium rectifiers and have an e.h.t. type rated for 40V r.m.s. per plate or 80V peak inverse in television fly-back circuits.

Breeze connectors for coaxial cables operating at 7-10kV were exhibited by Plessey, who also had a range of microwave components. Variable resistors, of both the wire-wound and carbon types, fully sealed for tropical conditions, were also shown.



Muirhead wave analyser and its power unit.

MATERIALS

Further advances in the performance of permanent magnets are foreshadowed by a new process developed by the Permanent Magnet Association, though it will be some time yet before magnets will be commercially available. Using an alloy similar in chemical composition to Alnico, it has been found possible to grow columnar crystals internally in a direction favourable to the magnetic circuit, and magnets formed by this method have given figures for BH_{max} of the order of 7 to 8 × 10^6 gauss-oersteds compared with the previous best of 5×10^6 for the anisotropic heat-treated Alcomax III.

A new ceramic material, K3,000, was shown by Mullard Electronic Products. Developed for use in r.f. bypass capacitors, it has a permittivity of the order of 3,000 in the temperature range 10° to 70° C.

Deflector Coil Characteristics

3. *Performance of Frame Coils*

(Concluded from p. 151, April 1950)

By W. T. COCKING, M.I.E.E.

SO far as the field efficiency is concerned all the conclusions reached about line coils apply equally to frame coils with only one exception; it is not possible to reduce LI^2 appreciably by using copper screening around core-type coils at frame frequency. With the ring-type iron circuit and normal forms of construction the LI^2 figure for the frame coils is normally higher than for the line. There are two reasons for this; on the one hand the frame coils must necessarily be shorter than the line because the bent-up ends must fit inside the ends of the line coils, and on the other hand the bent-up ends of the frame coils must be longer because they have to pass over the side wires of the line coils. As an example, with the assembly used for the measurements of Table 2 and with ring 2, the line coils have $LI^2 = 1.06$ and the frame coils $LI^2 = 1.32$. For ease of comparison both figures are for the same deflection.

However, at frame frequency the LI^2 figure is not always of the first importance. The energy lost in the resistance of the windings is no longer negligible compared with the energy stored in the inductance but actually greatly exceeds it. The real figure for the deflection power is now proportional to $RI^2 = LI^2 \times R/L$.

Because of this it is theoretically possible to adopt quite different methods of improving frame-coil efficiency. For instance, if the window area of the iron circuit is increased the field efficiency decreases (LI^2 increases) but the winding area increases and so larger wire can be used and the resistance decreases (R/L decreases). If R/L decreases more than LI^2 increases, RI^2 decreases and the efficiency is improved.

In some cases this occurs to a marked extent and low RI^2 figures are possible in spite of very poor LI^2 values. As an example, one commercially-produced core-type coil has $LI^2 = 6.08$ and $R/L = 0.185$ so that $RI^2 = 1.12$, whereas the coil referred to just above with $LI^2 = 1.32$ has $R/L = 1.88$ and $RI^2 = 2.48$. The commercial coil is actually not quite as good as it sounds for its resistance has been reduced so much that it is no longer permissible to ignore the energy stored in the inductance. It is necessary to use the accurate expression $RI^2(1 + 0.105L/R)$ which equals 1.74 in this case. Using this expression also for the bent-up end coil we get a figure of 2.61 instead of 2.48.

Although the commercial coil has only 1/4.6 of the field efficiency the resistance losses are so low that it needs only 1/1.5 of the input power of the other coil.

Although the RI^2 figure, modified if necessary by using the full expression, indicates the power input needed by the coil for deflection it is necesary to be very careful in using it. In practice, the important factor is really the power which must be provided by the valve which feeds the coil, not the power which must be fed to the coil. Under ideal conditions the two are proportional to each other, and then the lower RI^2 the better. In practice, however, it is not always possible to match valve and coil and when this happens a decrease of RI^2 may be of no benefit; it may merely increase the mismatch and leave the power supplied to the valve from the h.t. supply unaltered.

This is not the place to enter into a discussion of methods of feeding the deflector coil, but it is necessary to realize that in some cases improvements in the efficiency of a frame deflector coil confer little or no practical benefit. The true utility of a frame coil can only be assessed by considering it in conjunction with the valve and coupling circuit.

Even if RI^2 were a direct measure of the practical goodness of a coil when connected in circuit there is not a great deal that can be done to reduce the figure. With a given form of construction RI^2 can be reduced only by increasing the winding area. This can be usually done only by increasing the window area of the iron circuit, which increases LI^2 but reduces R/L more. However, the iron circuit is common to the line and frame coils in most cases and the increase of window area reduces LI^2 of the line coils. The magnitude of the power involved in line deflection is so much greater than in frame that the net result is likely to be an increase in the total power required.

Coil Inductance

So far little or nothing has been said about the actual number of turns on the coils. This is a minor matter with little or no effect on the efficiency, for it affects neither LI^2 nor R/L. If the coils are not fed through transformers, the turns must be chosen to suit the requirements of the valves which supply them with the saw-tooth current; in other words, they must be chosen to match the valves. If transformers are used the number of turns is not at all important because the transformer ratios can be chosen to suit.

Transformers are usual in commercial practice and for the line scan a coil inductance of some 5–10 mH is common. This usually needs 150–200 turns in each coil of the pair. The wire gauge is from No. 26 to No. 32 s.w.g. and is convenient whether the coils are wound to shape or bent after winding. Frame coils have the same order of inductance but they are often a little higher—up to about 25 mH.

In cases where transformers are not used higher inductances are necessary. For the line scan the inductance needed is of the order of 70 mH and something around 500 turns per coil is required. For the frame an inductance of up to about 2 H is desirable in many cases and this will call for something approaching 3,000 turns per coil.

A practical limitation occurs here because it is not possible to reduce the wire size indefinitely. With the winding area often available 3,000 turns would require No. 46 gauge wire and this is much too weak mechanically for a deflector coil. It is undesirable to use any wire smaller than No. 42 s.w.g. and a limit of No. 40 is preferable. With this last gauge the limit to the turns is around 1,000 per coil in many cases.

To a large extent it is this which limits the possibility of matching the coils to the valve. If it were possible to reduce the wire size without limit it would be possible to wind on turns until the voltage drop across the resistance of the coils reached the limit set by the valve and h.t. supply. The current would then be a minimum and optimum matching would be obtained. As it is, the voltage drop across the coils is often well below that permissible in the valve circuit and the current must be correspondingly increased.

The same factor arises, but in a different way, even when transformer coupling is used. It is no longer in the deflector coil but is transferred to the transformer. It becomes much more complicated to investigate, however, because the matching then becomes tied up with questions of the size, weight and cost of the transformer as well as its efficiency and power of distorting the scan.

There is one form of deflector-coil construction which must be mentioned here because it does permit an unusually large winding space for the frame coils. It has already been briefly referred to and is based on a lamination which acts as a split iron ring for the line coils, while the two halves of the ring form poles for the frame coils. The iron circuit is built from a stack of laminations of the form shown in Fig. 3*. The advantages of this form of construction are two; the winding space for the frame coils is increased and so R/L can be reduced, and the laminations, if earthed, provide screening between the side wires of the line and frame coils. The disadvantages are a relatively low field efficiency for the frame coils, for an appreciable amount of field closely encircles the side wires, and a field distribution within the c.r. tube which is controlled by the shape of the poles and, therefore, nor readily changed.

An experimental assembly was constructed on a $1\frac{1}{4}$-in stack of 0.02-in G. L. Scott type S.31 motor-stator laminations. The line coils occupied nearly 60° for each side limb instead of the usual 45° and had bent-up ends. The internal diameter of the split ring formed by the poles was 42 mm. The frame coils were simple slab coils of circular section with a simple bend to clear the tube neck. They did not fully occupy the winding space available and so the R/L figure obtained was not so low as would be possible. The winding distribution in the line coils was also not quite right in this first attempt and there was some barrel distortion of the raster.

The line coils gave $LI^2 = 0.94$, $L = 18.8$ mH, $R/L = 1.56$. The frame coils gave $LI^2 = 2.19$ (for the same 7.5-in deflection), $L = 30.3$ mH, $R/L = 0.81$ and $RI^2 = 1.76$. Although LI^2 is considerably worse than for a bent-up end frame coil, R/L is much lower and the true efficiency is better.

Constructionally, the frame coils are much easier to make than the bent-up end type. The line coils are slightly more difficult than usual, because one end must be bent-up with the iron circuit in place. In addition to the partial screening afforded by the iron, the line coils can be rotated relative to the frame while the assembly is in operation so that it is easy to adjust the assembly for a rectangular raster and minimum magnetic coupling between the two sets of coils.

One disadvantage is that the raster shape is seriously affected by any imperfections of the lamination assembly. It is necessary to take great care to obtain a true stack and it was found to be only too easy to stack the laminations so that they had a slight twist. A more serious drawback is the lack of control over the frame field distribution. This means that it is not possible with a single type of lamination to make deflector-coil assemblies which are suited to all types of cathode-ray tube. It is mainly this last point which has made the writer view this form of construction with some disfavour, but the difficulty of obtaining a sufficiently true stack to avoid raster distortion is another factor. It is also one which applies to all core-type coils. He has concluded therefore, that the bent-up end coils with a ring-type iron circuit is the best form of construction.

Effect on Focus

So far deflector coils have been considered only in respect of their efficiency. It is, however, necessary that a deflector coil shall produce a rectangular raster evenly focused over its surface even if this entails a sacrifice of efficiency. This matter has to be discussed in rather general terms because actual measurements of defocusing are rather difficult.

With a ring-type iron-circuit, the shape of the raster is governed by the disposition of the side wires of the coils. The focus is also affected by this but also by the end connections. Referring to Fig. 8(a), the diagram shows a section though the middle of an assembly of line coils only. It can be shown that to produce a uniform magnetic field within the tube the turns density should vary as cos θ, o the total turns

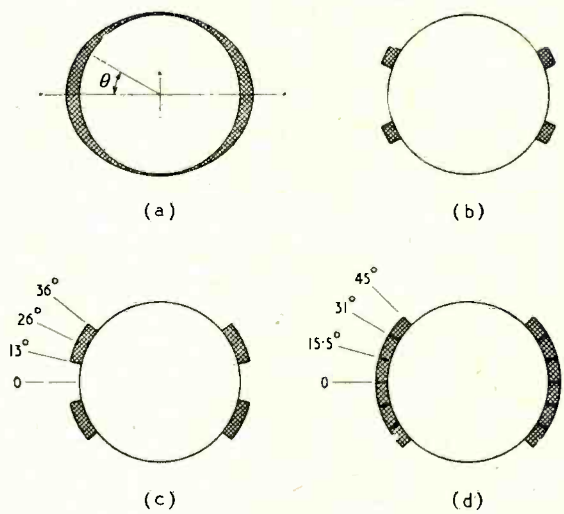


Fig. 8 (a). Shows a graded winding of varying thickness and (b) a small uniform winding. The latter must be centered on a 26° angle (c) for a curved-face tube. A 45° winding with the turns centered on 26° is shown at (d), the turns are distributed by changing the wire size in steps.

* March 1950, p. 97.

as sin θ. This calls for a winding of varying thickness and is consequently an inconvenient construction.

In practice, the grading of turns is usually made in steps. One way of doing this is to change the wire gauge at intervals during winding; another is to wind the coil in a number of identical sections which are spaced at varying intervals; still another is to wind the coil in evenly spaced sections and to vary the number of turns in each section.

As the number of sections is reduced so the approximation to the gradual distribution decreases and it is at its worst when each side limb degenerates to a single uniformly-wound section as shown in Fig. 8(b). A rectangular raster is easily secured with all these arrangements, but the focus improves as the turn distribution approaches the gradual.

Although it is commonly said that a uniform deflecting field is needed, this is not actually the case. The radius of curvature of the tube screen is greater than the deflecting radius and a suitable non-uniform field is necessary if the raster is to be rectangular; the departure from uniformity is greatest for a flat-face tube. Strictly speaking a deflector coil should be designed for a given tube and each tube type should have its own design of coil. In practice, this is not necessary and one design is usually satisfactory for all curved-face tubes and another for all flat-face types. Because a less uniform field is necessary with the latter it is more difficult to secure good focusing with them.

A uniform field gives pincushion distortion of the raster with all tubes. To obtain a rectangular raster the field must be made increasingly of pincushion shape as the radius of curvature of the tube screen increases, for a pincushion field tends to give barrel distortion of the raster. A coil assembly designed for a flat tube will therefore give barrel distortion on a curved screen and, conversely, one designed for a curved screen will give pincushion distortion with a flat.

The field becomes of the pincushion type as the bulk of the turns shift to small angles in Fig. 8. This means that the sin θ distribution must be weighted so that more turns appear for small values of θ and less for large. With the small ungraded coils of Fig. 8(b) the spacing between the adjacent limbs must be decreased.

When both line and frame coils fit around the tube neck, as in the bent-up end type of coil, θ is limited to 45°, for there are eight sets of side wires to fit around the tube neck. It is found that a rectangular raster requires that 50% of the turns lie between 0 and 26° and 50% between 26° and 45°. If the side wires are in one uniformly distributed section, the easiest to make, they must then extend from 13° to 39° as shown in Fig. 8 (c). Such a coil can give very good results with a curved-face tube, such as the MW14C. There is some defocusing in the corners but not a serious amount. This distribution was used in the *Wireless World* Television Receiver.

Better focusing and efficiency are obtainable with the full 45° occupied by a distributed winding. A suitable distribution is shown in Fig. 8 (d). The first 15.5° section contains 25% of the total turns, the middle section of 31–15.5 = 15.5° contains 36.5% and the third of 45–31 = 14° the remaining 38.5%. Note that this last section is the inside one of the coil as wound. The distribution is obtained by changing the wire gauge. This winding gives a better focus, and is somewhat more efficient because there is less waste space. It is more difficult to make, however.

The major defocusing troubles in a deflector coil usually come from the end connections. The field produced by these ends is chiefly in the form of loops encircling the end wires. Some field is necessarily produced in a direction acting along the electron beam and so having a defocusing action.

If the ends are bent-up well away from the tube neck the field which they produce within the tube, where it can affect the electron beam, is relatively weak and very little defocusing occurs. However, such ends take a greater length of wire and so produce a greater total field and the efficiency suffers.

Apart from the end connections, the field produced by the side wires extends beyond the ends of the assembly; it bows outwards from the ends. This is inevitable for it is not possible to terminate a magnetic field abruptly in a uniform medium. This bowing field itself has components acting along the electron beam which affect the focus. The only way of mitigating the curvature of the field is by increasing the diameter of the assembly, but this has a big effect on efficiency.

It is found, in practice, that the end bowing of the field is not serious for an assembly of 36-mm inside diameter. When the end connections are taken as closely as possible around the tube neck some defocusing in the corners does occur and it is desirable to keep these end connections further from the tube. Assemblies giving a rectangular raster and very little defocusing are possible with an LI^2 figure of the order of 1.3 or better.

The effect of the end fields is more serious at the front of the coil assembly where the beam emerges from the field than at the back where it enters it. This is because the beam enters the field on the axis of the tube in the most uniform region of the field and at the greatest possible distance from the end connections. At the front, the beam emerges from the field anywhere over a relatively large area and at full deflection is not greatly separated from the wall of the tube.

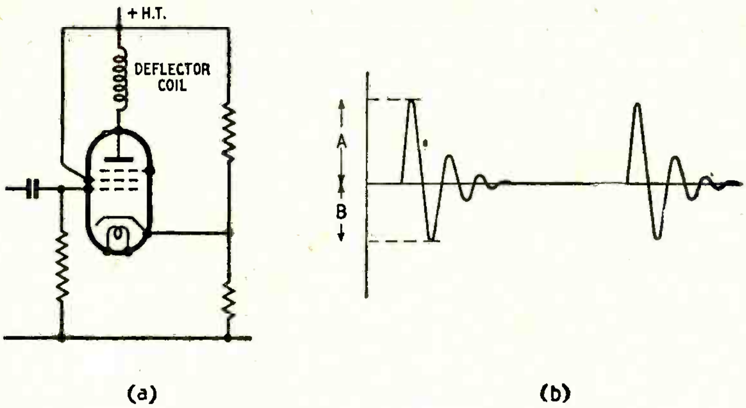
It is clear, therefore, that the front end of the assembly is more critical for the avoidance of defocusing than the back end. Consequently, it is permissible to bend up the back end connections less than the front, and it is advantageous to do so because it reduces the amount of wire needed and improves efficiency slightly.

Iron Losses

Nothing has so far been said about iron losses in the ring or core. Such losses inevitably occur but have no effect at all on the efficiency of the deflector coil as we have been considering it. They can, however, have a big effect on the efficiency of the circuit which feeds the deflector coil.

The importance of iron losses depends on the type of circuit. If critical, or slightly under critical, damping is used, as in the *Wireless World* Television Receiver, the iron losses are unimportant. Indeed, a fairly high iron loss is an advantage since it reduces the power that must be dissipated in resistances. In addition, it provides distributed, as distinct from lumped, damping of any subsidiary resonant circuits which may be formed between sections of

Fig. 9. The line output stage modified as shown at (a) can be used to measure overshoot. The picture seen on a c.r. oscilloscope is shown at (b).



windings and their self-capacitances. In this case laminations as thick as 0.02 in are quite satisfactory and are often to be preferred to thinner ones.

Matters are quite different when the circuit is of the type using a damping diode. It is then desirable to let this valve provide as much as possible of the damping and iron losses should then be kept to a minimum. The inherent total losses are easily measured in terms of the overshoot and from them figures for the Q can be computed. This is unnecessary, however, in many cases for it is the overshoot itself which is important.

The easiest way of measuring overshoot is to include the coil directly in the anode circuit of the line time-base output valve, removing all damping circuits and increasing the bias on the valve so that it remains cut off for, say, a third of the scan period. The input wave should cut the valve off very sharply on fly-back. The circuit is shown in Fig. 9 (a) and in (b) the anode voltage waveform as seen on an oscilloscope. It is usually sufficient to place the oscilloscope input lead near the anode of the valve; if it is connected directly to it, the voltage is usually much too great.

The fractional overshoot is the ratio B/A. It cannot exceed unity and if the measured value is greater, something is wrong with the equipment—probably the oscilloscope amplifier is overloading! An overshoot much over 0.9 is unlikely in practice.

The writer has not so far made many measurements of overshoot, but as an indication of what to expect he has obtained a figure of 0.9 for a deflector coil without iron. The same coil with a 1-in stack of 0.02-in laminations forming a 42-mm diameter ring gave an overshoot of 0.625 only. With a damping diode the circuit efficiency varies very roughly as the square of the overshoot, or in this particular case, in the ratio $(0.9/0.625)^2 = 2$. The deflector coil efficiency itself varies in a 2 : 1 ratio with and without the iron, so that in this case considering coil and circuit together the overall efficiency would be the same whether the deflector coil had an iron circuit or not.

In practice, of course, a transformer is needed and the iron losses in its core have a marked effect on the overshoot. This modifies matters and makes the deflector-coil efficiency of more importance than the losses in its iron circuit. Nevertheless, when a damping diode is used it is desirable to minimize the core losses. The laminations used should, therefore, be as thin as possible and of a high grade material with minimum hysteresis loss.

It is usually difficult to obtain thinner laminations than 0.014 in and although these are really much thicker than is desirable, they are appreciably better than 0.02 in. The quantity of iron used must obviously have an effect on the iron losses and it is reasonable to suppose that the use of, perhaps, one-half of the number of laminations needed for a full stack and spacing them out to occupy the full space would appreciably increase the overshoot.

It was shown earlier that this reduces the coil efficiency by only a small amount, so that it would probably be advantageous to adopt this form of construction. This lies in the future, and at the time of writing no measurements have been made to show the possibilities. The matter is complicated by the transformer. This component not only has itself high core losses, but is inefficient on a field basis. Because of the need for high insulation and low self-capacitance the leakage inductance tends to be large. This means that the transformer itself has a large waste field and stores a good deal of energy. Its efficiency is often no more than 50%.

The transformer efficiency does not directly influence the deflector coil but its core losses do, for if the core losses are large the overshoot will be small no matter how small the losses in the deflector-coil iron circuit are made. It will usually be advantageous to try to reduce core losses in one component only when those of the other are of the same order of magnitude. Of course, if the losses in one are very heavy and in the other very small, it is always useful to improve the poorer one, but a big improvement may be needed to be worth while.

Club News

Birmingham.—The first of a series of d.f. tests will be undertaken by members of the Slade Radio Society on 14th May. At the meeting on 12th May the first of a series of discussions on television fundamentals will be opened by R. T. Turner and will deal with time bases. On 26th May D. Symons will describe the construction of a television receiver using ex-Government equipment. Meetings are held at 7.45 in the Parochial Hall, Broomfield Road, Erdington. Sec.: C. N. Smart, 110 Woolmore Road, Erdington, Birmingham, 23.

Sheffield.—The reorganized Sheffield Amateur Radio Club now meets on the second Wednesday of each month at Albreda Works, Lydgate Lane, for technical lectures and on the fourth Wednesday at the Dog and Partridge Inn, Trippett Lane. Sec.: E. Walker (G2LT), 11a Welwyn Close, Intake, Sheffield, Yorks.

Sunderland.—The last of the lectures in the series on valve manufacture, which have been given by members of the staff of Ediswan's to the Sunderland Radio Society, is on "Testing and Inspection" and will be given by H. Booth on 17th May at Prospect House, Prospect Row, Sunderland. Sec.: C. A. Chester, 38 Westfield Grove, High Barnes, Sunderland, Co. Durham.

British Amateur Television Club.—The note on this club in our February issue was a little ambiguous. The purpose of the club is to encourage amateur activity in television *transmission*. Sec.: M. Barlow (G3CVO), Cheyne Cottage, Dukes Wood Drive, Gerrards Cross, Bucks.

WORLD OF WIRELESS

Europe's Wavelengths ◆ International Video Standards ◆ Component Standardization ◆ Audio Exhibition

Copenhagen Observations

FROM observations made at both the B.B.C. checking station at Tatsfield and the measuring station of the new European Broadcasting Union at Brussels it appears that all the 25 countries who were signatories to the Copenhagen Broadcasting Convention have conformed to it in most respects.

There have, however, been departures from the Plan by some of the non-signatories. Although Spain was not represented at the Copenhagen Conference—because she is not a member of the United Nations—she was allocated new frequencies but has, so far, continued to use the old wavelengths. As many of these come between the frequencies allocated at Copenhagen to other countries there has been considerable interference in certain parts of the Continent. Luxembourg also continues to operate on its old long wavelength as well as on the new medium-wave one.

Some stations in Palestine, Egypt, Andorra, Malta, Austria and Trieste, have not conformed to the Plan and the stations in the American Zone of Germany, for which three frequencies were allocated, are said to be operating on twenty-five. The American Forces Network is using five—Frankfurt, 593 kc/s (10 kW); Stuttgart, 1,061 kc/s (50 kW); Munich, 1,554 kc/s (100 kW); Beyreuth, 548 kc/s (10 kW); Berlin, 611 kc/s (1 kW).

To assist stations in calibrating their transmitters the B.B.C. recently placed the long-wave transmitter at Droitwich at the disposal of the European Broadcasting Union so that details of measured variations could be broadcast throughout the early hours of the morning in English, French and Russian. Stations in Brussels and Paris were also used for this purpose.

Television Standards

MEMBERS of the Television Study Group of the International Radio Consultative Committee (C.C.I.R.)—one of the four permanent committees of the International Telecommunication Union—are visiting countries on both sides of the Atlantic for demonstrations of television preparatory to meeting to discuss international standards. They will have seen American, French and Dutch equipment prior to seeing demonstrations in this country from 26th April to 5th May. On the following day the committee will open its meeting in London which is scheduled to last eight days.

Plans have been made for the 50 or so members of the committee, representing the governments and radio industries in fifteen countries, to visit research establishments of the B.B.C., G.P.O. and the industry.

News in Morse

A REVISED schedule of the London Press Service morse transmissions from Post Office stations has been secured in response to requests from readers and is given below. The material broadcast in this service "is not copyright and may be used for personal information, distribution or 'house' newspapers." The speed of transmission is from 20 to 27 w.p.m. We are advised that preparations are being made to replace the morse transmissions to the Near and Middle East by a Hellschreiber service.

The number in the fourth column of the table indicates the zone of reception (1, Europe; 2, Near and Middle East; 3, Africa; 4, N.E. Asia; 5, Australasia; 6, India; 7, S.E. Asia; 8, N. America; 9, S. America).

G.M.T.	Call	Freq. (Mc/s)	Zones
0015–0045‖ ...	GPX	11.645	8
0100–0330§ ...	MIK	9.725	8
0100–0415§ ...	GIN	10.960	9
0130–0315 ...	GIJ	6.985	1, 2
	GIB	11.980	3
0445–0545* ...	GBI	10.865	2
0945–1045* ...	GCV	19.365	4
1100–1200* ...	GIM	12.975	1, 2
	GCV	19.365	4, 5
1115–1215† ...	GPA	20.100	6, 7
1200–1300† ...	GCF	19.005	3
1215–1315* ...	GPA	20.100	6, 7
1330–1430* ...	GIM	12.975	1, 2
	GDZ	13.910	4, 5
	GCF	19.005	3
1445–1545* ...	GPF	16.190	2
	GPA	20.100	6, 7
1600–1700* ...	GIM	12.975	1, 2
	GBI	10.865	4, 5
	GCF	19.005	3
	GAG	17.105	6, 7
1700–1800* ...	GAG	17.105	6, 7
1700–1800† ...	GBI	10.865	4
1815–1945 ...	GIB	11.980	7
	GBI	10.865	4
1830–1930* ...	GKU3	12.455	1, 2
1945–2045* ...	GIB	11.980	6, 7
	GBI	10.865	4
2100–2200* ...	GCI	8.730	1, 2
	GAH	8.065	4, 5
	GAQ4	14.905	3
2215–2315* ...	GCX	8.920	6, 7
2330–0100‡ ...	GIJ	6.985	1, 2
	GAH	8.065	4
	GIB	11.980	3
	GCX	8.920	6, 7
2330–0045* ...	GAV	14.455	9

* Weekdays only.
† Alternate Fridays.
‡ Terminates at 0030 on Mondays.
§ From 0100–0345 on Mondays.
‖ Mondays excluded.

R.E.C.M.F. Report

THE seventeenth annual report of the Radio and Electronic Component Manufacturers' Federation records that nearly one-third—approximately £4,000,000—of the total value of the radio industry's exports during last year was of components and associated products exported direct.

The question of standardization has again been considered at some length by the Technical Panels of the Federation. From the component makers' viewpoint, standardization—particularly dimensional—has much to commend it since it simplifies tooling and production, but it is pointed out that it is not a matter for the component manufacturer alone. The principal difficulty in the way of introducing greater standardization is the reluctance of many manufacturers to restrict their individuality of design. Moreover, the "modern radio and electronic component is a maid of all work" being used in equipment ranging from domestic receivers to electro-encephalographs.

At the annual general meeting on 29th March the representatives of the following firms were elected to the Council for 1950-51: Belling & Lee, British Centralab, British Electrolytic Condenser, Bulgin, Garrard, Long and Hambly, T.C.C., Westinghouse and J. & H. Walter.

B.S.R.A. Exhibition

PLANS for the exhibition of recording, reproducing and audio equipment, which is being organized by the British Sound Recording Association for 20th and 21st May, include space for some twenty exhibitors and demonstrations of manufacturers' equipment in a separate hall. Mobile recording equipment provided by the B.B.C., E.M.I., Pathé Pictures and M.S.S. Recording, will also be on view.

The exhibition will be held at the Waldorf Hotel, Aldwych, London, W.C.2, from 2.30 to 6.0 on the 20th and from 10.30 to 6.0 on the 21st. Admission will be by catalogue, price 1s.

I.A.R.U. Jubilee

TO mark the 25th anniversary of the formation of the International Amateur Radio Union, a congress is being held in Paris from 17th to 20th May under the auspices of the Réseau des Emetteurs Français.

Two committees will be selected

from the delegates; one will deal with licensing regulations and the other with technical matters such as interference and propagation and with the proposal that amateurs should co-operate with the International Scientific Radio Union (U.R.S.I.) in undertaking scientific observations. The R.S.G.B. is submitting a paper on the latter subject.

Indexes

It is regretted that there has been some delay in producing the index to the 1949 volume of *Wireless World*. It will be available this month, price 1s 1½d by post, from our Publishers. Cloth binding cases for the volume are also obtainable, complete with index price, 4s 10d including postage. Our publisher can undertake the binding of readers' issues; the cost, including binding case, index and postage on the bound volume, is 13s 3d.

Copies of the 56-page index to the Abstracts and References Section of our sister journal *Wireless Engineer* are still available. The index includes subject and author sections and a list of the names and addresses of the 180-odd journals regularly scanned for abstracting. The index is obtainable from our Publishers, price 2s 8d.

Pioneer Craftsman

A LIST of the jobs on which E. F. Hills (see photo) has worked since he joined Marconi's W.T. Company in 1903 as a tool and instrument maker reads like a potted history of radio. He started with the ten-inch spark coil, which formed the heart of early transmitters like the one shown in our Marconi Marine Jubilee photo last month. Mr. Hills made one of the first facsimile transmitters; he worked on Navy arc sets in the 1914-18 war and on radar in the last war. In 1948 he transferred to the near-by English Electric Valve Company's works, and is now making jigs for assembling television camera tubes (see page 162).

OBITUARY

It is with regret that we record the death on 23rd March of **Daniel Bonney,** head of the External Relations Division of the English Electric and Marconi group of companies and director of nine overseas associated companies. He had been with Marconi's for 24 years having joined the company when he was 22.

We also regret to record the death at the age of 49, of **F. A. Cobb,** M.P., Assoc.I.E.E., who, for the past three years has been managing director of Electronic Tubes, Ltd., of High Wycombe, Bucks. He was on the engineering staff of 2LO in the early days of the B.B.C. and from 1926 to 1929 was chief engineer of the Indian Broadcasting Company at Calcutta.

The death is also announced of **G. H. Nash,** C.B.E., M.I.E.E., at the age of 69. From 1911-1928 he was Chief Engineer of Standard Telephones and Cables, and was a director of the company from 1927-1938. He also held a number of executive positions in international telegraph and telephone concerns. From 1942-1945 he was Deputy Director at the Ministry of Aircraft Production.

PERSONALITIES

Sir Edward Appleton, who prior to his appointment as Principal of Edinburgh University was Secretary to the D.S.I.R., has had a further honour conferred on him. He has been awarded the Sir Devaprasad Sarvadhikary Gold Medal for 1949 by the University of Calcutta. The medal is awarded biannually to "one of the most famous scientists of the age."

Major-Gen. L. B. Nicholls, C.B., C.B.E., M.I.E.E., who retired from the Army in 1947 to become a director of Cable and Wireless, has been appointed managing director of the company in succession to **John Innes,** C.B., B.Sc., A.M.I.E.E., who has retired. After commanding the Second Divisional Signals in France in the early months of the war, he served as Chief Signals Officer successively in the Middle East, North Africa and Europe.

Prof. E. B. Moullin, M.A., Sc.D., president, and **W. K. Brasher,** M.A., secretary, of the Institution of Electrical Engineers, are representing the Institution at the second Commonwealth conference of representatives of engineering institutions being held in Johannesburg in April.

P. G. A. H. Voigt, B.Sc., A.M.I.E.E., has gone to North America to explore the high fidelity position in Canada with a view to introducing in the Dominion the Voigt loudspeaker produced by Voigt Patents, Ltd., of which he is a director.

FROM SPARK COIL TO IMAGE ORTHICON.—E. F. Hills, with 47 years of wireless service to his credit, at work in the English Electric Valve Company's factory at Chelmsford.

H. J. Leak, M.Brit.I.R.E., director of the firm of manufacturers bearing his name, is visiting the Continent to arrange for an exhibition of the company's equipment at the Milan Fair.

Oswald F. Mingay, editor of the Australian *Radio Electrical Weekly*, who has been in this country for some months, is leaving on April 29th for the United States where he will continue his study of the world's radio and television industries. He is due back in Sydney at the end of July having been away 13 months.

B.B.C. APPOINTMENTS

A. R. A. Rendall, Ph.D., M.I.E.E., who joined the B.B.C. Lines Dept. in 1935 and has since successively held the positions of Asst. Head of the Lines Dept. and Asst. Head of the Designs Dept. has been appointed Head of the Designs Dept. in succession to H. B. Rantzen who recently resigned to join the United Nations Organization. Dr Rendall was with the International Standard Electric Corp. prior to joining the B.B.C.

E. G. Chadder, who, since joining the original B.B.C. in 1923, has successively held the posts of Engineer-in-Charge at Aberdeen and Washford, Asst. Supt. Engineer (Transmitters and Studios) and, since 1939, Supt. Engineer (Studios), has been appointed Senior Supt. Engineer (Sound) in succession to L. Hotine who recently resigned.

F. Williams, B.Sc., M.I.E.E., has been appointed Supt. Engineer (Studios), B.B.C., in succession to E. G. Chadder. He joined the Corporation in 1925 and after successively being Engineer-in-Charge of the studio centres at Cardiff, Birmingham and Manchester, was appointed Asst. Supt. Engineer (Studios) in 1940. He became head of the Corporation's Engineering Secretariat last year.

A. P. Monson has been appointed Superintendent Engineer (Recording) in succession to **M. J. L. Pulling,** who was recently appointed Senior Superintendent Engineer (Television). Mr. Monson joined the B.B.C. in 1933 and became head of the Transcription Recording Unit in 1941 and Assistant Superintendent Engineer (Recording) in 1943. Prior to joining the B.B.C. he was with Creed & Co.

H. W. Baker, for the past four years Engineer-in-Charge of the B.B.C.'s television station at Alexandra Palace, has been appointed Asst. Supt. Engineer (Television). He left Marconi's to join the B.B.C. in 1926 and held the post of Asst. Engineer-in-Charge at Alexandra Palace from 1937 until the television service closed down in 1939. During the war he was Engineer-in-Charge of various B.B.C. transmitters including the high-power long- and medium-wave station at Ottringham.

H. Walker, O.B.E., A.M.I.E.E., has been appointed Engineer-in-Charge of the London television station in succession to H. W. Baker. He has been with the B.B.C. since 1931 and joined the staff at Alexandra Palace just before the station opened in 1936. After serving in the R.A.F. during the war he returned to A.P. as Asst. Engineer-in-Charge when the television service re-started in 1946.

W. Balfour, who, prior to joining the B.B.C. in 1934, was at the G.P.O. station at Portishead, has been appointed Engineer-in-Charge of the B.B.C. studio centre and transmitter at Aberdeen. He succeeds **W. W. Inder** who has retired after seventeen years' service.

IN BRIEF

Licences.—Although the total number of receiving licences (sound and vision) in the United Kingdom decreased by 1,800 during February, the number of television licences increased by 31,200. The figures are: sound, 11,891,200; vision, 316,700.

Amateur Exhibition.—The R.G.S.B. is planning to hold the fourth Amateur Radio Exhibition at the Royal Hotel, London, W.C.1, from 22nd to 25th November.

Radio Officers.—The casualty rate among Marconi Radio Officers during the 1939-45 war was higher than in the Fighting Services—one man in six in the company's war-time staff of 6,000 radio officers lost his life. This fact was given by Sir George Nelson, chairman of the Marconi International Marine Communication Co., at the company's Jubilee banquet which was attended by some 200 guests, including representatives of State and the shipping and radio industries.

"British Plastics," our associate journal, is organizing a plastics exhibition and convention, in co-operation with the British Plastics Federation, to be held at Olympia early in June, 1951.

Television Society.—Attendances at the meetings of the Television Society have increased to such an extent that it has been decided to limit the number of visitors. Admission of visitors will in future be by ticket only, obtainable from the Lecture Secretary, 180 Bromley Road, Beckenham, Kent.

"B.B.C. Television Service" is the title of a 32-page booklet issued by the Corporation giving a short history of the development of television and a technical description of the present system This 2s booklet is obtainable from the B.B.C., The Grammar School, Scarle Road, Wembley.

FROM ABROAD

819-Line Television transmissions have begun from the new 300-watt station erected at Lille by Radiodiffusion Française. The frequencies are 185.25Mc/s, vision, and 174.5Mc/s sound. Horizontal polarization is employed.

German Amateurs.—A 28-page list of German amateur transmitters is included as a supplement to the 21st January issue of *CQ*, the official organ of the Deutcher Amateur Radio Club. The list includes German nationals only (DL1, 3 and 7) and not members of the occupying powers.

Television and the Cinema.—The growing affiliation between these two forms of entertainment in the United States is exemplified by the announcement that the American Society of Motion Picture Engineers, has changed its name to the Society of Motion Picture and Television Engineers.

Athens - New York direct phototelegraph service was recently opened by Cable and Wireless.

EXPORTS

British-Made Discs, with the trade name "London," are being marketed in North America by the London Gramophone Corp., which is a subsidiary of the Decca Record Co. In addition to the standard 78-r.p.m. records the company is also marketing long playing microgroove discs which are recorded, processed and pressed in this country by Decca. A recent report of the U.S. Dept. of Commerce states that the London Gramophone Corp. is importing 50% of all records going into the U.S.A.

Uruguayan Enquiry.—Tenders for three communications-type receivers covering all broadcasting bands—with charactersistics similar to the Hammarlund Super Pro 400X—two all-wave table models with band-spread tuning on short waves and two s.w. and m.w. battery portables with telescopic aerials, are called for by the Servicio Oficial de Difusion Radio Electrica, Montevideo. Tenders for six communications-type receivers are also being sought by the Direccion General de Communicaciones, Montevideo. Tenders must be presented in Spanish by accredited local agents. The specifications in Spanish are available for inspection at the Commercial Relations and Exports Department, Board of Trade, Room 1080, Thames House North, Millbank, London, S.W.1 (references CRE(IB)47165/50 and CRE(IB)47857/50).

Industrial Enquiry.—An Indian firm, intending to embark on the local manufacture of broadcast receivers, amplifiers, loudspeakers, and a few other accessories and components, wishes to hear from British firms willing to collaborate. Letters addressed under cover to the Editor, enclosed in a stamped airmail envelope, will be forwarded.

Belgian Congo.—Under the Belgian Congo Ten-Year Plan provision is made for the establishment of a wired wireless distribution system in the native city of Leopoldville for which a sum of Frs.612,000 has been provided. Catalogues, specifications and prices covering the supply and installation of the central receiver and erection of distribution wires should be sent without delay to the Gouvernement Général, 6ème, Direction Générale, Kalina, Leopoldville, Belgian Congo.

BUSINESS NOTES

Capacitors.—The production of trimmer capacitors by A. H. Hunt has been discontinued, and the tools and jigs for their manufacture have been acquired by Sydney S. Bird & Sons, of Enfield. The firm of A. H. Hunt is concentrating on fixed capacitors, and has opened a new factory at Wrexham, Denbighshire.

RCA Radar. — A low-priced radar set for small craft and an improved direct-reading Loran equipment, both recently announced by the Radiomarine Corporation of America, are to be distributed in this country by RCA Photophone, of 36 Woodstock Grove, London, W.12. The radar set has 30-kW peak power, works on 3.2cm and has 4 range scales (max. 20 miles).

Scope Laboratories — Australian manufacturers of the 6-second Scope soldering iron—notify us that their factory has been moved to 417, Keilor Road, North Essendon, Melbourne, W.6, Victoria, Australia.

Corner Ribbon loudspeaker described in our January issue is being demonstrated by Peter Hildesley, 73 Grosvenor St., London, W.1. (Tel.: Mayfair 6914).

"Testoscope."—Through a printer's error the voltage and price of the new popular model of the Runbaken "Testoscope" tester were incorrectly given in the advertisement on page 86 of our January, 1950, issue. Voltage should be 160/400, a.c. or d.c., and price 12s 6d.

Telegraphic Address of A. H. Hunt, Ltd., of Wandsworth, London, S.W.18, has been changed to "Capacitors, Put, London."

MEETINGS

Institution of Electrical Engineers

Commemoration of the Centenary of the birth of Oliver Heaviside on May 18th. "Heaviside, the Man," by Sir George Lee, O.B.E., M.C., at 3.0; "An Appreciation of Heaviside's Contribution to Electromagnetic Theory," by Prof. Willis Jackson, D.Sc., D.Phil.; "Heaviside's Operational Calculus," by Prof. B. van der Pol, D.Sc.; "Fifty Years' Development in Telephone and Telegraphy Transmission in Relation to the Work of Heaviside," by W. G. Radley, C.B.E., Ph.D., and "Some Unpublished Notes of Heaviside," by H. J. Josephs at 5.30.

Radio Section. — "A Million-volt Resonant-cavity X-ray Tube," by B. Y. Mills, B.Sc., B.E., at 5.30 on May 10th.

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

Northern Ireland Centre.—Faraday lecture on "Radar" by R. A. Smith, M.A., Ph.D., at 7.30 on May 2nd at the Wellington Hall, Belfast.

South Midland Radio Group.—"Some Electromagnetic Problems," by Prof. G. W. O. Howe, D.Sc., LL.D., at 6.0 on May 1st at the James Watt Memorial Institute, Great Charles Street, Birmingham.

British Institution of Radio Engineers

London Section.—"Multi - station V.H.F. Communication Systems Using Frequency Modulation," by E. G. Hamer and W. P. Cole, B.Sc., at 6.30 on May 25th, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Merseyside Section.—"History and Development of Rediffusion Systems," by M. Exwood, at 7 on May 3rd, in the Accountants' Hall, Derby Square, Liverpool.

South Midlands Section.—Visit to Sutton Coldfield television station May 27th.

Institute of Navigation

Symposium of papers on "Marine Radio Position Fixing Systems" at 4.0 on May 19th, at the Royal Geographical Society, 1, Kensington Gore, London, S.W.7.

British Kinematograph Society

"Motion Pictures for Television," paper prepared by the American Society of Motion Picture and Television Engineers at 7.15 on May 2nd at the Royal Society of Arts, John Adam Street, London, W.C.2.

Hull Electronic Engineering Society

"Electronic Counting Equipment" by Cinema-Television, Ltd., at 7.30 on May 12th, at the Electricity Showrooms, Ferensway, Hull.

THE

"Ohm's Law" of Electrostatics

Apparent Paradox of the Electrostatic Voltmeter

By "CATHODE RAY"

PEOPLE who teach electricity to those who intend to mess about with bells and lamps and kettles and even with motors usually rely heavily on water pipes and pumps for their illustrations, and fight shy of electrostatics. But if the instruction is with a view to radio, that won't do. For radio is full of capacitors, and people who have learnt to think of electricity only as currents can't cope with it. To them, a capacitor is just a break in the circuit.

So we radio people have to go through electrostatics—charged bodies, pith balls, and all. And if that seems too cobwebbed to be worth serious attention—well, perhaps that is why the behaviour of electronic circuits is sometimes perplexing. Although many people go along quite usefully for a time on a hazy idea of these fundamentals, sooner or later they get stuck. So I hope nobody will think the subject of the following discussion is out of place in *Wireless World.*

One of the first things we are taught in electrostatics is "Like charges repel ; unlike charges attract." The pith balls and gold-leaf electroscopes are brought in to demonstrate the truth of these statements, and (provided the teacher has had the supreme good luck to hit on a nice dry day for it) the repulsion and attraction are duly demonstrated. Irrespective of whether the demonstration was a success or not, however, we are faced with the unanimous ruling of the wise men that two charges, q_1 and q_2, concentrated at points separated by a distance d, repel one another with a force equal (if the right units are used) to $\frac{q_1q_2}{d^2}$

(To avoid unnecessary complications we shall assume the permittivity is 1 every time.)

If q_1 and q_2 are like charges—both negative *or* positive—the result is positive ; but if they are unlike charges it is obviously negative, and of course a negative repulsion is an attraction.

Although charges concentrated at points are impossibilities, so that nobody can demonstrate the above law accurately by direct experiment, indirect methods of proof have been quite successful.

So far so good. We go ahead and draw imaginary lines coming out of positive charges and ending on negative charges to represent the electric field with its attractive force, and learn that there is a continuous fall of potential along them. We also learn that if the opposite charges are on parallel metal plates the plates attract one another, with a force proportional to the square of the voltage between them, and that this is the principle on which the electrostatic voltmeter works. An electrostatic voltmeter is really just a small variable capacitor, with one set of plates so delicately mounted that even the very small attractive forces that arise in practice make the plates move and indicate the voltage. Since the force is proportional to V^2, it makes no difference whether the voltage is $+V$ or $-V$.

The first feelings of uneasiness may occur when one hears it explained that it is only the *difference* of potential that counts, and that although +100 volts is a high potential relative to −100 V or even 0 V, it is at the same time a low or negative potential relative to +200 V. If, then (we say to ourselves) the potential difference and hence the attractive force between any two bodies is the same, regardless of whether their respective potentials are −50 V and +50 V, 0 and +100 V, or +100 V and +200 V, what happens to the doctrine that "like charges repel"? Or, sticking to that doctrine, so convincingly demonstrated, what about the electrostatic voltmeter? Can it be used to measure the voltage across the anode resistor in Fig 1, which has both its ends positive? Or will its pointer move backwards off the scale because its plates, bearing "like charges," repel one another? If so, what happens when the earth is disconnected? And does the voltmeter still refuse to work properly if one terminal is at +0.001 V and the other at +600.001 V? If not, why not? And are you still perfectly clear about the whole affair? If you are not, you may care to read on.

What is meant by an electric charge? There are various ways of defining or describing it. One may think of charges as the things which, when in motion, are an electric current. Electrons are (or carry) small negative charges. But the mere presence of electrons is not enough to charge anything. Generally there are equal numbers of positive particles, which cancel out the external influence of the electrons, so that no electrical effects can be detected. A single electron by itself is a very minute negative charge, and behaves in the special ways which we describe as electrical. So does a unit composed of

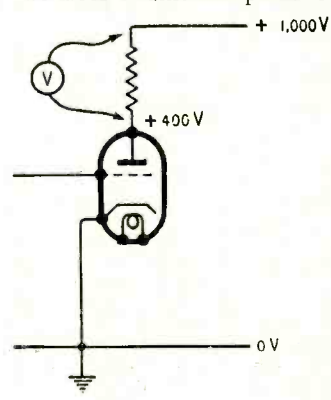


Fig. 1. Can an electrostatic voltmeter be used to measure the voltage between two points of the same sign?

1,000,001 electrons and 1,000,000 positive particles —except, of course, that its greater mass prevents it from moving about as nimbly as an unattached electron. Similarly, one positive particle (such as an ion), or a combination of 1,000,000 positive particles with 999,999 electrons, is a minute positive charge.

The important fact about charges is that there is a force of attraction between opposite kinds, tending to bring them together again into the neutral or unelectrified state. Hence the attraction between oppositely-charged pith balls, or plates of an electrostatic voltmeter. If you want to charge anything—that is to say, to separate negative from positive particles—you have to use an electromotive force, reckoned in volts, to do it, and in doing it you set up a back voltage tending to discharge. This back voltage is generally called the difference of potential between the two places where the separated opposite charges have been made to go, and the routes along which the attractive force between them acts are called lines of force.

The difficulty about really fundamental things like electric charges is that there is nothing more fundamental that can be used to describe them. If you have to give a detailed description of a building, it is quite easy. You can say how many bricks or stones compose it, and how they are arranged, and what materials are used for decoration, and so on. You can take for granted people know what bricks and paint and paper are. But it is more difficult to describe the raw materials; and the difficulty increases the farther back the inquiry is pressed. When it comes to describing electrons, we can say a lot about what they do, but really nothing at all about what they *are*. For us to do that, they would have to be made of still more elementary parts, and so far as we know they aren't. So fundamental things can only be discussed in terms of mental pictures, analogies, mathematical "concepts," etc., such as "lines of force." This is very helpful in enabling people to make practical use of things they really don't understand. The fact that nobody knows what electrons are has not prevented millions of people from making use of them in most complicated and ingenious ways—in radio sets, for example. Usually all concerned manage to agree to use the same mental pictures when they discuss these fundamental things or perform the calculations necessary to exploit them to the best advantage.

Although these concepts are so helpful, and it is difficult to see how we could carry on engineering and other applied sciences without them, they are dangerously liable to mislead us into accepting them as realities. It is rather like a clerk at some head office, whose life is so bound to his figures of manpower and output that he forgets that they are only artificial symbols of the real things in the factory.

Lines of force, for example. We know by experiment that exceptional things happen in the space around what we are pleased to call "electrically charged bodies." We just don't understand why or how these things happen, but it has been found by careful study that they always happen in certain definite ways and with certain numerical relationships. So scientists have defined various quantities such as charge and potential, and have enunciated various "laws" connecting them, and to help you and me to grasp these they have imagined such things as lines of force. Owing to the care with which these things have been defined, they make up a consistent system, and one can work about with them and design electrical appliances and predict their performance with confidence. But they are quite arbitrary. If there are beings in Mars who have studied these things they may have quite a different way of thinking about them, yet leading to the same results.

So with this is mind, let us look into the charge and potential question.

We had got as far as the basic fact that we can't have one without the other. Suppose you have a light tinfoil-covered ball suspended in the room by an insulating thread. To charge it, you have to apply an e.m.f., as in Fig 2. What the e.m.f. of the battery does is to remove electrons from the ball and transfer them to earth. These electrons still maintain their mysterious bonds of affinity with their positive partners left on the ball, and calling these bonds "lines of force" helps us to visualize them but doesn't actually explain anything. What we do know is that they show up as a voltage—a "potential difference"—between ball and earth; and when enough electrons have been transferred to make this p.d. equal to 1,000 volts (in this case) the current ceases, because the battery can't hold back a greater voltage than its own. We say the ball is charged to + 1,000 V. It would be equally true to say that the earth is charged to − 1,000 V (relative to the ball); but nobody *would* say so, because it has been agreed, for general convenience, to refer all potentials t earth, whose potential is arbitrarily called zero Except with this understanding, it is meaningless to say anything has a certain potential. All we can

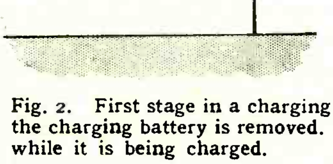


Fig. 2.

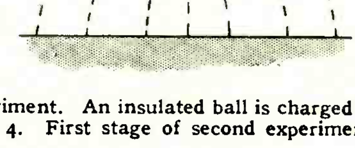


Fig. 3.

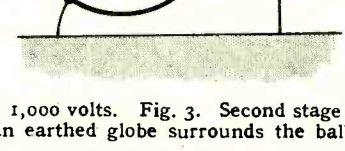


Fig. 4.

Fig. 2. First stage in a charging experiment. An insulated ball is charged to + 1,000 volts. Fig. 3. Second stage: the charging battery is removed. Fig. 4. First stage of second experiment: an earthed globe surrounds the ball while it is being charged.

Fig. 5. Second stage, corresponding to Fig. 2. Fig. 6. First stage of third experiment: the globe is at + 1,000 V. Fig. 7. Second stage: the globe is charged, but the ball is uncharged *although it is at a potential of + 1,000 V.*

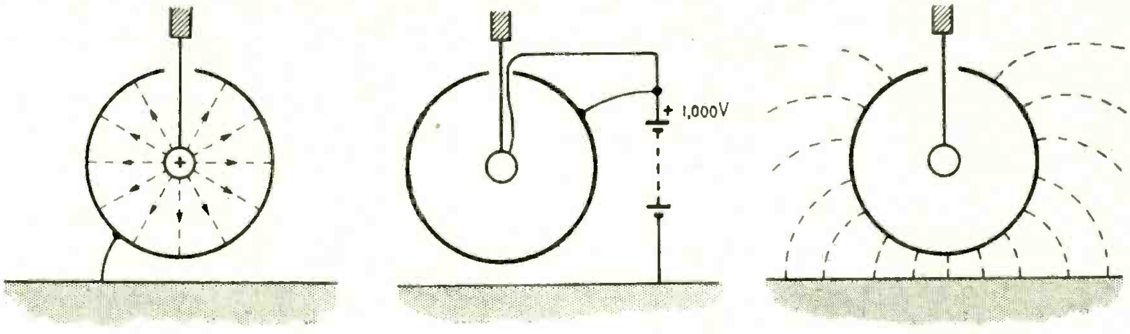


Fig. 5. Fig. 6. Fig. 7.

know is that there is a certain potential difference between it and earth or any other specified location.

By taking note of the amount and duration of the charging current, we could measure the charge needed to cause the p.d. of 1,000 V. The amount of charge needed to set up a given p.d. is very important in practice, and has been given the special name "capacitance." If the 1,000-V battery transferred 24,960,000,000 electrons (= 0.004 microcoulomb), the capacitance would be 0.004/1000 microfarad, or 4pF. The bigger the ball, and the closer to earth, the greater the capacitance. That part of the story is likely to be familiar to all readers; in fact, people who work much at radio and kindred arts soon find themselves able to visualize capacitance and estimate its magnitude far more readily than the potentials and charges themselves. It is therefore a particularly valuable "concept." The relationship which expresses it, $C = Q/V$ (where Q is the charge and V the p.d.) is about as important in electrostatics as $R = E/I$ in current electricity.

In Fig 3 the battery has been removed; and as the connection to earth has gone with it the electrons have been unable to get back, and the ball remains charged to + 1,000 V. To emphasize this, a few lines of force have been dotted in. They show the paths electrons would take if they were free to fly across the space from earth to ball. (Unfortunately the conventional plus-to-minus arrows point in the opposite direction.)

Next, suppose the experiment to be repeated with the ball at the centre of a hollow metal globe connected to earth (Fig 4). The result (Fig 5) will be very much the same, except that all the lines of force will end on the globe. They could not go through it to earth, because a line of force between globe and earth would indicate a p.d. between them, and that is impossible so long as there is a connection of negligible resistance between the two, making the potential of the globe the same as that of earth. Exact measurement would show that the charge was greater this time, indicating a greater capacitance. That is a well-known result of shortening the lines of force.

Lastly, after having taken care to discharge the ball by earthing it, repeat the experiment with the globe connected to + 1,000 V. (Fig 6). This time it will be found that the ball won't charge at all. No charging current flows through the connection to it from the battery, though of course a comparatively large current will have flowed into the globe to charge it to 1,000 V. But since the ball and the globe are at the same potential, there can be no lines of force between them, so no charge on the ball. This agrees with our "law," $C = Q/V$, in the form $Q = VC$, which indicates that zero V between two things with capacitance to one another (such as the globe and the ball) necessarily means zero charge. Looked at another way the ball has no capacitance to earth (because screened by the globe), so that even when there is a V to earth there can be no Q.

Charge and Potential

So we see that being at a high potential (to earth) doesn't necessarily mean being charged. If the surroundings are at the same potential there can be no charge, and so no forces. For example, the fact that both sides of the electrostatic voltmeter in Fig 1 are positive to earth need not mean that they are both positively charged. With a little care in arrangement, any question of repulsion and consequent errors in readings can be kept out of it, without limiting the use of the instrument to points that are of opposite potential to earth.

Suppose we have two parallel plates, with a p.d. of 100 V between them. This will cause a certain attractive force, tending to pull them together. What we want to be quite clear about is what difference it makes if the plates are at, say, + 50 and − 50 V, + 100 and 0V, or + 200 and + 100 V.

Fig 8 shows the first of these. The battery main-

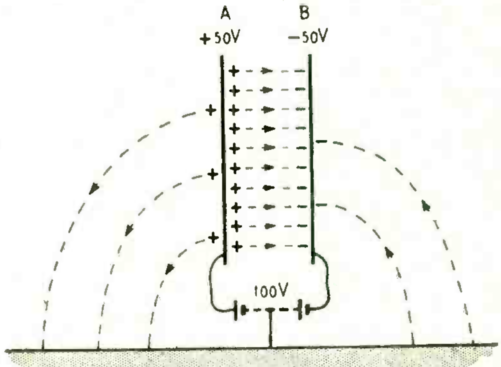


Fig. 8. State of charge when two plates, with a p.d. of 100 V, are respectively positive and negative to earth. A is assumed to have a larger capacitance to earth than B.

tains the 100-V p.d., and if we know the capacitance between the plates the charge follows from $Q = VC$. Suppose it is 10 units, each represented in the diagram by a + and − sign with a dotted line of force linking them.

So much for the internal situation. Externally, A has a certain capacitance to earth, and is being held at + 50 V with respect to it; so it must have received an additional charge. If the capacitance of A to earth is, say, 0.6 times its capacitance to B, this charge will be 3 units, as indicated. (Remember the p.d. to earth is only half that to B.) Similarly, if the capacitance of B to earth was 0.4 times its capacitance to A, it would have an additional negative charge of 2 units. These external capacitances are larger than would be likely in practice, in order to make the diagrams clearer. But the principle is the same whatever the values. So besides being attracted to one another, A and B will be attracted to earth (in its widest sense). The net attraction between A and B is reduced by the capacitances to earth. If A and B were the plates of an electrostatic voltmeter, such counter-attractions would cause variable errors unless precautions were adopted.

Fig 9 shows the plates with the same p.d. between them, but the potentials to earth are 100 V and zero respectively. So there is no extra charge on B, but A has to carry twice as much as before. Considering only the "internal" charges, the fact that B carries as many units as A, although it is at zero potential while A is at + 100 V, may seem rather strange. But the capacitance between B and earth, when they are short-circuited, is infinitely great, so any charge on B is possible without p.d. to earth.

In Fig 10 both plates are positive; but as there is the same p.d. between them as before, the internal situation is unchanged. Compared with Fig 9, the external charge on A is doubled, owing to the doubled voltage; while now the external charge on B is positive. The net charge on B is therefore only 6 negative units; the remaining 4 needed for internal affairs are derived from a separating-out of the electrons and positive ions composing B.

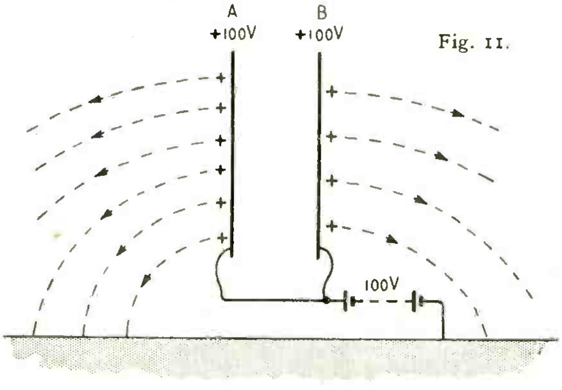
If A were the moving plate of a voltmeter, it would be attracted more strongly to the surroundings than to B, so would read lower than zero! If, on the other hand, it were the fixed plate, the external attraction wouldn't matter. Making B the moving plate would be all right so long as it was earthed, as in Fig 9. But at any other potential, as in Figs 8 and 10, there would be error due to the counter-attraction of earth. This can be overcome, however, and the instrument made suitable for use under conditions such as Fig 1, by surrounding the moving plate with a metal screen connected to the fixed plate. This makes the counter-attraction always the same at any scale reading, so that it can be allowed for in the calibration.

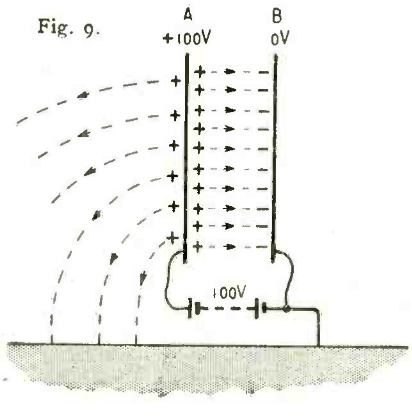
Just to complete the series we might add Fig 11, showing the situation with zero p.d. between the unscreened plates. Here all the lines of force have external destinations, so the plates tend to be drawn apart.

When considering the experiment illustrated in Fig 6, we noted that connecting the globe to + 1,000 V put the previously earthed ball in such a condition that no charge moved on to it when it was connected to + 1,000 V. Seeing that the ball has appreciable capacitance, this can only mean that connecting the globe to + 1,000 V also raised the potential of the entirely insulated ball from zero to + 1,000 V. This, of course, is one of the most popular uses of capacitance—to alter the potential of some part of a circuit without any conducting path.

Yet another deduction from $V = Q/C$ may be of some interest even though it is not often used. Suppose you charge a capacitor and then take it to pieces by pulling the plates apart; what happens to the charge? Well, assuming the insulation remains perfect, so that the charge cannot escape, the only possible result of forcibly decreasing C is for V to rise. So if you want a higher voltage than any you have got, charge a capacitor and then remove one side of it into mid-air!

In any event, put $V = Q/C$ alongside Ohm's Law in your primary kit of mental tools; it is a great help in all these problems.





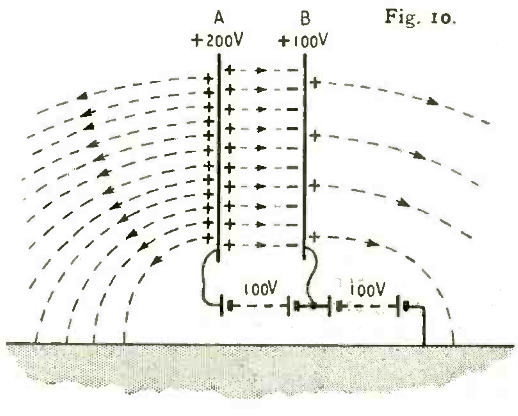


Fig. 9. Same p.d. between plates as in Fig. 8, but one plate earthed.

Fig. 10. Same p.d. between plates, but both positive to earth. Part of the negative charge on B is derived from itself.

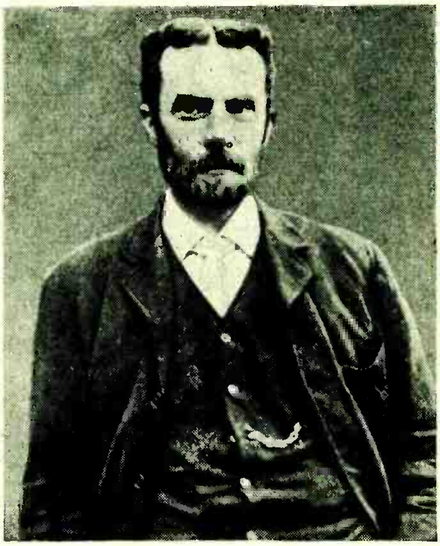
Fig. 11. No p.d. between plates; both positive to earth.

Oliver Heaviside and His Layer

An Appreciation of His Work

By SIR EDWARD APPLETON, F.R.S.

THIS month the world of science and engineering is celebrating the centenary of the birth of Oliver Heaviside, mathematical genius and one of the pioneers of electrical communication. It is therefore fitting that some reference to Heaviside's contributions to radio science should be made in *Wireless World*, Britain's oldest wireless journal. Oliver Heaviside was born on May 13th, 1850, at 55, King Street, Camden Town, and died in Torquay on February 4th, 1925. His aunt was married to Sir Charles Wheatstone, the pioneer of electric telegraphy, while his brother was a divisional engineer of the British Post Office, stationed at Newcastle-on-Tyne; so that Oliver, as a youth, was stimulated by a scientific atmosphere of electrical interest. Until fairly recently there was some obscurity concerning the record of Heaviside's doings in his early twenties, but it now seems clear that he actually served as a telegraph operator in the Great Northern Telegraph Company, working at the Newcastle station of the company which operated a cable to Denmark. It was during the four years of his service with the telegraph company (1870-1874) that Heaviside began to publish papers on telegraph theory. He was associated during the same period with his brother in conducting experiments on duplex telegraphy, first over an artificial line and later between Newcastle and Sunderland. But his interests were more theoretical than practical and, in 1872, he started the publication of a stream of papers, mainly fairly short and appearing principally in *The Electrician* and *Nature*, which continued for forty years. These papers were concerned with the propagation of variable currents through wire circuits and the propagation of electric waves through the ether of space, as well as with the development of his own new and vigorous methods of solving differential equations, especially those representative of electrical circuits.



Oliver Heaviside, 1850-1925.

When Heaviside was 38 years of age Heinrich Hertz in Germany succeeded in generating and detecting electric waves. We know that the two men corresponded on scientific matters in a most friendly manner though it seems that they never met in person. Heaviside, of course, lived through the heroic age of the birth and early development of practical radio communication and doubtless pondered a great deal about the question of the propagation of radio waves round the spherical shape of the earth. Indeed, we know that a mathematical friend, G. F. Fitz-Gerald of Dublin, actually put the problem directly to him in 1899 when people were actively discussing whether Marconi's success in communicating over short distances might yet be crowned by the achievement of trans-Atlantic radio transmission. It is not, however, known whether or not Heaviside worked mathematically at this problem of electric wave diffraction round a conducting earth. All that is available at present in the way of record in this connection is Heaviside's famous suggestion concerning the possible existence of an electrical conducting layer in the higher atmosphere which would facilitate round-the-earth transmission. This occurs in his remarkable article entitled "Theory of Electric Telegraphy," written in June, 1902, and published in the tenth edition of the "Encyclopædia Britannica." The significant passage reads: "There may possibly be a sufficiently conducting layer in the upper air. If so, the waves will, so to speak, catch on to it more or less. Then the guidance will be by the sea on the one side and the upper layer on the other." In the language of to-day it would appear that Heaviside pictured the space between the spherical surface of the earth and the lower surface of the upper-atmospheric conducting shell as a wave-guide, which, as we now know, will transmit all wavelengths of value less than $2h_0$, where h_0 is the distance between the conducting ground and the conducting layer.

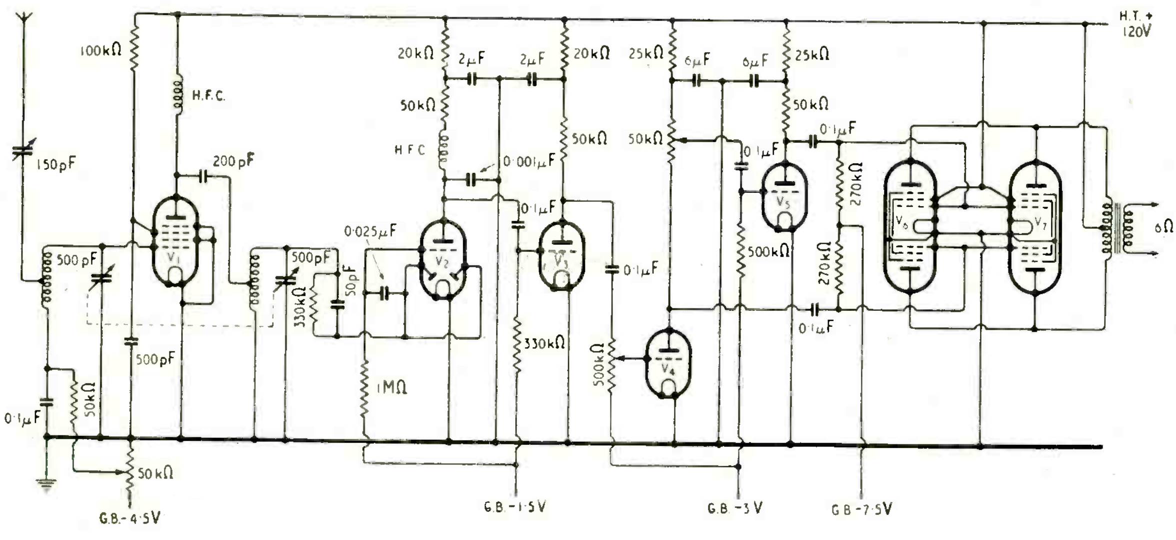
Heaviside was not alone in postulating the existence of an upper-atmospheric conducting layer which facilitated long-distance radio propagation. A similar suggestion was made by Professor A. E. Kennelly of the United States about the same time; and, now that we know such a layer actually exists, it is known as the Kennelly-Heaviside Layer. Its existence was proved directly by observing the succession of signal interference maxima and minima produced at ground level by the direct and reflected rays when the wavelength of a transmitter was gradually varied through a known amount. The height of the Kennelly-Heaviside Layer (or E Layer, as it is often termed) was found to be of the order of 100km above ground level. It should, however, be pointed out that it was Heaviside's suggestion rather than the even more detailed formulation of Kennelly that prompted in this country all the early radio work on the ionosphere, as the complex of ionized layers is now termed. Especially important in stimulating my own interest in the subject was the theoretical work of Dr. W. H. Eccles who gave precision to Heaviside's suggestion by expressing it in a modern form, accounting for the layer conductivity in terms of electrons and ions. Also, so far as I am aware, Eccles was the first to use the term "Heaviside Layer."

Nowadays the ionosphere is subjected to an hourly sounding of its characteristics at many places all over the world; for, over the last quarter of a century, we have learned how to find the electron concentrations in the various ionized layers, and also how to relate such results to the processes whereby radio waves are reflected and refracted at different ionospheric levels. As a result of this work the subject of ionospheric forecasting has deveoped, whereby it is possible to indicate in advance to the radio-communication engineer the range of radio frequencies likely to be most effective in transmission from one place to another, in any part of the world, at any time and over any distance.

But the original stimulus to all these developments came, as I have said, mainly from Heaviside. As also in the case of his work on operational mathematical methods, Heaviside said the first word about something that many others later developed and extended. That is characteristic of a genius.

Economical Battery Set

For High Quality Reception of Local Stations



DESIGNED by L. Thomas, this straight receiver will give a maximum power output of 3-4 watts for an average h.t. consumption of under 10 mA and an l.t. consumption of 1 amp. Decoupling is sufficient to maintain stability until the h.t. battery voltage falls from 120 V to 90 V.

Since reception of only a few local stations is required, the selectivity given by the two tuned circuits is ample, provided that the series aerial capacitor is adjusted for optimum results. The diode detector plus amplifier, using a double-diode triode (V_2), was adopted because it was found to give better quality than a leaky-grid detector, for the same filament consumption.

The triode phase-splitting circuit does not contribute to the gain of the receiver, but gives markedly better quality than the usual q.p.p. driver transformer. No correction circuits for attenuating high frequencies are used on the two double-pentodes, because these valves are in parallel, and consequently have a low joint impedance which automatically reduces loudspeaker resonances. In any case, a certain amount of top accentuation is desirable to balance the extended bass response given acoustically by the loudspeaker. This is a 12in dual suspension model by Sound Sales, Ltd., in a "phase inverter" cabinet. The output transformer is the *Wireless World* model, marketed by M.R. Supplies, Ltd.

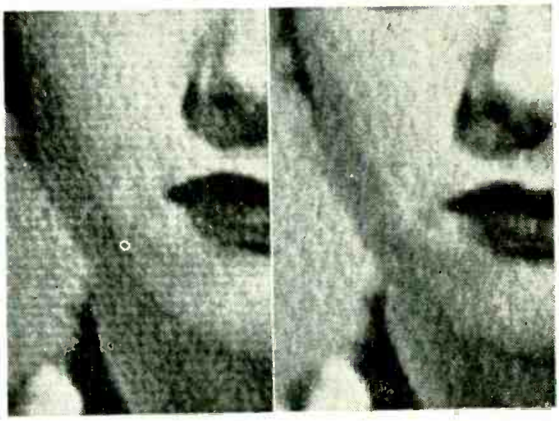
A list of the valves used is given below. Unfortunately these have now become "obsolete" or "replacement" types, so in case there should be any difficulty in obtaining them, the "current" types in brackets are suggested as suitable alternatives.

V_1	:	Mullard VP2B	(Cossor 210VPA or (Mazda VP23).
V_2	:	Mullard TDD2A	(Mazda HL23DD).
V_3	:	Mullard PM2HL	(Marconi HL2).
V_4, V_5	:	Tungsram LD210	(Marconi HL2).
V_6, V_7	:	Cossor 240QP	(Mazda QP25).

More About Spot Wobble

Removing "Lininess" from Television Pictures

By T. C. NUTTALL *(Cinema-Television, Ltd.)*



Enlarged sections of a television screen picture ; one with and one without spot wobble.

THOUGH I am fully in agreement with R. W. Hallows as to the benefits arising from television "spot wobble," in the March *Wireless World*, I cannot entirely agree with the explanation given in that article. What I regard as the correct explanation involves some unusual conceptions, and it is hoped this article will clear up misunderstandings.

Spot-wobbling is an old idea, but in recent years three important applications have been found for it. These are:—

(1) To cover up some faults liable to occur with certain methods of recording television pictures on film.

(2) To reduce screen saturation effects in high-power c.r. tubes for large-screen projection systems, and

(3) To remove objectionable line structure effects from large, bright, directly viewed television pictures of high quality. It is this third application which has, naturally, excited the widest general interest, and is the one with which we shall be mainly concerned in this article.

Before we can hope to understand how spot-wobble works, we must have a clear idea of the nature of the defects which we intend to correct. I am going to start, therefore, by showing that the simple explanation of interlacing, as normally given, is insufficient to describe all that actually takes place in practice.

In an interlaced system, as we all know, the odd-numbered and even-numbered lines are scanned in separate frame traversals, spaced in time by one-fiftieth of a second; the process is repetitive, so that the full complement of lines will be scanned in any two consecutive traversals. If our circuits and apparatus are working properly the scanned lines will be accurately interlaced on the c.r. tube screen. This, however, is by no means the whole story: accurate interlacing in the observer's eyes involves the two further factors of persistence of vision and fixation of the eyes.

The odd and even lines are presented to the observer as two flashes separated in time by one-fiftieth of a second. He can get the impression of an interlaced set of lines only if his persistence of vision is sufficient to "store" the visual information for the required time.

Now the persistence of vision is very much affected by the brightness of the object being observed, as is shown very clearly by the relations between brightness, frequency and flicker. The earliest television systems used a frame frequency of 12½ per second, but that was when the pictures were very dim. As the brightness was increased it became necessary to raise the frame frequency to 25 per second and later to 50 per second to avoid flicker. C.r. tubes have improved so much in the last few years that the limit to the brightness we can now use is once more determined by considerations of flicker. (The Americans can use more brightness than we can because their frequency is 60 instead of 50).

We are obviously working in a range of brightness where persistence of vision is no longer sufficient to give the observer the impression of a set of interlaced lines. Instead, he gets the impression of a set of lines (only half of the full number) which *change their position* at each flash. If he allows his eyes to follow the movement he will see this half-set of lines crawling up or down the picture at a rate which will cause them to travel the full height of the picture in about 7½ seconds. This is what I shall refer to as the "crawling line" effect. Even if persistence of vision does not fail us we must still recognize that the observer must keep his eyes still if he is to see the odd and even lines in their correct relative position. But the observer will not keep his eyes still—he will want to follow the movements of objects in the picture. Whenever the observer's eyes are moving up or down he will lose the effect of the interlace, and if the rate of movement approximates to the crawling rate he will become acutely aware of the crawling line pattern. This effect is probably seen at its worst when the B.B.C. wind their titles and captions slowly up the picture, often at the most objectionable speed!

These effects may not appear very serious on a c.r. tube with a poor focus, but then, of course, the general definition will be poor. It is only when we have taken some trouble to produce a bright, sharply focused picture that we realize the seriousness of the crawling line effect. With a good focus, the black-to-white contrast in the crawling line pattern is greater than any contrast in the picture details.

The B.B.C. pictures contain, nominally, 377 active lines, or, say, 188 per frame. When we complain of "lininess" we can be reasonably sure that the 188 crawling lines are to blame—the 377-line pattern is too fine to be objectionable—so we must concentrate our attention on removing the effects of the 188-line pattern.

We may expect that any method of removing the 188-line pattern must also cause a reduction in the picture definition. This generalization is true only in a qualitative sense, for we shall find that the possible methods differ considerably in the extent to which they spoil the definition. We are, obviously, seeking the method which does the least damage.

We might consider the use of c.r. tubes with elliptical or rectangular spots, or astigmatic focusing systems, etc., but we can reject all these on various grounds. The size and shape of c.r. tube spots are very ill-defined quantities which vary with brightness, and any attempt to put tight limits on them would produce enormous difficulties in design and manufacture. In any case we should find that these solutions do not satisfy our "minimum damage" condition. The required solution must be more cunning than these.

Heterodyne Whistle Analogy

At this stage I would like to introduce a useful analogy with the 9-kc/s heterodyne whistle in an ordinary radio sound receiver. The whistle is unimportant in a poor set, but it comes into prominence when we take steps to improve the "top" response. When this happens, the designer puts in a "whistle filter," and if the filter is sufficiently selective the whistle is cut out with only a small degradation of the sound quality. Our 188-line pattern is a rather close analogue of the heterodyne whistle. It is a pattern, with a clearly defined spacing, which is interfering with our enjoyment of the picture. The first clue which we get from this analogy is that we should take advantage of the regularity of the pattern to use some device which operates to remove this particular pattern in a selective manner.

Suppose that we could produce a c.r. tube with a double spot, so that each line scan would draw two lines, and 188-line scans would draw 376 lines. If the spots were the right distance apart (half the normal pitch of the 188 lines) the 376 lines would be equidistant and all signs of the 188-line structure would have disappeared (see diagrams A and B).

This is obviously a selective system, and it can be shown that it is the most selective system which is theoretically possible. (Our selectivity is limited, compared with the "whistle filter," by the fact that we cannot produce "negative light" on the screen corresponding to the negative half cycles of ripple which can be produced in an electrical circuit).

This theoretically ideal system cannot be used in practice because we cannot make the c.r. tube with the required double spot. At this point we introduce the idea of spot-wobbling. If we could take a tube with a single spot and wobble this spot with a *square wave* wobble so that the spot occupied one position for half of the cycle and another position for the other half, and if, further, we could make the frequency of the wobble sufficiently high, then the tube would behave in all respects as though it had a double spot (see diagram C). This idea avoids the difficulty of making a special c.r. tube, but it is still not practicable, since there is no possibility of producing a square wave deflection at the frequency required (say about 10 Mc/s). All we can expect to obtain at this frequency is a sine-wave deflection.

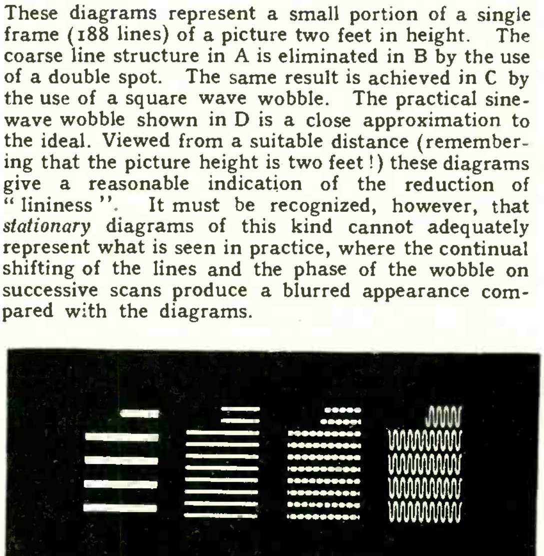
In a sine-wave wobble, the spot is travelling slowly at each end of its travel and is not actually at rest for any appreciable part of the cycle, also it wastes some time, compared with a square wave, in crossing from one side to the other. Nevertheless, the sine-wave wobble gives us a close approximation to a double spot and accurate calculation shows that it is not far short of the ideal. The sine-wave wobble is therefore both practical and a close approximation to the ideal (see diagram D).

The required amplitude of wobble is of considerable interest. It is easy to see that with a square-wave wobble the peak-to-peak amplitude should be half the 188-line pitch, and we would expect the sine-wave wobble to require a somewhat greater amplitude. Accurate calculation (see Appendix) shows that the correct peak-to-peak amplitude is 0.7655 (or, in round figures, say three quarters) of the line pitch.

The correct amplitude is a well-defined quantity; there is nothing arbitrary or empirical about it. If we use a whistle filter in a sound receiver we obviously tune the filter to the whistle frequency. Similarly, if we spot-wobble there is no point in using any other than the correct amplitude. Note that the correct amplitude depends only on the line pitch; it is not affected in any way by the size of the unwobbled spot.

The spot-wobbler can use any frequency between 8 and 10 Mc/s (there is nothing to gain by exceeding 10 Mc/s) but from a practical point of view care should be taken to avoid frequencies likely to produce harmonic interference (e.g., 9 Mc/s, whose fifth harmonic at 45 Mc/s might interfere with the radio receiver). Power requirements are very low, and one very small oscillator valve should be adequate. The biggest practical difficulties arise in connection with screening and decoupling to prevent the whole frequency finding its way to places where it is unwelcome. It is important to avoid any brightness modulation which might destroy the brightness equality of the two "equivalent spots," and so pre-

These diagrams represent a small portion of a single frame (188 lines) of a picture two feet in height. The coarse line structure in A is eliminated in B by the use of a double spot. The same result is achieved in C by the use of a square wave wobble. The practical sine-wave wobble shown in D is a close approximation to the ideal. Viewed from a suitable distance (remembering that the picture height is two feet!) these diagrams give a reasonable indication of the reduction of "lininess". It must be recognized, however, that *stationary* diagrams of this kind cannot adequately represent what is seen in practice, where the continual shifting of the lines and the phase of the wobble on successive scans produce a blurred appearance compared with the diagrams.



A B C D

vent the accurate balancing-out of the 188-line pattern.

Major Hallows wrote enthusiastically about the results produced by spot wobbling, and his reactions are typical of observers who have seen pictures on a 20-inch tube supplied for demonstration purposes with the Cintel film scanner installed at Alexandra Palace in May, 1949. When the lininess is removed, observers voluntarily reduce their viewing distance in a ratio of about two to one, which far more than compensates for the slight theoretical loss of definition produced by the spot wobble. The 405-line system is then found to give a very satisfactory degree of definition. It seems probable that the advocates of the so-called "high definition" systems (say 800 lines or so) are expressing their desire for less lininess rather than for more definition. With only a fraction of the complication and expense, spot-wobbling goes a long way towards satisfying this desire.

"Canned" Television Programmes

The other applications of spot-wobbling, although not, perhaps, of such wide general interest, are worthy of brief mention. In recording television pictures on continuously moving film (which method is used, for example, by the B.B.C.) it is often difficult to ensure accurate interlacing, on the film, of the two sets of lines forming each complete picture. The problem is primarily one of optical and mechanical accuracy in chasing the moving film, but is complicated by the rather unpredictable dimensional shrinkage of the celluloid base of the film. Any inaccuracy will result in a "pairing" of the recorded lines. (This will not be discovered until the film is developed, when, of course, it is too late to make any correction!) This defect is shown clearly in the photograph used to illustrate Major Hallows' article. If such a picture were scanned again for re-transmission serious "beat" patterns would result from interference effects between the original and the new scanning lines. Spot-wobbling can be used to avoid this trouble, and the small loss of definition which results is less objectionable than the beat patterns.

The other photograph was intended to show the effect of spot wobbling, but on examination it will be found that definition is lacking in both *horizontal and vertical* directions. Now a spot-wobble can cause loss of definition in *only one* direction, so it must be concluded that the loss of definition in this photograph was not caused by spot-wobbling. I would like to emphasize that this photograph is definitely misleading, as the loss of definition which would be produced by a correctly adjusted spot-wobbler would be so small as to be almost undetectable in a photograph of this size.

In high-power c.r. tubes used for projecting cinema-size television pictures the current density in the scanning spot is more than one hundred times greater than in an ordinary c.r. tube, and produces considerable saturation effects in the fluorescent material. This gives rise in turn to variations in brightness and colour; the latter, in particular, can be rather objectionable. These troubles can be largely overcome by the use of spot-wobbling which has the effect of reducing the current density and making it less critically dependent on exact focusing conditions, in addition, of course, to its normal effect of reducing or eliminating lininess. However, the non-linear nature of the saturation effects rules out any simple mathematical analysis of the problem so that, in this case, the optimum amplitude of wobble is determined by a process of judicious trial and error.

These modern applications of spot-wobbling were developed, in 1947-48, in the laboratories of Cinema-Television, Limited (who had acquired the patent rights in 1946). So far, spot-wobbling has been used mainly for high-quality demonstrations; as far as I am aware it has not yet been applied to any commercial television receivers, though this may be expected to follow in due course. A word of caution is perhaps not out of place here—spot-wobbling will not cure all television troubles. It will not turn a mediocre picture into a good picture, but it can and does turn a good picture into an excellent picture.

APPENDIX

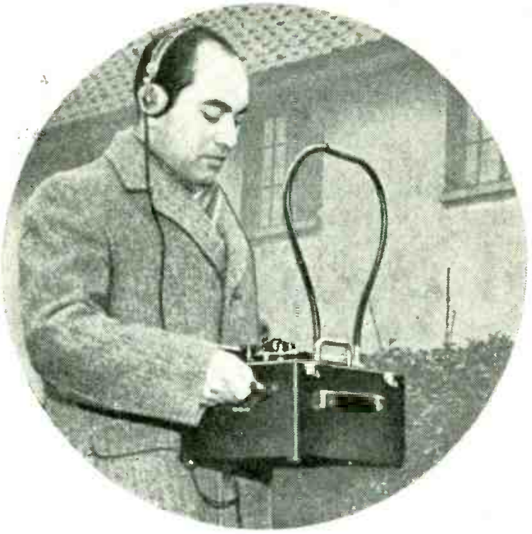
As the line spacing is regular, the screen brightness is a periodic function of distance measured across the lines and may be expressed as the sum of a mean brightness plus a fundamental (188-line) cosine component plus harmonic components (376 lines, 564 lines, etc.). We are interested in making the fundamental (188-line) component disappear; i.e., we want to make it have zero amplitude. The amplitude of any component may be found by the standard method of Fourier analysis; i.e., we multiply the brightness distribution by the appropriate cosine wave and integrate over one cycle to determine the mean value of the product. If we perform this operation on the brightness distribution of a wobbled spot we find that the integral turns out to be a standard form of the Bessel function $J_0(x)$ where x/π in our case is the ratio of the peak-to-peak wobble to the line spacing. The fundamental (188-line) component will disappear when $J_0(x)=0$. On referring to published tables of the Bessel functions we find that $J_0(x)=0$ when $x/\pi=0.7655$.

Television O.B. Links

At a recent discussion meeting of the Radio Section of the Institution of Electrical Engineers, it was emphasized that developments in television outside-broadcast technique were continually calling for new types of equipment. Also, increasing demands were being made for means whereby the vision signal could be passed to the transmitter. Before the war some 17 miles of low-loss balanced-pair cable had been laid in the London area; this has since been supplemented by 33 miles of coaxial cable. Connections to this 50-mile cable network can be made, up to distances of a few miles, through ordinary telephone circuits fitted with equalizers and amplifiers. This cable system is now used by the B.B.C. for about half the outside broadcasts, the remainder being passed by a radio link, which has a range of about 30 miles; this range could be extended by using links in tandem. The idea of "breaking in" to intermediate stations of the London-Birmingham radio relay link, though technically practicable, was not envisaged.

To reduce setting-up time, a certain amount of permanent wiring has been installed at places from where outside broadcasts were regularly relayed. Camera cables, however, could not be permanently fitted, as there was danger of deterioration.

As to the outside broadcast equipment itself, it was agreed during the discussion that it could undoubtedly be reduced in size, but the opinion was expressed that this would not greatly shorten the time needed for setting up. The link to the transmitter remained the most important factor.



The author operating the interference tracer.

Television Interference

Tracing an Unusual Source

By A. L. PARSONS, Grad.I.E.E.
(Murphy Radio)

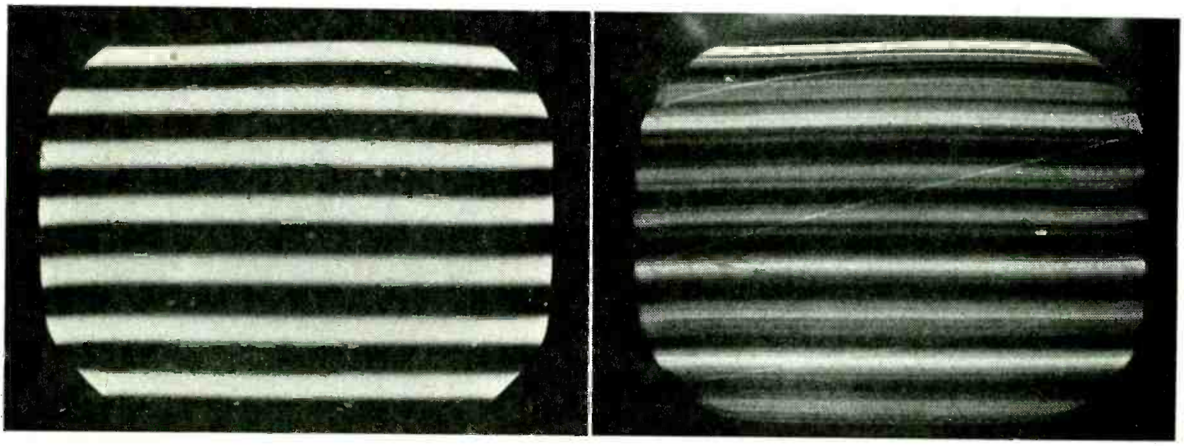
THE writer was recently concerned with a most perplexing case of television interference, the symptoms, cause and tracing of which may be of general interest.

The television receiver screen was sometimes cut in two by a very wide white horizontal band. This might have been diathermy since the interference appeared to me modulated at 50 c/s. However, this band would sometimes vary in width and brightness and sometimes the whole picture would break up into a series of white bands moving up and down the screen. Also, these latter symptoms were always accompanied by peculiar vibrations, which seemed to emanate from different components on the television receiver chassis.

It was also noticed that the vibrations bore some similarity to speech and music. Closer observation showed that the vibrations and picture variations were in fact inter-related and eventually it was proved beyond doubt, as a result of making comparisons with the loudspeaker output from a broadcast receiver, that these vibrations and variations were in direct sympathy with the B.B.C. Light Programme. Photographs of the interference patterns produced, one corresponding with orchestral music and the other with a steady note, are reproduced on this page.

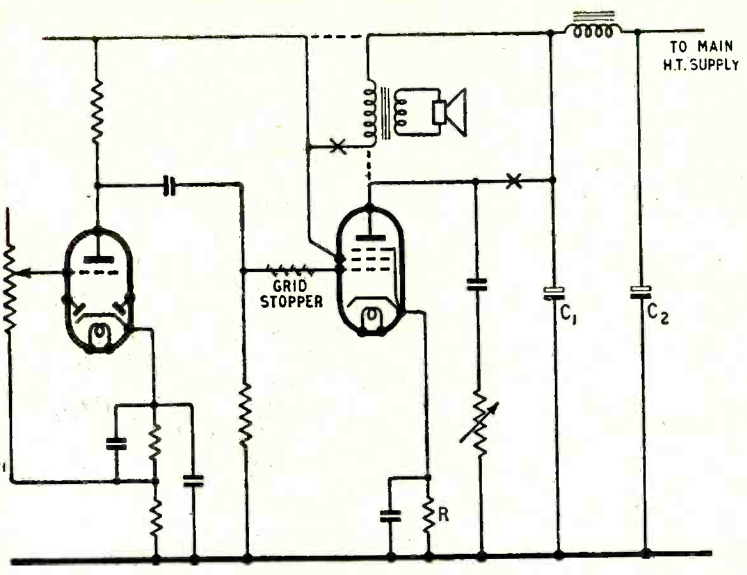
Several different types of television receiver were tried on the same aerial, but in spite of the fact that they employed different intermediate frequencies and, too, that some of them were of the "straight" type, similar interference patterns and vibrations were produced. It should be mentioned here that none of the sets showed any signs of interference on the sound channel. Tuning the oscillators of the superhet receivers over a small range caused no noticeable change in the interference.

With the aid of a Murphy Interference Tracer, Type TS17, the interfering frequency was found to be 44.8 Mc/s, and the source was finally traced to a house 40 yards away. The TS17, which Murphy is supplying to the Post Office, is essentially a highly sensitive eight-valve radio receiver, using miniature components throughout. Power supplies are from self-contained dry batteries, supplying 1½ volts l.t. and 90 volts h.t. An "S" meter and headphones are incorporated. The meter circuits have quick charge and slow discharge characteristics, which are extremely useful when checking impulsive interference. A rod aerial and small loop aerial are provided, and these can be used as required.



(a) (b)

Interference patterns produced with a steady note (*a*) and by mixed high- and low-frequency modulation (*b*).



The offending output stage. The leads which were disconnected are marked with a cross and the new connections and grid stopper are shown dotted. R was 100Ω instead of 320Ω and both C_1 and C_2 defective.

The interference source was eventually found to be an ordinary universal mains, superhet, broadcast receiver of approximately 1934/35 vintage, and tests showed that while the local oscillator and the i.f. amplifier were in no way to blame, movement of leads in the output stage altered the interference frequency. Also, placing a finger on the grid cap of the output valve was found to stop the radiation completely. The rather obvious conclusion was that the output stage was oscillating parasitically at 44.8 Mc/s and that the received programme was modulating these oscillations. The programme was, in fact, heard quite plainly on the headphones of the interference tracer.

More detailed examination of the receiver showed that a "dabbler" had been at work. The output valve was non-standard, the wiring incorrect (as shown in the diagram), the cathode resistor value low and the h.t. smoothing capacitors of low capacitance. The defective capacitors, with the resultant 50 c/s ripple from the half-wave rectifier circuits, accounted for the horizontal band on the television screen during breaks in the Light Programme. However, correction of all these faults did not remedy the parasitic oscillations. A remedy was eventually provided by the insertion of a 20,000-ohm grid stopper, as shown in the diagram.

There was still one query: why was the modulation always the Light Programme? The radio set owner soon answered that one when he explained that he "had no time for the Home Service."

NEW BOOK

Recent Advances in Radio Receivers. By L. A. Moxon, B.Sc. (Eng.), A.M.I.E.E. Pp. 178+v; figs. 92. Cambridge University Press, Bentley House, 200, Euston Road, London, N.W.1. Price 18s.

THIS book is the latest to be issued in the "Modern Radio Technique" series and, to quote the publishers' note, "is intended for readers familiar with the technique of designing radio receivers in 1939 and concentrates particularly on those advances which were made during the war years." This is a more accurate indication of the scope and content of the book than the title.

The book is short and, of the 178 pages of text, nearly one-half is devoted to considerations of noise in receivers of the radar type. Wide-band i.f. stages are also covered in some detail, including the design of multiple stagger-tuned amplifiers. The remainder of the work covers the recent trends in commercial and communication receiver design with some reference to f.m. and television receivers, including "some new circuit tricks."

As we might expect from the authoritative nature of the source, the chapters on noise and i.f. amplication are more detailed than the rest of the book, and much of the material has not appeared under a single cover before. The chapter on noise measurement is particularly commendable and should give the reader the information required to put the subject on a quantitative practical basis.

In treatment and presentation of the subject the book is not, however, all that could be desired; there is a tendency to use the concepts and jargon of this special field which is hardly in keeping with the declared objectives of the book. Mathematical proofs are studiously, almost laboriously, avoided, whilst condensation of argument has been carried to lengths which, only too often, make the final conclusions appear almost as unsupported statements. There is also a noticeable lack of the explanatory asides and references to establish concepts which make a textbook stimulating and interesting to read. Nor does the author always define his terms or set out his symbols very clearly; for example, on the same page (p. 13) we find the same symbol used for temperature and for pulse-length. Again, on p. 90, we are given a diagram of the response of a multiple stagger-tuned amplifier in which the symbol "*n*" appears, to find what this particular "*n*" is (a slightly different "*n*" has appeared on the previous page) it is necessary, first, to turn up the Appendix, where it appears in an expression, and then look back through the text until it is found, defined implicitly, in another expression! Furthermore, the symbols used are not always in accordance with the B.S.I. recommendations. The book is, however, notably free from errors and misprints whilst the diagrams are always clear.

In short, apart from method of presentation, the major portion of this book is of great value for the useful information it gives in a new specialized field; the later portion, however, tends to be a tantalizing collection of snippets and its main purpose should be to interest the reader sufficiently to turn up the original references.

E. J.

UNBIASED

By FREE GRID

Bloody but Unbowed

MY recent plea (*W.W.*, March, 1950), for the jettisoning of outworn nomenclature by substituting the terms cathode and anode for the misleading negative and positive for batteries and the like, has brought, as I expected, a deluge of protests from the diehards. One of the strongest supporters of the old + and − school of thought is the respected chief engineer of one of our great storage battery makers.

As is fitting, his words are as weighty as the products he fathers but unfortunately his arguments are not. The chief plank in his platform seems to be that the + and − signs have been "a British standard for over 50 years." I do not doubt it, but I would remind him that the

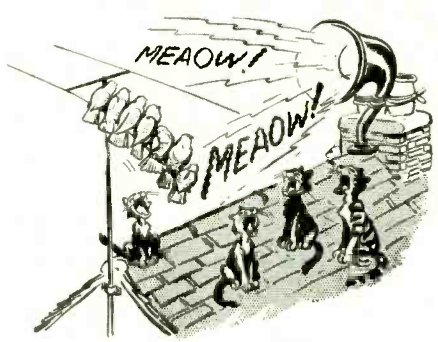
horse represented the British standard of transport for far longer than 50 years and had it not been displaced by the internal combustion engine there would have been far less demand for his products.

In addition he rails against the use of terms of Latin and Greek origin in articles dealing with any aspect of wireless technology. Does he not know that the words "plus" and "minus," which he champions so strongly, belong to one of these two detestable languages?

Other objectors point out that when a cell is supplying power its negative terminal will be its anode but this will become the cathode when the cell is being charged. I can only suggest that they look up the words κατά and ἀνά in a good Greek lexicon.

The B.B.C. Forsaw It

BUT enough of such matters for I want to say a few words about the plight in which the Americans now find themselves, having foolishly ignored the vast store of television engineering experience accumulated in this country since 1936. According to one of their radio trade journals, *Successful Servicing*, Feb., 1950, nemesis has overtaken them because they overlooked a menace which the B.B.C. forsaw over fifteen years ago. As you know, the Americans, "puffed up with pride and armed with arrogance"—to quote the words of one of their most famous sons—sniffed disdainfully at vertical polarization and the upright television aerial which we use; instead they adopted horizontal polarization and bird-perch aerials.



Needless to say such an open challenge to American pigeons was accepted. Unfortunately birds are no less stupid than human beings in failing to "pass along the car, please," but gregariously congregate on one limb of the aerial. Even if their weight does not always bend it their ill-distributed body capacitance upsets its electrical constants.

The result is that all the technical talent of the U.S. radio industry is now being diverted from more vital channels into finding a cure for this menace. Heating the aerial elements by eddy currents has proved a cure worse than the disease; while using electric motors to rotate the perches about their own axis is complicated. The most successful device, I should imagine would be to instal a loudspeaker near every aerial to belch forth recorded catcalls.

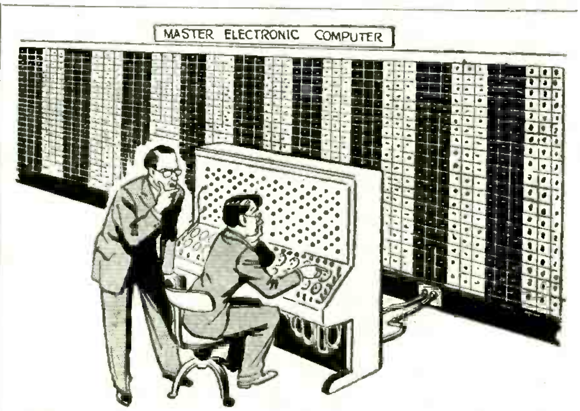
Radar to the Rescue

SCARCELY a day passes that we do not hear of some new radio application, more especially in the realm of radar. I do my best to keep you *au fait* with these but one development is now brewing which is of such importance that I wonder if I can reveal it to you without inviting the attention of MI5. At any rate, here goes.

I hear on high authority that the Government is much concerned at the number of road accidents involving very ancient cars. The reason for many of the accidents is said to be the drivers' inability, especially when reversing, to see through the dense clouds of smoke which the cars emit. Operations like reboring or resleeving can cure some of them, but in many cases the patient is too far gone to respond to such treatment.

It is therefore proposed to make an order in Council to make it compulsory for these modern Elijah's chariots—for some of them emit flames, too—to carry radar so that the drivers can see through the smoke clouds. This government order will, of course, mean great activity in the radio factories and I am told it will be given high priority.

A greater diversion of new cars to the home market would seem to my untutored mind a simpler way of solving the problem. But it ill behoves me or any of us radiomen to urge this point on the Government. Let the automobile industry do its own work. For my own part I feel this scheme should be made applicable to all cars and every motorist be made to drive blind, as indeed, so many of them appear to do at present.



"Wrong answer again, Bellamy; it's obviously the time constant of R531 and C672."

Manufacturers' Products

New Equipment and Accessories for Radio and Electronics

Neon Indicators

A RANGE of miniature neon indicator tubes is now available from the General Electric Company, Magnet House, Kingsway, London, W.C.2. They are designed for use on 200-250 V mains supplies, when connected in series with a 0.25 to 0.5 MΩ resistor (1 watt).

Current consumption and other details are given below:—

Type	Supply	mA	Cap	Price (s d)
F ...	a.c.	0.5	Small Edison screw	4 6
G ...	a.c.	0.15	Miniature bayonet, centre contact.	3 6
"Tuneon"	d.c.	0.5	Small Edison screw.	4 6

Radio-Television Console

IN the new Model TRC124 "Ekcovision" console (Model TRC1124 for the Midlands), a pre-set radio receiver giving three alternative stations on medium waves and one on long, is combined with an 18-valve television circuit operating a 12in c.r. tube (picture size 10⅜in × 8in). Basically the design of the television receiver follows that of the TSC102. Focus is fixed with an auxiliary pre-set adjustment for mains voltage fluctuation; the operating controls are "Brightness" and "Contrast." Interference suppression circuits are provided for both vision and sound channels.

The radio receiver comprises three valves, a frequency changer (UCH42), i.f. amplifier and detector (UAF42) and output (10P13). Station selection is by rotary switch, and illuminated indicator panels show the name of the station being received.

Made by E. K. Cole, Southend-on-Sea, Essex, the Model TRC124 costs £75 12s including tax.

New Auto-Radiogram

AN interesting feature of the six-valve superhet circuit of the Model ARG23AE radio-gramophone, made by the Marconiphone Company, Hayes, Middlesex, is the employment of an earthed-grid triode in the signal-frequency amplifying stage.

On the gramophone side the latest lightweight type pickup is used in conjunction with a new record-changer mechanism handling ten 10in or 12in records, unmixed. A two-position switch gives normal or extended frequency range to suit all types and conditions of record.

The "double-console" type cabinet includes a compartment for record storage, and both the radio tuning panel and record changer compartment are provided with doors. A 10in permanent-magnet loudspeaker is fitted and the rated power output of the amplifier is 5 watts.

Dimensions are 38in × 35¾in × 17½in and the price is £108 7s 3d including tax.

New Television Valves

THE range of Mullard valves for use in television equipment has recently been extended to include two new types on the "Noval" (9-pin) base. These valves are a triode-pentode (ECL80) and an r.f. pentode (EF80). Both offer special advantages in the design of television equipment.

The EF80 is characterized by a particularly high slope and is primarily intended for use as an r.f. amplifier, or mixer valve, in television receivers. Its general performance corresponds with that given by the Mullard high-slope pentodes EF50, EF42 and EF91. It has the distinct advantage over these valves, however, in that it can be operated with an h.t. voltage of 170 only as against the usual 250 volts. This makes the EF80 a particularly useful valve for the transformer-less type of television receivers.

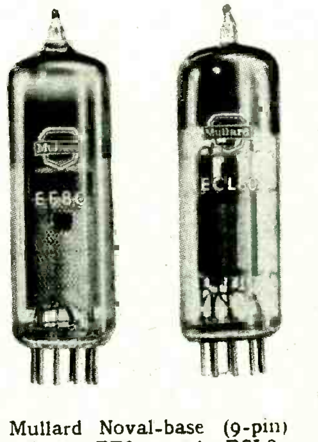
Having separate triode and pentode sections, the ECL80 has a wide number of uses. It enables sets to be designed with the fewest number of valves and thus reduces the size of the equipment. Three straightforward ways of using this valve in television receivers are as follows: (a) pentode section as synchronizing pulse separator, triode section as line oscillator; (b) triode section as frame oscillator, pentode section as frame output; (c) triode section as a.f. amplifier, pentode as audio output valve.

The makers are Mullard Electronic Products, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

Dielectric Heating Oven

A NEW 5-kW r.f. heating oven for thick plastic pellets and rubber preforms has been introduced by the General Electric Company, Magnet House, Kingsway, London, W.C.2. The salient feature of the design is the large area of the electrodes (24in × 18in) and the continuously variable spacing (up to 6in) which can be adjusted while the set is in operation. The lower earthed electrode slides out on a drawer for ease of loading.

A pre-set matching inductance



Mullard Noval-base (9-pin) valves, EF80 and ECL80 high-slope pentode and triode-pentode respectively for use in a.c/d.c television receivers.

The earthed electrode in the G.E.C 5-kW dielectric heating oven pulls forward for ease of loading.

gives wide latitude in adjusting the coupling to the electrical characteristics of the work.

Sound Amplifying Equipment

SEVERAL additions have been made recently to the range of sound amplifying equipment made by Ardente Acoustic Laboratories, Compton, nr. Guildford, Surrey, and many well established products have been redesigned.

Of chief interest among new products are the Type 360 and 660 amplifiers for a.c. mains. These have outputs of 30 and 60 watts respectively for distortion levels of less than 2%. In both types a low-noise, high-gain input stage (EF37) is followed by a double triode (ECC33) in which one section is used as a phase-splitter to feed the push-pull output stage (two EL37s). In the Type 360 a single GZ32 rectifier supplies h.t. and bias is automatic; in the Type 660 there are two GZ32 rectifiers and a separate selenium rectifier supplies fixed bias. A relay is fitted for h.t. switching, and a guard circuit prevents the application of h.t. until the output plug is connected. The frequency response is 1 db down at 20 and 10,000 c/s and 3 db down at 20,000 c/s. Bass and treble cut controls are included.

The amplifiers are available in cabinet and rack-mounted form, and suitable radio-tuner and mixer units can be provided. Prices are £36 and £45 for the rack types and £45 and £58 for the cabinet models.

Other recent additions to the Ardente range include the new "Black Prince" moving-coil microphone, the redesigned Type PMBG labyrinth loudspeaker, Types PMDC, PMCH and PMDW diffusion loudspeaker units and the Type PMDH marine loudspeaker in corrosion-resistant silicon aluminium alloy.

Versatile V.H.F. Transmitter

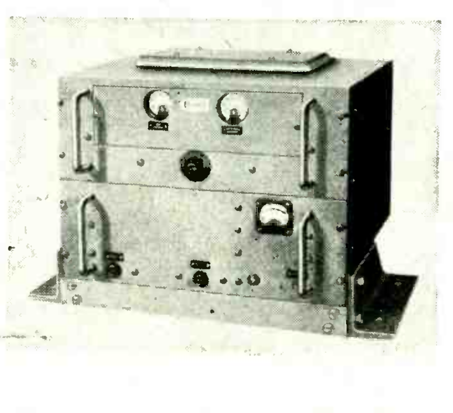
DESIGNED originally to meet certain local requirements at airports, the PT10 transmitter has a wide field of application as a fixed station transmitter for a short-range v.h.f. radio telephone service.

Rated at 12 watts output, the equipment consists of separate r.f. and modulator units, which can be assembled for either rack or desk mounting and can be combined with a receiver to form a complete radio telephone installation.

For airport use the coverage is 118 to 132 Mc/s and operation is on a single spot frequency in this band, the desired channel being selected merely by plugging in an appropriate crystal and making a few minor tuning adjustments.

Operation of the equipment has been simplified considerably by the use of wide-band inter-valve couplings wherever possible so that tuning adjustments are reduced to a minimum, while pre-set circuits in the audio part of the transmitter check any tendency to overmodulation. Grid, anode and cathode current metres are included for routine servicing and for tuning whenever a new channel is required.

The whole equipment is very compact and economical to operate; the supply required is 230 volts, 50 c/s. It is made by The Plessey Co., Vicarage Lane, Ilford, Essex.



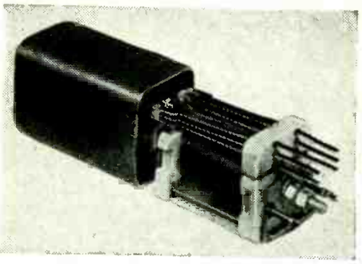
Plessey 12-watt v.h.f. radio telephone Type PT10, assembled for desk mounting.

Miniature Relays

RELAYS play an important part in all kinds of radio and sound amplifying equipment, but for economic reasons and the fact that remote control is not often needed, they are rarely found in broadcast sets. "Business radio" and the many kinds of mobile v.h.f. radio-telephones rely to a great extent on relays for their operation, and the latest miniature types produced by Engel and Gibbs, 983-5, Finchley Road, Golders Green, London, N.W.11, should find applications for these purposes.

The normal patterns measure $1\frac{9}{16}$in high; the base is $\frac{7}{8}$in × $1\frac{1}{16}$in and the weight is 1.4 oz only. There is an hermetically sealed model with the same base dimensions, but $1\frac{13}{16}$in high, and this weighs 1.6 oz. Normal operating power is 1 watt at d.c. voltages up to 50. If higher voltages have to be used, a series resistor must be included. A.C. models are not available, but a simple rectifying circuit will supply the low current needed.

The relay contacts are mounted on a ceramic block, and, while designed for relatively low d.c. voltages, they will handle up to 300 mA at 240 V a.c. On d.c., an external quenching circuit is needed for control of voltages in excess of 50.



Midget relay suitable for use in mobile and business radio-telephones, made by Engel and Gibbs.

Apart from loading considerations, the relay is eminently suitable for a.f. and r.f. circuit control, aerial switching from send to receive in low-power sets being one such application. The normal contact arrangement is double-pole change-over. Contacts are of either pure silver or palladium-silver mounted on nickel-silver or beryllium-silver blades as required, and each blade has two contact tongues accurately aligned.

Hospital Radio

A VERSATILE new radio equipment (Type ET101) for hospitals has been introduced by the Amplifier Department of Philips Electrical, Century House, Shaftesbury Avenue, London, W.C.2.

It consists of a compact enamelled metal consolette in which a radio tuner for short, medium and long waves is mounted above a ventilated amplifier compartment which can be fitted with an interchangeable amplifier, of 15, 25, 50 or 100 watts output. A pilot loudspeaker is provided for tuning, and input terminals are available for gramophone and microphone inputs.

Audio Signal Generator

OPERATING from either a.c. or d.c. mains (200-250 V) the type T/1 audio signal generator made by Pennine Amplifiers, 9-11, Southgate, Elland, Yorks, covers 40 to 16,000 c/s in two ranges. Maximum power output is 3 watts and alternative output impedances of 2.5 and 3,000 ohms are provided with an output voltage control calibrated for each impedance.

The instrument weighs $6\frac{1}{2}$ lb, measures only 7in × $5\frac{1}{2}$in × 4in, and should be useful to the serviceman for checking loudspeaker response, etc. The price is £9 9s.

LETTERS TO THE EDITOR

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

European Television Standards

WE may assume that any medium-definition European television standard, whether 405, 455, 525, 567 or 625 lines, will be temporary. The future lies in high-definition black-and-white or else in colour. Therefore, for this impoverished continent, I suggest we should start with the cheapest practicable system that will allow the mass market to be reached, and will make the best use of the metre-band wavelengths. I cannot understand the present advocacy of 625 lines for Europe.

Taking into account present possibilities and future probabilities, it is not difficult to find the right course. It is to standardize on 405 lines with the full theoretical bandwidth of 3 Mc/s. Alternatively, as a compromise, we could use 525 lines with a reduced bandwidth of 3 Mc/s.

When we become richer we can think of high definition or of colour.

C. L. ZAALBERG.

Overschie, Holland.

"Wireless World" Television Receiver

HAVING built the *W.W.* long range television receiver, I feel that my experiences might be of interest to readers in the fringe area who might be contemplating building, yet doubtful of the possibilities.

From my address you will see I am at extreme range, but in spite of this am receiving strong and steady signals.

The very slight fading that takes place is only noticeable on the sound channel, the vision remaining steady with the gain control well down.

I would mention that I have fitted separate gain controls to sound and vision receivers, having found individual control to be an advantage.

The performance is definitely at full entertainment value and the picture remains rock steady.

W. FORD.

Blackburn, Lancs.

Spot Wobble

I READ with much interest the article by R. W. Hallows on spot wobble in your March issue.

The process was first brought to the notice of engineers in this country by the writer in *Wireless World* of September 4th, 1936—by the courtesy of Ferranti, Ltd.—when it was used as a method of overcoming the discrepancy in line width between the two systems of 405 lines and 240 lines when using a cathode-ray tube receiver.

It was originally the subject-matter of a patent application in 1935, which was not granted because of the prior patent of the French Compagnie des Compteurs.

There is one point I would like to stress, not only is the appearance of the picture improved without losing any definition, but the screen of the picture tube is used efficiently. By having luminescence in parts normally not excited the light output is increased.

In the current article there is mention of the use of the device in colour television. When the writer was associated with the late John L. Baird, frequent use was made of spot wobble in both colour transmitters and receivers with great advantage. The same was experienced in stereoscopic television, though to a lesser degree.

In conclusion, as the tendency seems to be towards 15 or 16in picture tubes using a very fine spot produced with accelerating potentials of 11 to 15 kV, the use of spot wobble in a receiver of this type is rapidly becoming an absolute "must."

E. G. O. ANDERSON.

Television, Ltd.,
London, S.W.1.

Dark Television Screens

FROM his letter in your March issue it appears that Mr. Humphreys is either unaware that certain American cathode-ray tubes for direct viewing feature a darkened filter glass face plate, or he is hinting to tube manufacturers that there is a sound principle involved in this method of improving picture contrast.

I am not at all sure, however, that the "dark" face plate is the most satisfactory method. The highlight brightness obtainable with "daylight" aluminized tubes operated at high accelerating potentials is recognized as being more than adequate at night in a room where the normal amount of ambient illumination is provided. Such tubes provide a contrast improvement compared with non-aluminized types by eliminating reflections within the tube (also the ion-burn menace is warded off without resort to ion-traps or devices which might cause spot distortion).

The prime consideration for comfortable viewing becomes a matter of further improving the contrast in the presence of ambient illumination, which illumination, ideally, should be of the same order as that of the average picture brightness. A proposed method is to place a thin neutral-grey coloured, or "Polaroid" absorbing screen in front of the tube, preferably tilted or curved in order to avoid direct reflections from light sources in the room into the eye of the observer. An increase in contrast from 7:1 to about 30:1, equal to cinema film standard, is theoretically possible, on the assumption that there are no reflections either between the back of the filter and the front of the tube, or between the front and back surfaces of the tube face plate.

It may well be that the convenience of being able to change the filter according to the illumination outweighs the apparent additional advantage of the "dark-faced" tube in minimizing the remaining reflections. The rather paradoxical procedure of increasing accelerating voltage and scanning power, and then of reducing the maximum brightness with filters is, nevertheless, one which can yield a picture of the highest definition under viewing conditions which are the most pleasing.

G. A. PHILLIPS DALES.
Johannesburg, South Africa.

FURTHER to Alan Humphreys' letter in your March issue, I would like to point out that a projection television screen can have quite an advantage over a direct viewing tube when being viewed with light falling on the screen.

Obviously, with a direct viewing tube the black portions of the picture are nowhere near black if any light falls on the front of the screen, the "blacks" being a white screen which reflects a considerable amount of light.

With a projection system, the major portion of the extraneous light that falls on the screen is transmitted and not reflected, hence the black parts of the picture still remain black even with a considerable amount of stray light in front of the receiver.

In addition to this, the projection screen has the advantage of not reflecting any images of objects in front of the receiver as the screen face is not polished but has a matt finish.

If a projection-type receiver is placed alongside a normal direct-viewing receiver and both are adjusted in darkness, as soon as the light is switched on this effect is noticed considerably, the direct-viewing tube being well down in contrast compared with the projection screen.

E. O. FRISK.
Optical Works, Ltd.,
London, W.5.

Broadcast Volume Levels

"CATHODE Ray" (your December issue) evidently considers that the B.B.C. is sweetly reasonable in its technical handling of the relative volume levels of speech and music, and infers that critics of the official policy are, to a man, anti-social owners of commercial receivers manufactured before 1935. He classes complainants with the classic old lady who wanted the B.B.C. Dance Orchestra to play louder when her H.T. battery was running down. The old (and surely, dying) hobby horse is trotted out; "boom" in old receivers reduces the intelligibility of speech, volume being manually increased as an arbitrary compensation.

This does, of course, occur, but the complaint is more widespread than this, and cannot be localized at the door of bass resonance. The controversy thrusts itself upon every citizen, throughout the summer, and the B.B.C. by its appeals for "hush" on hot evenings tacitly admits that the position is serious. The issue is simple: speech broadcasts are *not loud enough*.

The solution is equally simple. Let the B.B.C. instruct the engineers to increase the modulation level of speech. It is a procedure that should be acceptable to technician and aesthete: the volume compression system would require no modification, and music lovers who enjoy their fortes *fortissimo* would be in no wise discomfited.

Surely such a palpable panacea could be granted a trial?

Yours faithfully,
JOHN and GLADYS HART.
Weybridge, Surrey.

Terminal Terminology

"FREE GRID'S" so-called "obvious" nomenclature is an unfortunate example of hopeless befogging. If the cell which he mentions is supplying power to his radio set its negative terminal will be its anode. When the same cell is being recharged, its negative terminal will then be its cathode.

The explanation is that the terms anode and cathode are used to indicate the "in" and "out" terminals when we wish to draw attention to the direction of flow of current, while positive and negative are concerned with potential difference.

If "Free Grid" will examine the circuit of a valve rectifier he must surely agree that the cathode of the valve is the positive terminal, so far as the output connections are concerned. The cathode of a metal rectifier is always marked + rather than cathode to minimize confusion.

The more frequent association of + with anode and − with cathode arises from the fact that there are most devices absorbing power than there are producing it.

T. C. NUTTALL.
London, S.E.19.

Curious Effect

I VIEW on a television receiver built principally to *Wireless World* design. By accident, it was noticed that, after being switched off completely for about five minutes, the screen flashed.

I then watched carefully after each period of viewing. The flashes, as many as three in succession at times, appear in the bottom right-hand corner. The first one appears about five minutes after switching off, and the others follow at two-minute intervals.

The flashes always occur at the same place on the screen, all circuits are quite cold, and there was no fire in the room.

Is the flash due to energy released in the screen phosphor, and, if so, could any of your readers suggest why it appears only in the bottom right-hand corner, and whether these flashes also occur during screen bombardment in the course of a programme?

ALAN F. DAVIDSON.
London, S.E.3.

Valve Types

THE statement of your correspondent, Mr. H. O. Bradshaw, that "the valve position in this country has always been notable for its confusion" is probably an all-time record in under-statement.

Besides the 4-, 5-, 7-, 9- and what-have-you pin bases, there are valves with octal bases and octal valve characteristics which bear non-octal designations, not forgetting the cunning types with bases which have all the appearance of being octal, but are not.

To further befuddle this crazy jumble, each maker adopts his own system of designations, the meaning of which is an incomprehensible mystery, so that tables of "equivalents" are necessary to lend succour to the courageous adventurer who would penetrate this bewildering maze.

If your correspondent hopes to see a change from this hotchpotch, which has been tolerated for years by those who are oblivious of the fact that it is excluding them from many world markets, he must indeed be sanguine.

G. P. H. de FREVILLE.
London, S.W.7.

"Q" Priority

YOUR contributor "P. H." says, on page 216 of *Wireless World* for June, 1949, that the article on "Q" Meters by H. G. M. Spratt in the January, 1949, issue was, to his knowledge, "the first account of this nature to be published in any English-speaking technical journal."

May I refute that statement? I myself published a comprehensive article on the "Q" Meter and its theory, including the corrections required, etc., in the *Proceedings of the Institute of Radio Engineers*, New York, as long ago as 1942. A reference to that paper is given in your own publication, "Radio Data Charts."

V. V. L. RAO.
Madras, India.

MANUFACTURERS' LITERATURE

LEAFLET describing stabilized power supply unit Type SP11, giving five stabilized outputs from 200-250v a.c. input, from A. E. Cawkell, 7, Victory Arcade, The Broadway, Southall, Middx.

List of transmitting and industrial valves, neon indicators, barretters, etc. Also cards showing (a) valve equivalents, and (b) and (c) Mazda valve and c.r. tube complements for London and Midlands television receivers of many makes, from Edison Swan Electric Co., 155, Charing Cross Road, London, W.C.2.

Technical Bulletin No. 55, describing an automatic telegraph distortion monitor for use on 5-unit code systems from Airmec Laboratories, Ltd., High Wycombe, Bucks.

Leaflet on E.M.I. "Flexible Dipole" indoor television aerial from E.M.I. Sales and Service, Ltd., Hayes, Middlesex.

Folder on the "Consol 66" navigational receiver for yachts and small craft, which provides for reception of Consol signals and normal direction-finding beacons, from Industrial Radio Co., 16, Devereux Road, Southend, Essex.

Leaflet describing the "Hydraclamp" hydraulically operated vice with universal joint, and adaptors for holding receiver chassis, etc., from Spencer, Franklin, Ltd., 292, High Holborn, London, W.C.1.

RANDOM RADIATIONS

By "DIALLIST"

Fluorescent Lamps on D.C.

A READER who has had a good deal of experience of fluorescent lamps running on d.c. has been kind enough to send me some interesting facts about their proneness to cause interference with radio and television reception. I gather that he has found interference as common on d.c. circuits as on a.c., and just as severe. The symptoms, too, are the same: the interference-producing lamp develops a bright spot on one heater. I wonder whether other readers who have run these lamps on d.c. have had similar experiences? I ask because I don't feel sure that the misbehaviour described by this correspondent isn't at any rate partly due to the fact that his mains supply is very "rough," having, as he puts it, a ripple sufficient to give a reading on the a.c. range of an AVO. Has any reader found that fluorescent tubes fed by well-smoothed d.c. cause interference? If so, it seems that there may well be something in the idea that the bright spot represents a small semi-detached flake of the surface material of the heater, vibrating under electron bombardment.

Television's New Look

THOUGH I'VE ALWAYS liked our 5:4 aspect ratio and still feel that it gives an image of more pleasing shape, I'm glad that the B.B.C. has decided to change over to the 4:3 ratio used in other countries. The main reason, of course, is that the 5:4 form factor doesn't fit in with standard sound track films. That's a very important consideration, for such films are bound to play an increasingly important part in the news broadcasts. For example, with the advances in making and transmitting films that are continually taking place, I can see no technical reasons why, say, next year's Grand National should not be seen on television screens that same evening. Another reason why the change is to the good is that it is one step nearer to general standardization. On this side of the Atlantic we've now got (1) 50 frames per second interlaced and (2) the 4:3 aspect ratio accepted by everyone The remaining fence—the number of scanning lines—is, of course, by far the most difficult. Still, it's something to have reached agreement on two points out of three.

No Great Difficulty

The majority of viewers, I take it, simply trued up the circle on the test pattern and left it at that, making the image extend to the full height of the mask and not missing the small amount of width now sliced off by the vertical edges of the mask. Treated in this way, an image on a 12-inch tube that was previously 10 × 8 inches now becomes $10\frac{2}{3}$×8in, but $\frac{1}{3}$ inch is lost at either edge. Alternatively, the width may be left at 10 inches and the height reduced to $7\frac{1}{2}$in, in which case there is a $\frac{1}{4}$in gap at top and bottom. The handyman will probably worry off a third of an inch from each vertical edge of the mask and so obtain the full benefit of a larger image—$85\frac{1}{3}$ square inches against the original 80.

The New Radio Channels

ON THE MEDIUM WAVES the new broadcasting channels seem, so far, to have given results that are about as satisfactory as could be expected in the circumstances. Unfortunately, a number of countries haven't signed the new agreement; and some of those that promised to come into line haven't, at the time of writing, entirely fitted themselves into their new channels. One unexpected complication has been caused by the surprising decision of our good and usually so reasonable friends, the Americans, to use many channels that were not allotted to them for their zone of Western Germany. That sort of thing will no doubt right itself in time; but I'm afraid that broadcasting conditions in Europe will never be as they should be until we have a European body armed with powers similar to those of the U.S. Federal Communications Commission.

Try it and See

THE EDITORIAL SUGGESTION in last month's *W.W.* that metre-wave competitive broadcasts should be tried out from the Wrotham station very much appeals to me. The only sure and certain way of discovering whether competitive broadcasting can provide more acceptable entertainment than the monopolistic brand is to give it a reasonable trial. And there could be no better way of trying it out than by adopting a system which gives it full play and at the same time allows the B.B.C. to continue its own broadcasts without interruption. There's another point too: So far as I can see, if competitive broadcasting has a future in this country, that future is likely to lie on the metre waves. The reason is that the small number of our medium- and long-wave channels is hardly suited to competitive broadcasting on a national scale—and local or semi-local broadcasting of that kind would not be likely to furnish what is needed.

Pros and Cons

The most that could be done in a national way on the medium and long waves would be to use the channels now assigned to the Home, Light and Third Programmes to form three competing chains. It is doubtful whether competitive broadcasting could achieve its object unless it provided every listener with a wider choice of programmes than that. There is likely to be less congestion on the metre waves, which would give competitive broadcasting, if it comes here, a better chance of spreading itself and of showing what it can do.

How Do You Feel?

Have you ever found yourself so exasperated by the B.B.C.'s fare that you simply had to sit down and write to them about it? If so, I'm open to wager that your irritation was increased when at length a smug, complacent, "mother-knows-best" reply reached you. Those who have received an answer of the kind I'm thinking of must have felt that a spot of competition might do the programme side of the B.B.C. a power of good!

"Club-Model" Radio-Gramophone

FOR the overseas market G.E.C. have introduced a large automatic radio-gramophone for hotels, small dance halls, etc. The specification includes a 30-watt amplifier and alternative radio receivers can be specified. If required a 60-watt amplifier can be supplied, and there is provision for a moving-coil microphone for announcements.