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The

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THE
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VOL. X. OCTOBER, 1933. No. 121

Editorial

Some New Types of Broadcast Transmitting Aerials

THE August number of the *Telefunken Zeitung* gives some particulars of two interesting types of aerial which have been erected at stations recently equipped by the Company. At Breslau—a 60 kW station with a wavelength of 325 metres—there is a single self-supporting wooden tower, a photograph of which is here reproduced. The height of the tower is 140 metres, and the aerial consists of a wire hanging vertically down the centre of the tower. At the top is a bronze ring 10 metres diameter to serve as a terminal capacity; this suppresses about 40 metres or an eighth of a wavelength of the standing wave on the vertical wire. A current node occurs at a height of 19 metres and maximum current at 100 metres as shown in the diagram. This current distribution gives a polar diagram in the vertical plane such that practically no energy is radiated at an angle of 60 to 65 degrees to the horizontal, while the horizontal radiation is increased by about 25 per cent. The radius of the area in which reception is obtained free from fading has thus been increased by about 40 per cent, or in other words, the service area has been doubled.

About 80 metres above the ground a

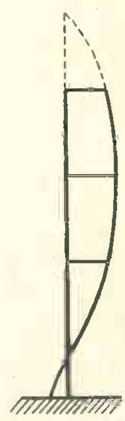
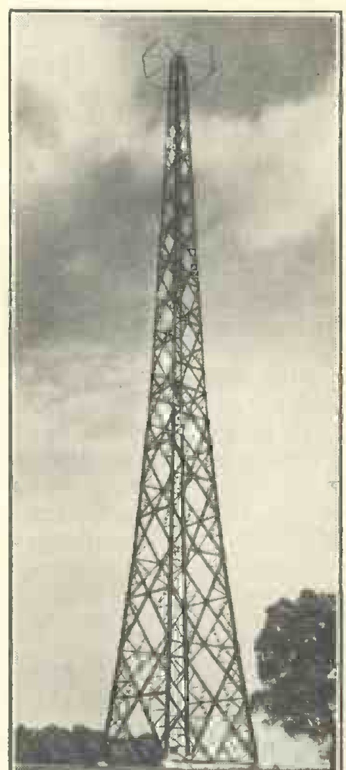
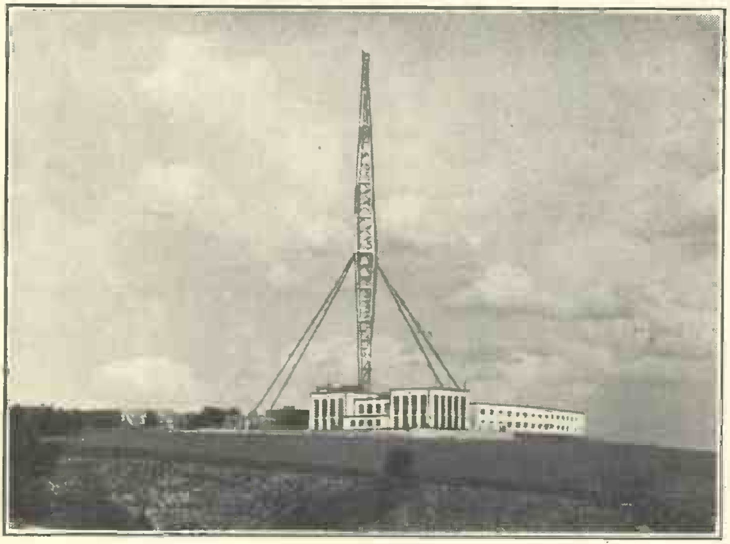


Diagram showing amplitude of current.



(Right) The Breslau self-supporting wooden tower.

switch is inserted in the wire; this switch, which can be operated from the ground, disconnects the upper part and enables the lower part of the aerial to be used as a quarter-wave transmitter with a current anti-node at the ground level.

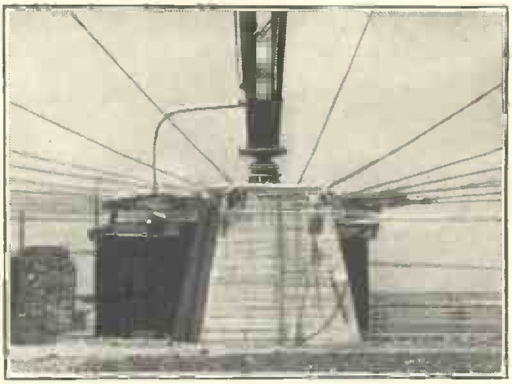


Vienna steel lattice mast.

An entirely different type of aerial is being installed by the same company at the 150 kW Bisamberg station, nine miles north of Vienna. The lattice mast is of steel, coated with zinc (not galvanised); as can be seen from the photograph, its form is that of two square pyramids placed base to base. The total height is 130 metres and it is supported at the midpoint only by four insulated guys. The tower itself constitutes the aerial, the current flowing in the steel and its zinc coating. As the wavelength is 517.2 metres, it will be seen that the height of the tower is almost exactly a quarter of the wavelength. In view of the nature of the soil in the neighbourhood of the aerial it was decided to use an insulated system of radiating wires as a counter-capacity. The photograph shows how the horizontal wires are kept taut by means of helical springs which are short-circuited by means of jumpers to provide a by-pass for the high-frequency current. The hut behind the base of the tower contains the tuning and coupling elements of the aerial.

Although at present the station is working with this one tower and radiating uniformly in all directions, it is intended ultimately, when complete data of the field strength at different distances have been obtained, to erect another similar tower with an entirely independent counter-capacity. This second tower will be situated a quarter of a wavelength to the east of the present tower and will be tuned to a somewhat longer wavelength; it will act as a reflector and cause the energy to be radiated predominantly towards the west. The reason for this will be apparent from a study of the map of Austria, from which it will be seen that the country lies mainly to the west of Vienna. This is even more so with regard to the distribution of German-speaking population.

The wavelength of the Vienna station was too long to allow of the use of the anti-fading device employed at the Breslau station.



The horizontal wires are kept taut by means of helical springs.

In one case the vertical distribution of radiation, and in the other the horizontal distribution, will be affected in a special manner and it will be interesting to study the results obtained in the two cases.

G. W. O. H.

Applications of the Dynatron*

By M. G. Scroggie, B.Sc., A.M.I.E.E.

Summary.—The characteristics and operating conditions of the screen-grid valve used as a dynatron are reviewed from a practical point of view. For theory the reader is referred to existing literature except where it is found necessary to supplement or criticise the treatment of certain matters of practical importance. The precautions to be observed in obtaining the maximum advantage from the special features of the dynatron are detailed, and it is shown how it may be applied to receivers, wavemeters, standard signal generators, beat frequency oscillators, and apparatus for measuring the radio-frequency resistance of oscillatory circuits, the power-factor of dielectrics, and the admittance of chokes and similar components.

THE theory of the dynatron oscillator has been dealt with in numerous articles, mainly of recent date; for convenience a bibliography is appended. Here it is proposed to set forth the practical aspect of the matter, which is of some interest in view of the ubiquity of oscillators in laboratory work.

The dynatron possesses substantial advantages over other types of oscillator that are available for the same purposes, and in addition has applications for which other types are not available. For example, a two-terminal oscillatory circuit, with one terminal "earthy," can be maintained in oscillation; there being no necessity for tappings, or auxiliary circuit elements. The oscillations are in general more stable in frequency than those maintained by triodes (17, 19, 25) † and are under more precise control. Details of these and other advantages will appear when considering the characteristics and applications.

Although a dynatron patent was taken out no less than 18 years ago, it is only comparatively recently that valve development has made it a really useful tool. While it is possible to obtain dynatron effects with many types of triode, the effect is much more prominent in the tetrode; and improvement in valve conductances has still further extended the range of oscillatory circuit resistance that it is possible to neutralise by the dynatron negative resistance.

Almost any screen-grid tetrode may be used with more or less success, and the typical characteristic shown in Fig. 1 exhibits the common features. The anode current at zero anode volts may be quite considerable, amounting to a milliamp or more. As the voltage is increased the current rises rapidly and reaches a sharp maximum at about 10 or 12 volts, then decreases to form the dynatron slope.

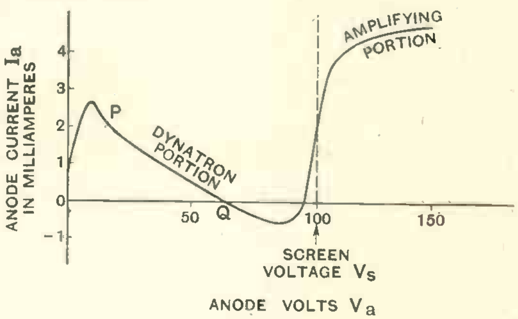


Fig. 1.

In some valves this portion of the curve is very nearly straight, in others there are occasionally irregularities, but the typical curve is concave viewed from above, and there is sometimes quite a knee at the point *P*, resulting in exceptionally low negative resistance between *P* and the top bend. This is, therefore, a useful region for coaxing difficult circuits to oscillate.

The anode current is shown to have negative values, and in some high-conductance valves this forms the major portion of the dynatron curve, while in others negative values are nowhere approached. At an anode voltage somewhat lower than the screen voltage the anode current exhibits the lower bend, blunter than the upper one; and the middle steep upward portion is always reached when anode and screen are at the same potential. Finally the curve flattens out in the portion generally utilised for amplification.

It is hardly necessary to plot a screen

* MS. received by the Editor, February, 1933.

† Numbers in brackets refer to bibliography.

current (I_s) curve, as this may be derived to sufficient accuracy for most purposes by one reading, taken, for example, at the point Q where I_a is zero. As $I_a + I_s = I_e$ is substantially constant so long as V_a only is varied, I_s is a reflected image of the I_a curve.

Fig. 2 shows how the typical characteristic is affected by varying the operating conditions. Both length and steepness of the dynatron curve increase with V_s, but a practical limit to this process is set by the concurrent increase of I_e, which has an adverse effect on the life of the valve. It appears that heavy screen current is particularly damaging to most types, and though the useful limit depends very largely on the design of the valve, 5 ma is suggested as a limit for prolonged runs and 10 mA for brief tests. That these figures may be conservative is shown by a test on a Mazda AC/S2 valve, which was operated as an oscillator for 2½ hours with a screen current of 20 mA at 110 volts. Both dynatron and amplification characteristics taken before and after the treatment showed no deterioration.

Increase of V_g, the control grid voltage, increases the slope, but not the length of the dynatron curve (Fig. 2*b*).

It is of interest to note that when I_a is zero or negative the mutual conductance is zero and negative respectively. The zero point suggests a useful condition in cases where it is desired to use a grid bias control without affecting the anode current.

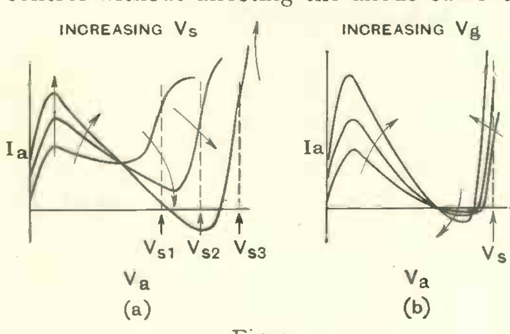


Fig. 2.

Variation of filament or heater current is similar in effect to variation of V_g, but it is generally more satisfactory to use some other form of control. The thermal time lag makes this particularly true of separately heated valves, which, because of their greatly superior characteristics, are the types mainly in view.

In considering desirable operating conditions it will be assumed for the moment that the various feed voltages are maintained at the steady values to which they are set.

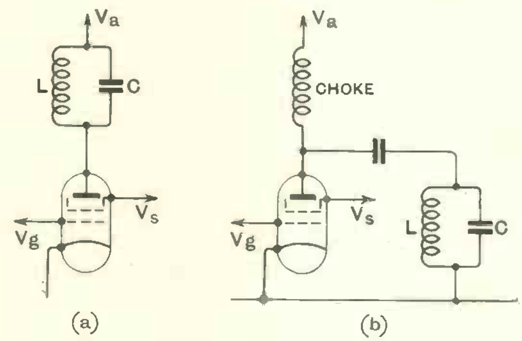


Fig. 3.

The simplest connection is that of Fig. 3(*a*); (*b*) is an alternative where it is desired to bring the oscillatory circuit to the cathode side of the feed. This circuit should be used with caution, as there is a possibility of the choke oscillating on its own. Oscillation is maintained when the dynamic resistance of the LC circuit is not less numerically than the negative resistance of the valve path in which it is connected.

That simple statement requires some elaboration, for in most treatments of the subject the negative resistance of the valve, which we will call ρ, is conveniently assumed to be constant, under any given set of conditions, an unpractical assumption which has led to great confusion of thought, as will be shown when discussing the effect of the valve on the frequency of oscillation.

In practice the initial working point is set to a nearly linear part of the dynatron slope. In general the oscillatory circuit has a greater positive dynamic resistance R than the ρ represented by the slope *at this point*, and if ρ were constant the amplitude of oscillation would increase without limit at a rate depending on the difference between R and ρ. Actually ρ varies all over the cycle of oscillation, and the amplitude adjusts itself to a value which makes the time-integral of $i_a^2\rho$, over a cycle, equal to I_a^2Rt. With some valves the range of adjustment of R

corresponding to various amplitudes of oscillation along the "straight" part is vanishingly small, and may be non-existent owing to the numerical value of ρ tending to decrease as the amplitude increases. What happens then is that oscillation once established travels at least as far as the nearest bend. In other words, the settings of a grid-bias or other control, corresponding to the starting and stopping of oscillator, do not coincide. This effect is referred to as backlash.

It is difficult or impossible to obtain continuous adjustment of the amplitude below this amount by manual control of V_g, though sometimes irregularities in the characteristic permit oscillation at one or more *fixed* small amplitudes, but the effect is not very stable. As the difference between R and the initial value of ρ is still further widened, by adjustment of V_g or otherwise, oscillation sweeps over the nearer bend in order to make the average ρ equal to R. *The actual travel cannot be plotted by drawing the load line of R and noting the points at which it intersects the valve curve.* Oscillographic tests show that a line joining the two extremes of oscillation may even show a positive slope. The average along the actual curve must be negative, however, in order to maintain the oscillation. Fig. 4 shows typical oscillograph curves of oscillation at three values of V_g, with constant load and hence constant average ρ. The lines AA, etc., show how erroneous it would be to assume that they represent the average ρ.

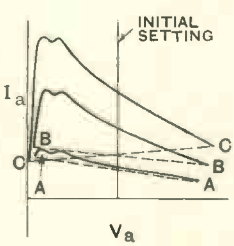


Fig. 4.

As the current in the oscillatory circuit is much more sinusoidal than I_a, which is the valve feed current, and the excursion of V_a is proportional to the former, one can see that the negative portion of the slope during which the valve feeds power into the oscillatory circuit is of longer duration than the positive portion when the valve absorbs power, and hence the balance is maintained.

The situation represented by the curve CC appears to be appalling as regards waveform, but it is not so bad as it looks, because of the fact just mentioned, that the oscillatory circuit current, and hence voltage across it, is much purer; particularly if the ratio $\frac{L}{C}$ is small. If this were not so, the violent flattening of the negative half wave would be counterbalanced by an excessive amplitude of the positive half, but as the diagram indicates, the amplitude is nearly as symmetrical in the over-oscillating adjustment as it is in the gentle one.

Nevertheless, CC is not an ideal state of affairs when harmonics are objected to, and oscillation should be restricted to the nearly straight travel.

It has already been explained that in ordinary practice this is difficult or impossible, so in the interests of stability R, or more conveniently ρ, is adjusted so that oscillation extends up to and slightly beyond the upper peak. Though purity of waveform is thereby sacrificed to some extent, practical tests show that it is a considerable improvement on the wave-form obtained from a triode oscillator operated under comparably stable conditions.

The other important feature is that although the amplitudes of harmonics are greatly dependent on such adjustment, the fundamental is not, and may be relied upon to be constant within fairly close limits. In fact, it may be predetermined to useful accuracy without direct measurement, simply by choosing an appropriate anode voltage.

Control of amplitude, where desired, is carried out by adjustment of V_a, and where about 5 per cent. accuracy is sufficient an anode voltmeter may be directly calibrated in oscillation voltage, which is to a great extent independent of other quantities. Zero corresponds to an anode voltage just to the right of the upper bend, and maximum corresponds to the centre of the dynatron slope. As V_a is further increased the oscillation amplitude diminishes again, but the first half of the slope forms the more satisfactory range of adjustment, because of the sharper limiting effect of the upper bend. Also because I_a is kept away from the negative region, I_s is minimised and greater power may be safely applied.

An exception to this useful property occurs in valves in which I_a is mainly negative. As the average ρ cannot be increased by I_a becoming negative at the low voltage end, oscillation continues along the voltage axis and the amplitude increases until the second bend comes to the rescue. Fig. 5 is a sketch of an oscillograph trace of such a valve, the thick line indicating the extent of the oscillatory voltage.

Excluding this case ; the desired maximum amplitude being known, the necessary V_s

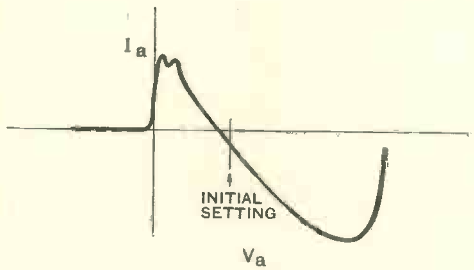


Fig. 5.

follows, being approximately 20 volts more than the double amplitude. V_g is then set to the greatest negative value consistent with stability of oscillation. In a variable-frequency oscillator a greater margin of stability is necessary because of the consequent variation of R. Assuming condenser adjustment of frequency, and R being equal to $\frac{L}{rC}$ where r is the resistance of the inductor, it tends to drop as the capacitance is increased, unless steps are taken to compensate for it. This may be done by designing the coil to have a resistance sharply rising with frequency, or conveniently by shunting it with capacitance and resistance in series (Fig. 6). The values are adjusted experimentally to suit the characteristics of the coil and the permissible minimum capacitance.

When it is important that harmonics should be excluded, or at any rate the somewhat variable harmonic content that is unavoidable even with intelligent manual control of V_g, it is worth while adopting automatic amplitude control. This is closely allied to automatic gain control as used in receivers, and the numerous published articles on that subject furnish information on the technique, which is in most respects applicable to oscillators also. As far as the writer is aware, only one article has appeared dealing specifically with oscillator control (27).

In its simplest form, the oscillation voltage is applied to a diode, and the unidirectional potential thus obtainable is used to control V_g. If the whole of the oscillation voltage is so applied, a very steep control of ρ can be obtained, so that once the amplitude of oscillation has built up to the amount sufficient to bring V_g to the point corresponding to the ρ which permits of oscillation at that particular amplitude, any further increase in amplitude brings into play a very large restoring bias. The result is an extraordinary stability of amplitude, which may be made to extend over any desired part of the slope. If the diode is arranged so that the potential of the anode is at the starting point of anode current, any amplitude of oscillation whatever causes a controlling bias to be applied, and consequently the amplitude is kept extremely small, and may be made still smaller by applying an initial bias to the dynatron. Larger amplitudes are obtained by biasing the diode, so that control comes into operation only when the peak oscillation voltage exceeds the bias. The amplitude thus bears a simple relation to the diode bias voltage, and by suitable design may be made approximately equal to it, within a few per cent.

The oscillation peak must of course exceed the diode bias by an amount which (unless amplified control is used) cannot be less than the controlling bias necessary to arrive at equilibrium. Therefore, when it is wished to judge the amplitude of oscillation by reading the diode bias voltage it is desirable either to have an auxiliary manual control to apply *approximately* the correct bias to the dynatron, or to make the diode bias large compared to the necessary controlling bias.

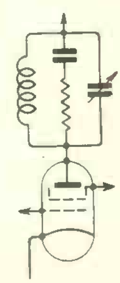


Fig. 6.

This method of operation is a close approximation to the ideal linear oscillation, and provided that the diode load is kept small the purity of waveform is exceptionally good. The amplitude may be adjusted very conveniently over a wide range while preserving the pure waveform. And it is obvious that by connecting in series with the diode bias a source of relatively low-frequency alternating voltage, very perfect modulation of the dynatron oscillation is obtained, and that the depth of modulation is equal to the ratio of peak modulating voltage to steady bias voltage.

As the tendency is to drive even laboratory apparatus without batteries, the assumption

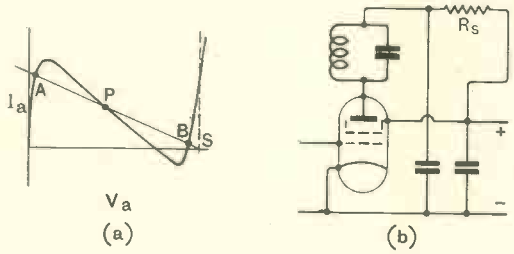


Fig. 7.

as to fixed supply voltages is not always justifiable. It is possible to arrange a fairly low impedance source for supplying the screen electrode, and power supply circuit impedance can be largely eliminated so far as A.C. is concerned by suitably large by-pass condensers. The obvious method of deriving the anode supply is by a voltage-dropping resistor in series, in conjunction with a large condenser. Attempts to accomplish this are rewarded by an entire absence of results. The reason is clear by drawing the line representing the feed resistance R_s (Fig. 7) from the point S, corresponding to the screen voltage, to the desired working point P. This line cuts the valve curve in two other places, A and B, and as at P the voltage-dropping resistance *exceeds* the valve negative resistance it is an unstable state of affairs, and the working point promptly settles down at A or B, depending on which end it starts from. These being pronouncedly positive in character, there is not the faintest hope of dynatron action.

So it is necessary to take the anode supply from a potential divider of resistance considerably lower than ρ. When using very low ρ valves, such as the Mazda AC/S2, it is important to exclude from the anode circuit any coils, such as even a single turn of wire, otherwise undesired oscillation is liable to confuse matters.

As ρ is the most important characteristic of the valve, it may be well at this point to refer to methods of measurement. An obvious way is to plot curves and draw a tangent at the working point. This is tedious and inaccurate. Another method is to display the curve on the screen of an oscillograph; expeditious enough if the apparatus is set up, but even more inaccurate. An excellent method is that described by E. N. Dingley (18), the circuit of which is shown in Fig. 8. This is a very simple bridge comprising source and detector, tapped resistor R_1 R_2, and resistance box R_3. When balance is obtained

$$\rho = \frac{R_1 R_3}{R_2} + R_1 + R_3$$

Convenient values are $R_1 = 99$ and $R_2 = 1$. The expression then reduces to $\rho = 100\,R_3 + 99$ and the 99 is often negligible. A decade box from 10–10,000 ohms gives therefore a range of from 1,000 ohms to one megohm. For accurate results the usual precautions in bridge work must be observed. Two factors that prevent extreme sharpness of balance are (*a*) the capacitance of the valve electrodes and leads, which may be neutralised by a mutual inductometer (shown dotted), and (*b*) the curvature of the valve characteristic. This gives rise to harmonics at balance which are aurally distinguishable if phones are used, and may be rendered negligible by using a small signal. When properly arranged, balance can be obtained to a few parts in 10,000. The steady voltage drop in the apparatus is negligible.

At very high radio frequencies the dynamic resistance R of oscillatory circuits is low, and difficulty may be experienced in obtaining oscillation (19). The present writer has pointed out (19) that the AC/S2 valve is particularly suitable, and strong oscillation at 60 megahertz has been obtained.

The capacitance of the anode to other electrodes should for various reasons be as

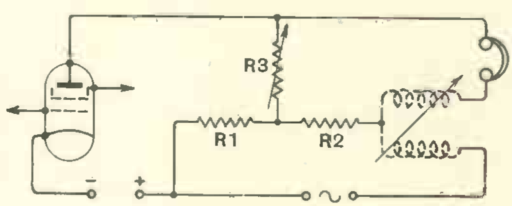


Fig. 8.

small as possible (11, 15, 23). It may be as high as 17 $\mu\mu$F. or as low as 2.5 (23). British valves are superior to American in this respect, that the power factor of the admittance is low, owing to the anode being brought out at the top terminal. They also appear to be better in oscillating properties (25).

All types seem to be consistent in one respect, namely their inconsistency. Samples which are closely uniform when used as amplifiers display marked disparity in dynatron characteristics. The dynatron effect is a more or less accidental one, and is in fact something of a blemish for the more common purposes of the valve, and so designers do not try to obtain consistency in this respect. For laboratory purposes valves must in any case usually be selected, so this drawback is not so serious as for large scale activities; but possible applications may make it desirable for more attention to be devoted to this matter.

The Table showing the principal characteristics of some prominent types of valves gives the averages of several samples in some cases, but ρ is liable to vary considerably from the figures quoted. It also varies in any one valve over the slope; the values given refer to points near the centre of the slopes, and may be considerably lower near the upper bend. As low as 2,000 ohms has been measured. Fig. 9 shows a typical characteristic. Variable-conductance valves are generally less suitable than other types, because of the greater range of grid bias required to effect a given degree of control. This is particularly so in the case of automatic control, and in Fig. 10 the degree of control which V_g has on ρ is indicated by the slope of curves drawn for various valves.

Turning now to dynatron applications: the first to be described in extended detail

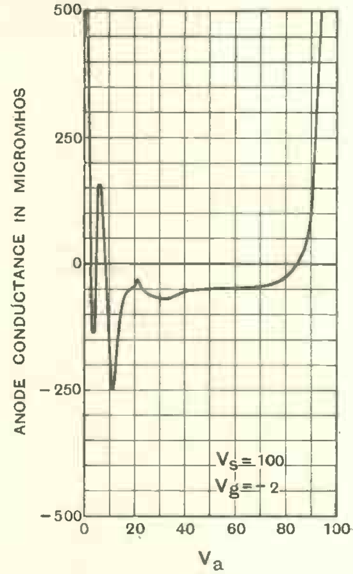


Fig. 9.—*Anode resistance of ACS2 (expressed as conductance to avoid discontinuity).*

was that of detector in a heterodyne receiver (3). This paper by A. W. Hull is not so out-of-date as the year of publication might suggest, and though heterodyne reception has been in abeyance for some years because of the focussing of attention on telephony rather than C.W., the revival of the superheterodyne makes this 10-year-old paper

TABLE.

($V_s = 100$)

Valve.	Negative Resistance ohms.		$I_a + I_s$ mA.		I_g starts at $V_g =$	C_{a-s} $\mu\mu$F.
	$V_g = 0.$	$V_g = -2.$	$V_g = 0.$	$V_g = -2.$		
Mazda AC/SG ..	13,000	20,000	17.6	11	−0.1	17.5
,, AC/S2 ..	6,400	11,400	19	9.8	−1.1	11.2
,, AC/S1VM ..	13,000	18,000	12.5	9.3	−0.4	11.0
Mullard S4VB ..	38,000	80,000	8.2	2.9	−0.5	6.3
,, S4VA ..	40,000	110,000	9.5	2.7	−1.1	7.0
,, MM4V ..	18,000	35,000	13	6.5	−1.1	7.0
,, PM12A ..	30,000	70,000	4	1.8	−0.3	5.8
Cossor MSG/LA ..	27,500	40,000	13.3	5	−0.9	13.2
,, VMSG ..	35,000	50,000	13.4	8	−0.5	12.0
,, 220VSG ..	14,800	26,000	11	6.3	0	6.9

V_g and I_g = control grid voltage and current respectively.
V_s and I_s = screen grid voltage and current respectively.
V_a and I_a = anode voltage and current respectively.
C_{a-s} = capacitance from anode to screen.

worth studying. The principal objection to the dynatron as a single-valve frequency changer is the inconsistency of its characteristics—not an insuperable difficulty, surely. The freedom from interaction between the anode oscillating circuit and the grid circuit is a very attractive feature for superheterodyne purposes, as is also the absence of oscillator reaction coil.

For the latter reason the dynatron finds an obvious vocation in wavemeter work. An existing absorption wavemeter, consisting of a coil and condenser, may be converted into a generating wavemeter without the loss of accuracy that would result from adapting to a triode circuit. Tests carried out by Messrs. H. W. Sullivan, Ltd., have established the fact that in suitable screen-grid valves the added capacitance is both small and stable and is consistent with the maintenance of very high precision so that the wavemeter error may be held down to 1 in 20,000. (30) The Mullard S4VA valve is used for this

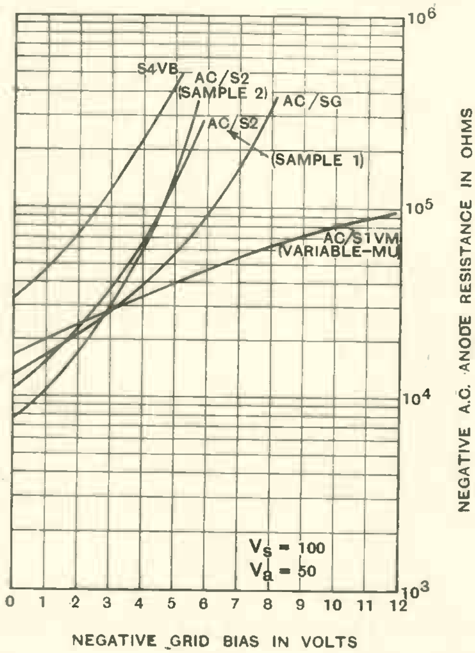


Fig. 10.—*Slope of curves* $= \frac{dV_g}{d\rho} \cdot \frac{1}{\rho}$, *which is a measure of control of grid on negative resistance.*

purpose and its relatively poor oscillating powers are no drawback in such low-loss oscillatory circuits.

The differences in capacitance between valve and valve, of the order of 1 $\mu\mu$F, are taken up by a fine adjustment calibrated for a number of spare valves.

Another useful wavemeter produced by the same firm is due to N. W. McLachlan (8) and theoretical points in connection with it have recently been dealt with by him (21, 23). Both radio and audio-frequency circuits are connected in series with the anode and when suitably arranged a completely modulated signal is given. The precision is lower, but for many purposes the advantages of modulation are more to be desired. The matter of modulation will be discussed later in another connection.

Apart from the convenience of application and the stability of interelectrode admittance, the dynatron is superior to the triode oscillator as regards independence on accurate supply voltages (17, 25). For all except the utmost precision it is possible to dispense with meters for setting the voltages exactly, so long as oscillation is no more than adequately maintained. The frequency of oscillation with a low-loss circuit is then extremely close to the limiting value $\frac{1}{2\pi\sqrt{LC}}$.

The advantages of using a dynatron for maintaining a crystal fixed-frequency standard have been investigated in a paper (25) which, among other interesting results, shows how oscillation can be maintained with battery feed interrupted by a crystal in the anode circuit. The maximum variation of feed voltages over which oscillation is possible is said to affect the frequency by an amount of the order of one in a million.

The standard signal generator for receiver performance testing requires an oscillation of stable and controllable amplitude, low harmonic content, and capable of amplitude modulation to any desired depth without frequency modulation. The dynatron fulfils these requirements with a notable absence of the elaborate associated equipment necessary for triode oscillators, and is therefore particularly suitable for commercial test-gear.

The intensity of the signal is controlled over a wide range by an attenuator, but as it is inconvenient to cover the necessary range (which may be 100 *db* or more) with close steps, it is desirable to be able to vary the amplitude of oscillation over a few *db* without shifting the frequency or waveform appreciably. Either the anode voltage control, or the automatic control already described, with voltmeter calibrated direct in *db*, fills this need.

The self-modulating circuit of McLachlan is not sufficiently flexible, but a separate audio-frequency dynatron makes possible any

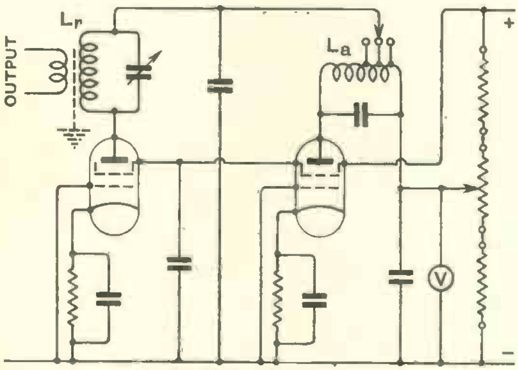


Fig. 11.

desired depth of modulation without interfering with the other adjustments. Fig. 11 shows a skeleton circuit of the anode control type. The two oscillators are run in parallel, with simultaneously variable anode voltage, but whereas the a.f. oscillator is fed straight from the supply, the r.f. anode circuit includes a portion of the a.f. coil L_a. As the oscillatory voltages across L_r and L_a are equal, a tapping to give any desired depth of modulation from 0 to 100 per cent. can easily be arranged.

The only difficulty is likely to occur when deep modulation is required and the whole or greater part of L_a is in series with L_r. The arrangement is then equivalent to the self-modulating system and the a.f. valve is likely to lose control of the situation. There are various possible methods of dealing with this; one is to make the dynamic resistance of the r.f. circuit appreciably higher than that of the other, so that when the valve is properly adjusted it is incapable of stimulating oscillation in the a.f. circuit. The relatively lower dynamic resistance of the a.f. circuit should be obtained by a low $\frac{L}{C}$ ratio rather than by high loss resistance, as it is more important to avoid harmonics here than in the r.f. circuit. This desideratum is facilitated in the equipment described by employing a fixed audio frequency which permits close adjustment of oscillation.

These considerations are easily confirmed by connecting one pair of cathode-ray oscillograph deflection plates across L_r and the other across the portion of L_a common to both valves. Fig. 12 shows the images corresponding to various operating conditions. When none of L_a is included, or no a.f. oscillation is taking place, the r.f. oscillation is indicated by a straight line (*a*), the length being a measure of the amplitude. The correctness of the amplitude control, and independence on other adjustments, is confirmed. When tapped for 50 per cent. modulation the figure (*b*) results. The depth of modulation is easily derived, being $\frac{CD - AB}{CD + AB}$. With pure linear modulation the sloping sides are straight and inclined at 45°. This is a test of modulation *per se* and not of a.f. waveform, which has no influence on the shape of the figure, though it may cause unevenness of illumination.

The right-angled triangle (*c*) is the sign of perfect 100 per cent. modulation. (*d*) indicates over-modulation, and is particularly likely to take place in the self-modulating circuit. This condition is also detected by the sound of the resulting signal.

The dynatron system described yields results as perfect as the oscillograph is capable of indicating. As the amplitude control is operated both oscillation voltages vary equally and the depth of modulation is preserved constant. The range of adjustment

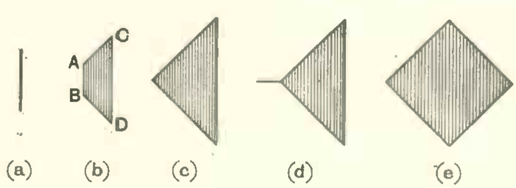


Fig. 12.

is limited to a quarter of the distance from the upper bend to the lower. By going beyond the limit a second triangle begins to form and, at the centre of the slope, appears as a complete image of the first (*e*). There are then two complete cycles of modulation to each one of the a.f. oscillator—a perfect frequency-doubler.

Obvious extensions of the system, such as the substitution of an amplifier valve for the a.f. oscillator, to permit of modulation by an external source of any kind, require no detailed description.

If automatic control is applied—and it is well worth while—there are many possible variations of circuit design, and a mass of detail is involved which lies outside the scope of this general article. It may be possible later to give some account of this. Fig. 13 shows the bare bones of the method. The amplitudes of both r.f. and a.f. oscillation are simultaneously adjusted by the slider S_1, which biases the cathodes of both control diodes positively, and the slider S_2 controls the percentage modulation by tapping off a proportion of the a.f. potential. Filter systems are included in the grid leads of both dynatrons, to prevent oscillation-frequency potentials from being impressed on them, but in the case of the r.f. valve to allow modulation-frequency potentials to have full effect.

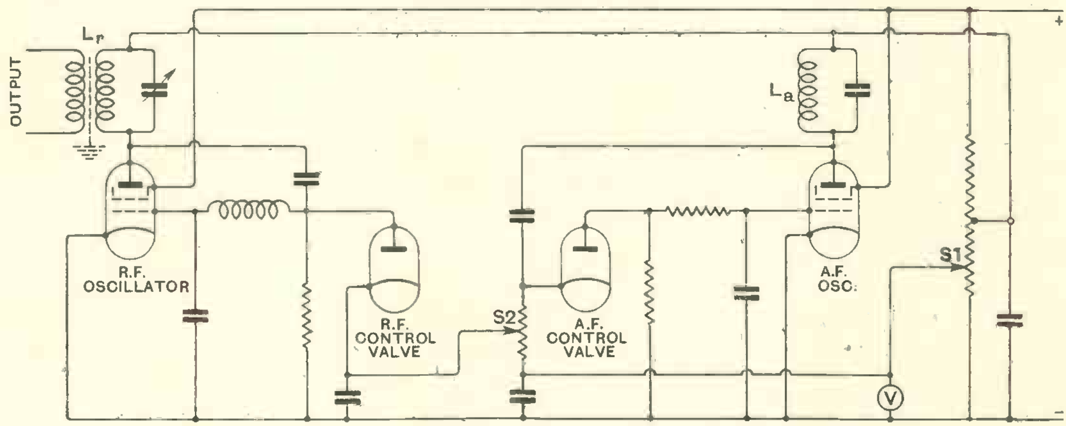


Fig. 13.—*Modulated oscillator with automatic grid bias controls.*

Particular valves are not given, because they are a matter for circuit design, depending on the frequencies of oscillation and other factors.

The companion piece of equipment essential for all performance testing, not only of radio receivers, but also of lines, amplifiers, filters, etc., is the beat-frequency oscillator. Two systems compete for favour. In the less-known one equal signals are applied to a square-law detector and a beat-frequency of good waveform results. The more popular method applies a weak and a strong signal to a linear rectifier. Both call for oscillators giving outputs of fairly definite voltage and great constancy of frequency. This is, therefore, another promising field for the dynatron.

An instrument designed to utilise a pair of dynatron oscillators proved very successful. Each anode circuit included a tuned astatic step-down transformer with a primary voltage of about 20 and a screened secondary with 1 volt output feeding a 500-ohm non-reactive resistor. The whole of the potential across one resistor and one-tenth that of the other were fed into a power grid detector. The weak signal frequency was fixed at 50 kilohertz and the strong signal varied from 40 to 50, giving a beat-frequency from 0–10 kh.

This was obviously a case for automatic control, as harmonics are practically eliminated, and oscillation maintained, regardless of frequency adjustments or of valve deterioration. In fact, any dynatron which will oscillate at all can be plugged in and will work always at the optimum adjustment. (See Fig. 14.)

Apart from the screening between the windings of the tiny r.f. transformers, no screening of any description and no buffer valves were found necessary—greatly simplifying construction—and beat oscillations of less than one cycle per second were obtainable. The frequency stability of the dynatron is of great value in this application, and the residual drift largely cancels out because of the symmetrical construction.

The utility of the dynatron is not restricted to adjustments which cause continuous self-oscillation to be maintained, but may be realised for the purpose of reducing losses in a tuned circuit (28). It is not always practicable to employ a triode in such cases.

Some considerable attention has been devoted to the application of the dynatron to the popular problem of measuring r.f. resistance. Colebrook (17) favours the dynatron in the subsidiary rôle of oscillator in a method requiring exceptional frequency stability but not otherwise connected with dynatron properties. Pauli (9) appears to have been the first to describe a method of measuring positive resistance by equalising it to the negative resistance of the dynatron, and Iinuma (11, 13, 15) who worked independently along the same lines has developed the technique in important respects. The present writer (24) has suggested a substitution method for rapidly measuring resistance and reactance, which is capable of useful elaboration.

The method of Iinuma is exceedingly simple. The oscillatory circuit whose resistance is to be measured is connected in series with the anode, and the grid bias is adjusted to the oscillation point. The negative resistance of the valve is measured at this point, and is numerically equal to the dynamic resistance R of the unknown.

As $R = \frac{L}{rC}$, r, the effective resistance of the coil, follows from a knowledge of L and C or L and f. The principal theoretical error is that due to the r.f. loss in the valve admittance. Iinuma has made a detailed investigation of this error and found it to be small in most cases (15). Reasonably good overall accuracy is claimed in spite of several disadvantages which he unnecessarily suffered. American valves were used, which as other workers have found (25) are not nearly such good dynatron oscillators as certain British types. Excessive screen currents are required for even moderately low negative resistance. The anode is brought out at the cap along with the other electrodes, resulting in larger capacitance and bad power-factor. The method of measuring ρ was by increments—a much less satisfactory way than that illustrated in Fig. 8.

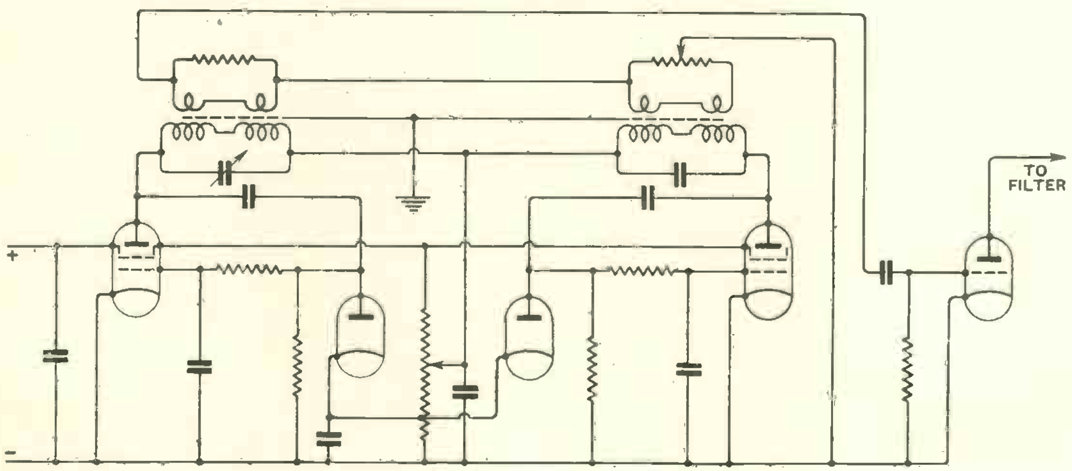


Fig. 14.

With these improvements this method may be expected to compare very favourably in accuracy with any known methods, and convenience and rapidity are much greater.

The dynamic resistance of a tuned circuit can be measured over a wide band of frequencies in a few minutes, and by a suitable switch-over to the bridge of Fig. 8 errors of manipulation and calculation are far less likely to arise than in systems of possibly greater theoretical precision. It will be noted that measurement is not confined to radio frequencies.

Tests made on a number of coils from 12 μH to 50,000 μH showed remarkable consistency of results. Measurements were made with and without a short piece of fine eureka wire in circuit, and the resistance of this wire, as given by the difference between the results of the two tests, was compared with the measured d.c. value. The error, relative to the whole resistance in circuit, was less than 1 per cent., except at the extremes of frequency. A Mullard S4VB valve was used, having a capacitance from anode to other electrodes of only 5.6 $\mu\mu F$ and power-factor of 0.01, and thereby introducing a loss smaller even than that of the standard condenser used for tuning the coils.

A feature of the method which is especially valuable in these days when "potted" coils are the rule is that, unlike other methods, magnetic coupling to the coil under test is not required. Another feature of great practical value is that an oscillatory circuit of the type used for r.f. amplification can be measured *in situ*, by rearranging the feed connections to convert its amplifying valve into a dynatron. Condenser, screen, and lead losses are thus included, and the actual amplification can be estimated with accuracy.

It is important to observe that it is assumed that the resistance of the valve at the threshold of oscillation is the same as that measured by the bridge. Apart from the possible difference due to valve dielectric loss already mentioned there is an obvious discrepancy if the valve stops oscillating abruptly as described in an earlier section. The secret of accuracy is to adjust the valve to eliminate electrical back-lash in the oscillation control. The loss due to the valve can be estimated by paralleling in another valve of the same type.

This naturally suggests the measurement of power factor and permittivity of dielectrics against a standard low loss variable condenser at any audio or radio frequency. The dielectric sample is clamped between metal plates to form a condenser in parallel with the standard. A coil appropriate to the frequency of the test, and of as high efficiency as possible, completes the oscillatory circuit. After a test with the sample in circuit it is removed and the initial frequency restored on the standard condenser before making a further resistance test. If C is the capacitance difference (and therefore that of the sample) and R_1 and R_2 the two dynamic resistance readings; neglecting the change in resistance contributed by the standard condenser, and assuming the power factor of the unknown is not very large, then power factor

$$= \frac{R_1 - R_2}{\omega C\ R_1 R_2}$$

The usual beat or double beat note method enables the frequency $\frac{\omega}{2\pi}$ to be brought to equality in both tests.

The sensitivity of the method, depending as it does on the difference between R_1 and R_2, is increased by making the capacitance C of the sample a large proportion of the total. At the same time it is desirable in the interests of accuracy for the self-capacitance of the coil to be a small part of the whole, and as it is seldom possible for the capacitance of the sample to be numerically large, one must use common sense to judge of the best condition of measurement.

A somewhat similar method has been extensively used by the writer in research on r.f. chokes. These may be considered as an admittance which is a source of loss to any circuits across which they may be effectively in parallel. This admittance is conveniently represented by a resistance shunted by a reactance, but for ease of measurement and for comparison a positive or negative capacitance was the form in which the reactance was actually expressed. It was necessary to test a very large number of chokes over the whole useful broadcast band of 150 to 15,000 kilohertz at frequent intervals because of the numerous sharp sub-resonances. The apparatus employed was a dynatron oscillator with grid bias control and voltmeter, low-loss coils covering the range of frequency, a main tuning condenser, and a small variable-maximum condenser on which readings could be taken to 0.1 $\mu\mu$F. Curve sheets were made out covering the whole range of frequency and with V_g as ordinates. A preliminary test was made to mark off the sheets with curves corresponding to the critical V_g for just stopping oscillation, with various high non-reactive resistances, from 20,000 to infinity, shunted across the tuned circuit. This resulted in a number of roughly horizontal lines. Having thus calibrated the valve, runs could be made on chokes shunted across, and the resulting curves plotted on the prepared sheets indicated the effective parallel resistance of the choke over the range of frequency; and very interesting results they were. The initial calibration curves being not perfectly horizontal, a more accurate impression could be gained by replotting to resistance ordinates, but for getting a preliminary idea of the performance this is not necessary.

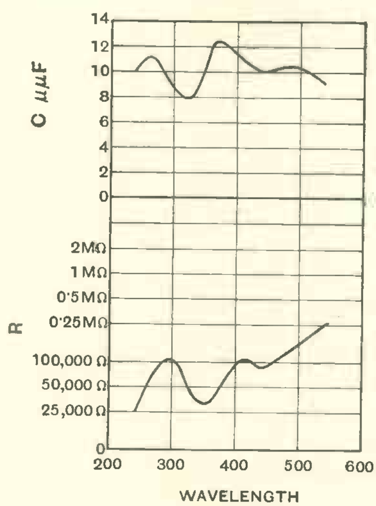


Fig. 15.

Well-designed chokes maintained a resistance of one megohm or more over most of the range, but some samples descended well below 20,000 ohms in places!

The capacitance was obtained from the usual substitution readings, and showed obvious relationship to the resistance curves (Fig. 15). Large capacitance and low resistance ran in accompaniment, and the shape of the capacitance curves at resonances was that of a first differential of the resistance curves, for reasons explained in any standard theory. The frequencies were in all cases equalised at the threshold of oscillation.

The change of frequency resulting from the connection of the choke was assumed to be entirely due to the capacitance thereof. In view of the fact that large changes in resistance were involved, this assumption is not justified by theory. The usual theory appears, however, to be at variance with the facts, as will now be explained.

The usual expression for the frequency of oscillation is

$$\omega = \frac{1}{\sqrt{LC}}\sqrt{1 - \frac{r}{\rho}}$$

where r is the *series* resistance of the oscillating circuit, and ρ is, as before, the resistance of the valve, expressed as a positive quantity.

As $\frac{r}{\rho}$ is normally small compared with unity,

$$\omega \approx \frac{1}{\sqrt{LC}}\left(1 - \frac{r}{2\rho}\right)$$

(Bibliography, 19, 21, etc.)

Now even in cases where ρ has been recognised to be variable over the cycle of oscillation, results have been deduced on the tacit assumption that it is constant. Actually the only case that can be expressed in mathematical form is one which is of no practical interest—an infinite linear valve characteristic. For example, some writers have conveyed the impression that it is legitimate to use the above expression for computing change in frequency of oscillation due to varying V_g (and hence, we suppose, ρ) with a circuit of fixed r. It is a fact, noted by Percival (19), that it is possible to obtain very large shifts of frequency by so doing.

The absurdity of accounting for such shifts by the assumption of a change in the ratio $\frac{r}{\rho}$, r being a constant property of the oscillatory circuit, and ρ varied by control of grid bias or otherwise, is clearly shown by a little substitution.

R, the dynamic resistance of the oscillatory circuit, must be equal to ρ, for any difference would be inconsistent with uniform amplitude of oscillation. But

$$R = \frac{L}{rC}$$

So $$\frac{r}{\rho} = \frac{r^2C}{L} = \frac{r^2}{\omega^2L^2} = \frac{1}{m^2}$$

where m is the " magnification " of the coil, which is not a function of the valve at all, and the frequency is therefore constant! The fallacy lies in the failure to recognise ρ as a periodic variable. It is no use trying to avoid the difficulty by assuming ρ to be very nearly constant over the cycle of small amplitude oscillation and then applying it to a case where, due to the large difference between the value of ρ and R, oscillation of the type shown in Fig. 5 takes place! It is impossible to predict the effect on frequency of altering the dynatron slope of the valve, without an appalling problem in integration based on knowledge of the whole characteristic.

It may perhaps be supposed, however, that the expression for frequency finds a legitimate application where the valve is adjusted to the threshold of oscillation, and that the correction term $\frac{1}{2m^2}$ is negligible for highly efficient oscillatory circuits but appreciable for inefficient ones. Thus, a good coil has an m of, say, 225, and the correction is only ten parts in a million. With a bad coil having an m of 22.5 the correction is 1,000 parts in a million.

In the choke tests described the equivalent value of m was reduced to still smaller values, and as the change in frequency was ascribed solely to the very small capacitance of the choke, it appears as if large errors are involved.

Assume that no capacitance is added to the circuit except that due to adjustment of the measurement condenser necessary to preserve the frequency constant when a resistance R_x is connected in shunt. The added capacitance is $-C_x$. ρ_1 and ρ_2 are the resistance values before and after. The frequency correction term is constant, *i.e.*:—

$$\frac{r_1}{2\rho_1} \approx \frac{r_2}{2\rho_2} - \frac{C_x}{2C}$$

$$\frac{L}{\rho_1^2} \approx \frac{L}{\rho_2^2} - C_x$$

$$C_x \approx L\left(\frac{\rho_1^2 - \rho_2^2}{\rho_1^2\rho_2^2}\right)$$

Within the bounds of the approximation made in deriving this result, C_x works out at values of the same order as those ascribed to the capacitances of the chokes, and thus appears to invalidate the method of test.

Special tests were therefore carried out to shed light on this matter. A dynatron oscillator was set up with a switch-over to the bridge for measuring ρ, and small resistors (Erie $\frac{1}{4}$ watt type) of various values shunted across the tuned circuit, the capacitance being adjusted by the double-beat method to keep the frequency exactly constant throughout. In one run a coil of approximately 7,150 μH was used at a frequency of 150,000.

The capacitance of the resistors was measured by comparing one resistor with two others in parallel each of double the resistance, and found to be 0.8 $\mu\mu$F. The value of ρ with no resistor was 217,000 ohms.

Nominal Shunt Resistance.	ρ	Added Capacitance $\mu\mu$F to keep f constant.	Capacitance Due to Reduction in ρ $\mu\mu$F.	Ditto Calculated $\mu\mu$F.
—	217,000	0	—	—
250,000	116,000	0.8	0	0.4
50,000	43,900	1.0	0.2	3.6
25,000	23,300	1.1	0.3	13
10,000	10,650	1.6	0.8	63

This tends to restore shattered confidence, for it is difficult to see how an effect as large as that predicted by theory could have been missed. Other tests gave consistent results. Curiously enough the capacitance required to compensate for withdrawing the various resistors *without readjusting* V_g *to the threshold of oscillation* was in each case of the order of that given in the last column. It is not claimed that this is more than a coincidence!

The shift of frequency in practice, then, is comfortably small even over a considerable range of oscillatory circuit resistance.

Conclusion

The dynatron is, as has been seen, useful. It might be still more useful if the valve manufacturers cease to regard it as an accident.

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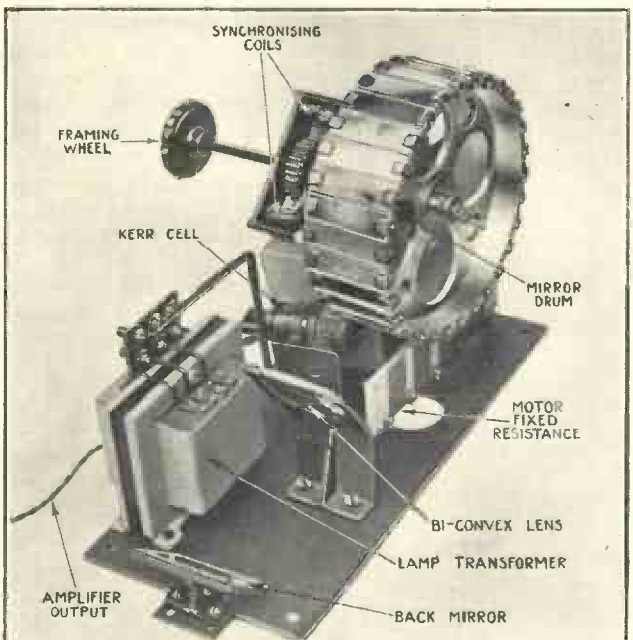

A New Television Receiver

A NEW television receiver on the Baird mirror-drum principle has recently been produced by Bush Radio, and the accompanying illustration shows the general construction of the television projector unit, the image being reflected from the rotating mirror-drum on to a screen 9in. × 4in. area.

With the present B.B.C. broadcasting carried out on 30 line 12½-picture system, the mirror-drum method is probably as satisfactory as any other; it is only when greater definition is required that the advantages of cathode ray systems are appreciable.

With this new Bush Radio receiver the programme can be followed with ease, and definition is sufficient to make well-known faces readily recognisable. A feature of the design is the simplicity of the synchronising system. In operation it is not unusual to be able to leave the apparatus without attention to the synchronising controls throughout the full period of the present B.B.C. half-hour transmissions.

S.-G. Valve as Superhet Detector*

By C. B. Fisher

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THE following notes on the use of a screen-grid valve as a first, or heterodyne, detector in a superheterodyne receiver are intended as an amplification of an article by E. C. L. White, entitled "The Screen-Grid Valve as a Frequency-Changer in the Super-Het." which appeared in *The Wireless Engineer*, November, 1932.

White discusses the circuit in which the local oscillations are introduced into the anode circuit. This is, of course, similar to the usual anode modulation circuit, but the conditions for modulation are different to those with which we are more familiar. White points out first that modulation can take place even when the anode-voltage, anode-current, and grid-voltage anode-current relations are both linear. Further, from measurements on a particular valve he shows that maximum efficiency is not obtained when the valve is biased to the knee of the grid-voltage anode-current curve. The analysis of the general case establishes these results, except that modulation is shown to be due to the variation of the plate resistance with grid-voltage, and not to variation of μ as stated by White, and shows other desirable operating conditions.

Let the variable part of the anode-current, i_a, over the operating range, depend in the most general way on the variable part of the anode voltage, p, and the variable part of the control-grid voltage, g.

$$\begin{aligned} i_a = {} & a_1 p + a_2 g \quad \ldots \quad (1) \\ & + a_3 p^2 + a_4 g^2 + a_5 g p \\ & + a_6 p^3 + a_7 g^3 + a_8 p^2 g + a_9 p g^2 \\ & + a_{10} p^4 + a_{11} g^4 + a_{12} p^3 g + a_{13} p^2 g^2 + a_{14} p g^3 \\ & + \ldots \\ & + \ldots \end{aligned}$$

The a's are constants for the particular valve under discussion, and depend in general on the fixed values of grid voltage and anode voltage about which g and p are variations.

For the sake of ease of manipulation and also because as we shall see higher order terms are not important in practical cases, we shall consider only the terms of power four or less. Let the voltage introduced in the grid circuit be a sine wave of radian velocity w_1 and amplitude A modulated by a second sine wave of radian velocity w_2, the depth of modulation being M. Then

$$g = A \cos w_1 t (1 + M \cos w_2 t) \quad \ldots \quad (2)$$

Let the local oscillator voltage have a radian velocity w_3, and amplitude B. Then

$$p = B \cos w_3 t \quad \ldots \quad \ldots \quad (3)$$

No general phase relations have been assumed between the three sine waves, as it can be shown that this is not necessary to obtain general results. By inserting relations (2) and (3) in equation (1) and expanding in first power cosine terms, the current which is passed on to the intermediate-frequency amplifier from the detector may be determined. The only terms of interest are those made up of expressions of the form $\cos(w_1 - w_3 \pm n w_2)t$ where π is zero or an integer.

These expressions represent the carrier and sidebands at the intermediate frequency. Performing the indicated operations we find:—

$$\begin{aligned} i_a = {} & AB \cos(w_1 - w_3)t \left[\tfrac{1}{2} a_5 + 3/8 a_{12} B^2 + 3/8 a_{14} A^2 \left(1 + \frac{3M^2}{2}\right) \right] \\ & + \frac{M}{2} AB \left[\cos(w_1 - w_3 + w_2)t + \cos(w_1 - w_3 - w_2)t \right] \left[\tfrac{1}{2} a_5 + 3/8 a_{12} B^2 + \frac{9}{8} a_{14} A^2 \left(1 + \frac{M^2}{4}\right) \right] \\ & + \frac{9}{32} a_{14} M^2 A^3 B \left[\cos(w_1 - w_3 + 2w_2)t + \cos(w_1 - w_3 - 2w_2)t \right] \end{aligned}$$

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* MS. received by the Editor, December, 1932.

$$+ \frac{3}{64} a_{14} M^3 A^3 B \left[\cos (w_1 - w_3 + 3w_2)t + \cos (w_1 - w_3 - 3w_2)t\right] \quad .. \quad (4)$$

The first term represents the carrier at the intermediate frequency, the second term the upper and lower sidebands due to the modulation frequency, and the third and fourth terms represent respectively the sidebands which contain second and third harmonics of the modulation frequency. An examination of equation (4) yields the following information :—

1. There is an increase in depth of modulation through the first detector when a_{14} is positive. This will result in distortion upon demodulation by the second detector when the apparent modulation is greater than unity. That is, approximately when

$$M\left[\tfrac{1}{2}a_5 + 3/8a_{12}B^2 + \frac{9}{8}a_{14}A^2\left(1 + \frac{M^2}{4}\right)\right]$$

is greater than

$$\frac{1}{2}a_5 + 3/8a_{12}B^2 + 3/8a_{14}A^2\left(1 + \frac{3M^2}{2}\right).$$

Such will be the case only when M is near unity, as both a and A^2 are ordinarily small. It is not an important source of distortion.

2. There are present in the output, sidebands involving the second and third harmonics of the modulation frequency. There will ordinarily be sufficient carrier present to demodulate these terms, but they will in any case be small as they have as a factor A^3, ordinarily small in comparison with AB.

3. It is to be noted that the odd-powered terms of equation (1) contribute nothing to the modulation products delivered to the intermediate-frequency amplifier. The terms of power two contribute no distortion, this is caused by terms of power four or greater. Thus if the valve characteristics are such that the family of anode-voltage anode-current curves and also the grid-voltage anode-current curves are all parabolas or cubics, the first detector will be distortionless. Note also as a matter of interest that if all the a's except a_1, a_2 and a_5 are zero, distortionless modulation will result, even though the anode-current anode-voltage and anode-current grid-voltage relations are then everywhere linear. The characteristic surface becomes a twisted plane. If the characteristic surface is a true plane then $a_5 = 0$, and no modulation takes place.

4. Assuming that the shape of the characteristic does not change appreciably due to changing inputs, least distortion will result with as small a signal voltage, and as great a local oscillator voltage as possible.

5. For maximum gain the local oscillator voltage should be high, and the grid should be biased to the point at which a_5 is a maximum, assuming that a_{14} is small. For a discussion of the evaluation of a_5 see Peterson and Evans, "Modulation in Vacuum Tubes Used as Amplifier," *Bell System Technical Journal*, July, 1927. Their parameter b_{11}, corresponds to a_5 and is shown to be equal to

$$\frac{\partial^2 I_a}{\partial E_p \partial E_g} \text{ or } -\frac{1}{R_0^2}\frac{\partial R_0}{\partial E_g}.$$

Where E_p and E_g are the anode and grid voltages respectively, Ia is the anode current, and Ro is the anode impedance, all evaluated at the operating point. Thus the best condition for modulation does not require the amplification factor of the valve to vary, so that the application of the circuit is not limited to screen-grid valves. The above analysis however, applies exactly only where the load impedance is small compared to the anode impedances of the valve, and this will ordinarily be the case only with screen-grid or pentode valves.

These results indicate that the first detector can be expected to be free from distortion, and provide a means for finding the best operating conditions. The analysis, it should be noted, also applies directly to the rather important case in which the local oscillations are introduced into the circuit of a second grid of the heterodyne-detector valve, instead of the anode. A complete analysis would include a consideration of the effects of the load impedance on the operation of the heterodyne detector. By a comparison of equation (1) of the present discussion with equation (3) of Peterson and Evans' paper, already mentioned, the corresponding tube parameters can be written down. Then by a substitution into equations (6) and (4) of their paper, the expression for the anode current can be obtained, and broken down to give the modulation products in the usual manner. The procedure for a generalised load impedance is given by F. B. Llewellyn, "Operation of Thermionic Vacuum Tube Circuits," *Bell System Technical Journal*, July, 1926.

Olympia, 1933

A Review of Exhibits of Technical Interest at the Annual Radio Show

IN this year's receivers the emphasis is on foreign station reception, as exemplified by the use of the superheterodyne principle to secure selectivity, automatic volume control to counteract fading, and various devices to combat "man-made static."

In the early days of the superheterodyne its chief claim was that of sensitivity; but the problem of selectivity has recently become so acute that it is this quality which is responsible for its present popularity. Almost every receiver with a pretence to long-distance reception is of this type, although at least three of them have no I.F. amplifier but merely I.F. tuned circuits to provide the desired selectivity. An example of this practice is to be found in the Kolster Brandes Model 444 A.C. mains superheterodyne, which employs only three valves in the receiver proper—one of the new H.F. pentodes as combined oscillator and first detector, a similar valve as second detector and a power pentode output valve. It may seem strange to have associated "man-made static" with long-distance reception in the K.B. range of sets; but the increasing use of electricity for domestic and other purposes is making this type of interference more common, and the increasing sensitivity of the modern receiver is responsible for making it more noticeable.

Battery sets have retained their popularity, thanks to the new economical output stages such as Class "B" and quiescent push-pull, which will give an output of the order of one watt of undistorted A.C. on full modulation, while on a normal programme the H.T. consumption averages only 7 milliamperes at 150 volts.

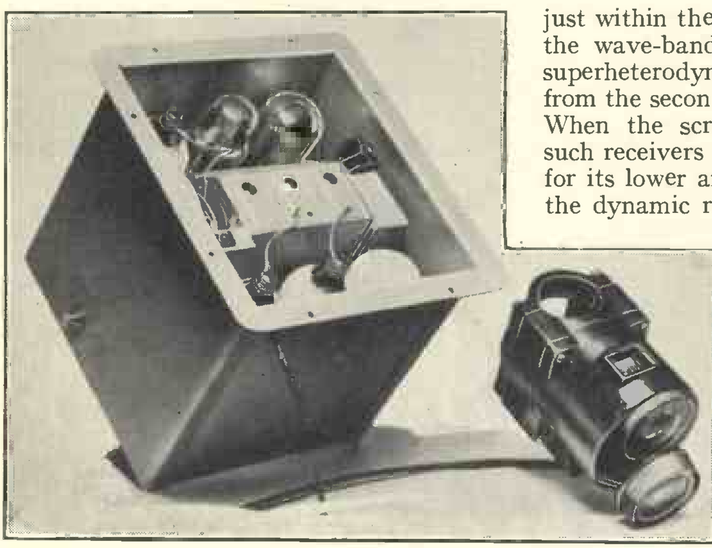
The majority of receivers are still described by the number of valves employed, including the H.T. rectifier in mains receivers, but E. K. Cole intend to classify theirs according to the number of "stages" employed. One complication is that to fall in line with circuits employing diode detection the triode detector should be given credit for its two functions of rectification and amplification, and classed as two stages. Other difficulties are special A.V.C. valves, and the oscillator of the superheterodyne. For, if one is considering the "quantitative" performance of the receiver, *i.e.*, the number of stations received, it seems reasonable to count only those stages which are in the direct chain between aerial and loud speaker; but if one considers it "qualitatively," *e.g.*, freedom from fading, reliability of oscillator performance, these extra valves must be included, and in one or two receivers there is a battery-economy rectifier connected to the output valve which would demand consideration. However so little information is conveyed by the bare number of "valves" or "stages" that the particular nomenclature adopted is probably immaterial provided that a standardised convention is adopted by all manufacturers.

Midget and Car Receivers

Midget sets are being made by Sunbeam Electric, Ltd., but the most attractive feature incorporated in these receivers, universal operation from A.C. or D.C. mains, is available also in normal sized receivers made by Cromwell Ltd. and many other manufacturers. The midget receiver has been adapted to the needs of the motorist by fitting it in a weatherproof metal case which may be mounted in any convenient position, the controls being extended by Bowden wire to a small panel mounted on the steering column. H.T. current is usually derived from the car accumulator by means of a rotary converter, for which purpose there has been added to the M.L. series a new totally enclosed model giving 40 milliamperes at 220 volts. Lissen's preliminary model, however, is a 6-valve battery superheterodyne with Class "B" output deriving its L.T. supply from the car accumulator, but its H.T. current from a dry battery. Another feature of this receiver is that it is one of the very few in the show employing the new powdered iron cored coils in the I.F. tuned circuits as well as in the signal-frequency circuits. Car receivers work from an aerial wire concealed in the roof, and automatic volume control is essential since local screening by buildings, etc., is liable to cause rapid variations in signal strength while the car is in motion. A further requirement is the silencing of the car's electrical equipment, and amongst the various resistance and capacity filters there are special heat-proof resistors for fitting at the sparking plug terminals.

High-frequency Amplification

History shows a steady rise in the A.C. resistance of the high-frequency amplifying valve, from the triode of some 30,000 ohms that was used in a neutralised circuit to the screened grid valve averaging a third to a half megohm, and now to the screened pentode whose anode resistance is of the order of one megohm. Since the dynamic resistance of the ordinary tuned circuit is much less than the anode resistance of the screened grid valve, one would expect the screened pentode to bring little increase in amplification beyond that due to its slightly better mutual conductance. But in a number of receivers tuned circuits of high dynamic resistance are secured by operating



Lissen car radio receiver and control panel.

the radio-frequency amplifier with a controlled amount of regeneration. For example, the Philips 634 " Superinductance " receiver, in addition to exceptionally good coils, has a potentiometer ganged to the tuning control which, by varying the bias on one of the H.F. valves, keeps the receiver

Ferranti " Arcadia " receiver.

just within the limits of stability throughout the wave-band, while several of the small superheterodynes have pre-set regeneration from the second detector on the I.F. circuits. When the screened pentode is applied to such receivers it should give a twofold gain : for its lower anode to grid capacity permits the dynamic resistance of the anode circuit to be increased without causing instability, and given a sufficiently high value of anode load its greater amplification factor becomes useful. These valves are available in both the normal and the variable-mu types, and the pentode construction enables them to handle without distortion a much larger anode voltage swing than would be permissible with a tetrode of similar impedance, a feature which is important in receivers designed for a very large detector input. The screened pentode with a low voltage on the screen is an excellent anode bend rectifier.

(The screen voltage required is so low that in the Atlas A4 receiver the grid bias for the 3-watt power pentode output valve is used as screen voltage for the pentode detector preceding it). Consequently it is frequently used as combined oscillator and first detector in superheterodynes, and with this in view it is available with a 7-pin base in which both the suppressor grid and the metallising of the bulb are brought out to independent pins.

The first entirely satisfactory single-valve frequency changer was the type known in America as the "Pentagrid"* but now manufactured by Ferranti who call it the "Heptode." Its electrodes are arranged to act as two valves in series, the oscillator modulating the flow of electrons into the detector portion, while the two sets of electrodes are screened from each other to prevent interaction between the oscillator and signal-frequency tuned circuits. A great advantage of the Heptode is that the detector portion has variable-mu characteristics, so that it is the only single-valve frequency changer that can be used for volume control. Thus the Ferranti "Arcadia" superheterodynes are fitted with A.V.C., although they have only two valves before the second detector, the Heptode and one I.F. valve. Until this type of valve is more generally available most of the larger superheterodynes are using separate oscillators, and an unusual example is the Cossor A.C. mains receiver, which employs a power valve (41 MP) as oscillator for the sake of constancy of output throughout the waveband.

Ekco Model AC 74 in a black bakelite cabinet with chromium insets.

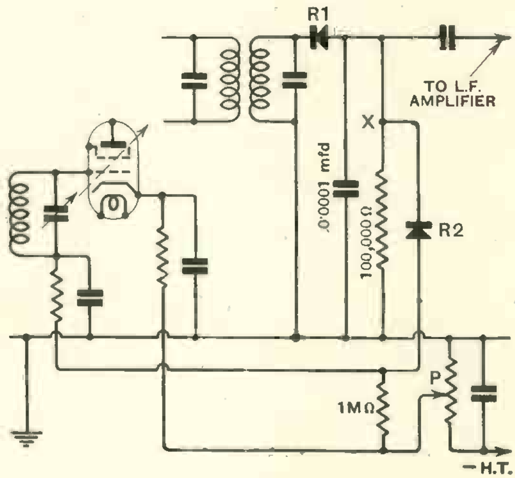


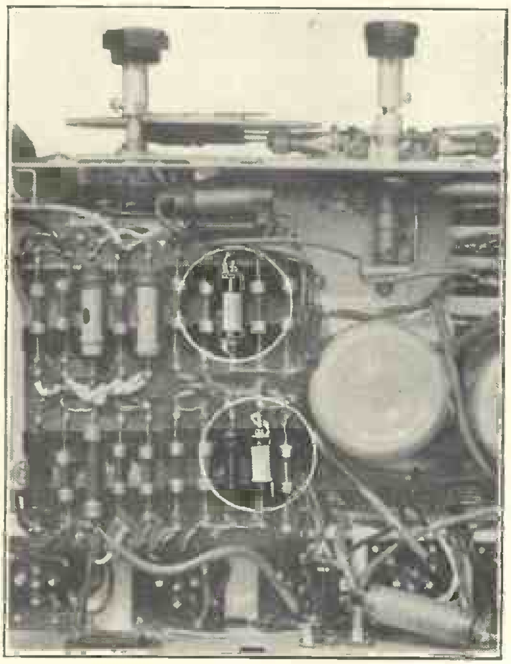
Fig. 1.—*Rectification and delayed A.V.C. with two "Westectors."*

Automatic Volume Control

The simplest form of A.V.C. obtains its bias voltage by rectifying the carrier voltage at the detector stage, and the valve largely employed in this arrangement has been the double-diode-triode in which one diode can provide delayed A.V.C. while the other diode provides the A.F. output to feed to the triode part of the valve. In many popular superheterodyne receivers employing this method the A.V.C. diode is fed direct from the anode of the I.F. valve, *i.e.*, from the *primary* of the last I.F. transformer; this avoids putting the load of two rectifiers on the secondary, and presumably aids in balancing primary and secondary to give a symmetrical tuning curve. The slight loss of selectivity due to the omission of one tuned circuit is immaterial to the working of the A.V.C. The objection to this form of A.V.C. is that the triode portion of the double-diode-

* "The Pentagrid Converter," C. L. Lyons, B.Sc., *The Wireless Engineer*, July, 1933, p. 364.

triode requires only a small A.F. input (say 3 volts peak) to feed an output stage of two or three watts, so that the carrier voltage is strictly limited. But this year a metal rectifier, known as the "Westector," is available, using the same copper oxide elements as the Westinghouse power rectifiers but of such small size that the inter-electrode capacity no longer prevents its use on radio frequencies. There are both half-wave and whole-wave types in two sizes, to withstand a maximum radio-frequency input of either 24 or 36 volts peak, and in most cases the audio-frequency output would be sufficient to feed the output valve, using a step-up transformer if necessary, without an intermediate A.F. valve. The circuit (Fig. 1) shows how A.V.C. can be obtained from these detectors by tapping off the voltage at the point X due to the rectified carrier; delayed A.V.C. is obtained with the aid of a second



Underside of Marconi 7-valve chassis showing size of "Westectors."

rectifier R_2 which has a suitable polarising potential from the potentiometer P so that no current can pass R_2 until the potential at X exceeds a certain value.

The Marconi 7-valve superheterodyne employs this principle for its second detector with delayed A.V.C., though an intermediate A.F. stage is used before the output valve. To illustrate the use of metal rectifiers, Westinghouse have published a design for an A.C. mains superheterodyne in which the Westector feeds directly a $2\frac{1}{2}$-watt pentode output valve; on gramophone reproduction an I.F. valve is used to provide the necessary A.F. amplification.

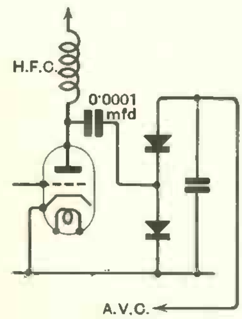
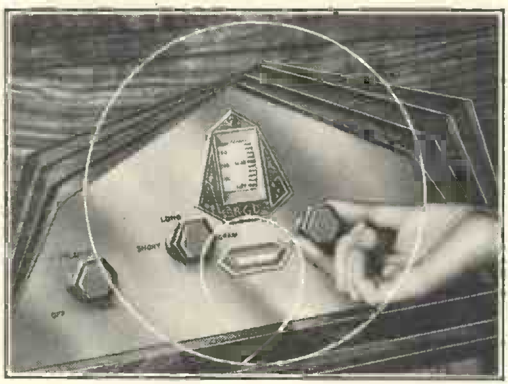


Fig. 2.—*A.V.C. from a triode detector.*

As an alternative to the very large input detector there is amplified A.V.C. in which an additional valve is employed as D.C. amplifier in order to obtain the necessary large bias voltage from a small detector voltage. An ingenious type of amplified A.V.C. for use with triode detectors has been developed by Westinghouse. The radio-frequency component of anode current, which with an ordinary valve detector is by-passed to earth through a small condenser, is rectified by a Westector and by using the voltage-doubler circuit shown in Fig. 2 a large A.V.C. voltage can be obtained from the average detector. The only objection to this use of the detector as a radio-frequency amplifier is that the increased radio-frequency impedance of the anode circuit will result in a greater negative feed back to the grid of the valve (unless it is of the screened grid type) and will increase the total anode voltage swing. However the Varley and Wearite units embodying this principle are undoubtedly the most practicable method of adding A.V.C. to existing receivers.

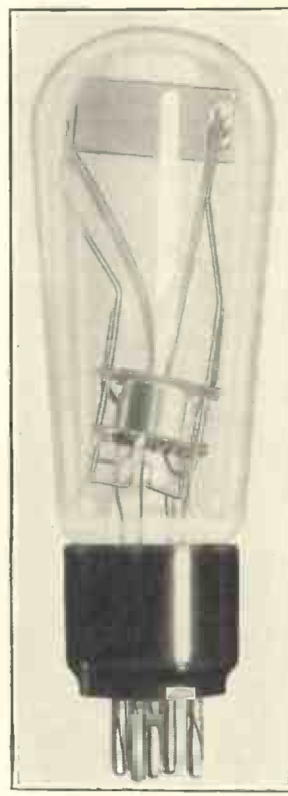
A possible objection to A.V.C. was that since the receiver automatically attains its maximum sensitivity in the absence of any signal, background noises might be unpleasantly prominent during tuning. In a number of sets this problem has been met by installing a sensitivity limiting device which may be set according to local conditions and when desired may be switched out of action altogether. But in the more ambitious receivers silent tuning is secured by using an intermediate A.F. stage whose negative bias is controlled so that in the absence of signals above a certain strength no anode current can flow. In the Brunswick and R.G.D. models the grid bias is reduced on the arrival of a signal by means of a relay connected to an additional rectifier fed from the I.F. amplifier; but whatever method is adopted the bias must be reduced suddenly by a considerable amount or else the A.F. valve would be operated on the curved portion of its characteristic. Thus in the Kolster Brandes 888 receiver



Control panel of R.G.D. Model 1201 showing visual tuning indicator.

there is a single diode tetrode valve of which the tetrode part amplifies the A.V.C. voltage while the diode provides positive bias to free the A.F. valve, but has a suitable delay potential applied to it so that nothing happens until the incoming signal is sufficient to free the A.F. valve completely. The Alba 7-valve receiver, however, employs no such extra valve but merely a double-diode-triode second detector, of which one diode provides delayed A.V.C. while the second gives the A.F. output and the steady voltage derived from it controls the bias of the intermediate A.F. valve. It is impossible to have a delay on this diode, which is also providing the A.F. signals, so there is a special scheme of interaction between the anode current of the controlled A.F. valve and the delayed A.V.C. which has the desired effect of putting the valve definitely in or out of action at a critical signal strength. A certain amount of backlash is desirable in the operation of all these systems, so that if a station has once come in it can be held, even though the signal strength at the detector may vary slightly.

It is sometimes claimed that by making tuning more critical these quiet A.V.C. systems render visual tuning indicators unnecessary, but the R.G.D. model 1201 has both. The most popular type of indicator is a meter in the anode circuit of one of the controlled valves; as the detector input rises A.V.C. increases the negative bias on the radio-frequency valves, so that accurate tuning produces the minimum anode current. For a direct indication of signal strength Standard Telephones have a miniature cathode ray tube, called the "Micromesh Tunograph," whose deflecting electrodes absorb hardly any power so that they may be connected across any circuit; on A.C. a line will appear on the screen whose length is proportional to the amplitude of the alternating potential applied. (The static sensitivity of this tube is 1 cm. for 13 volts.)



The "Micromesh Tunograph," a cathode ray tuning indicator.

The use of A.V.C. has resulted in two conflicting tendencies on the A.F. side of the receiver. On the one hand the detectors normally used, namely, double-diode-triode or Westector, are capable of loading the output valve directly, as in the Ferranti mains receivers, all of which employ a double-diode-triode second detector coupled to a $2\frac{1}{2}$-watt triode output valve. On the other hand silent tuning A.V.C. demands the use of an intermediate A.F. stage for noise suppression. A possible solution of the problem would appear to be the use of the relay type of control to short-circuit the A.F. signals at some point instead of controlling the bias of an additional valve.

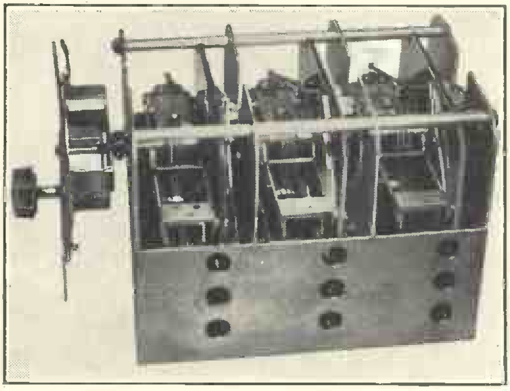
"Iron" Cored Tuning Coils

Another development in radio-frequency technique is the introduction of powdered iron cores for tuning coils. The first material to appear commercially was Ferrocart,* in which the particles are aligned by a special magnetic method and separated into layers by means of paper interleaving. Coils using this material are made by Colvern, but by now almost all coil manufacturers have produced their own core material, consisting of some particular magnetic alloy finely powdered and compressed with special insulating and binding materials. These coils are very compact and suffer less loss when screened, thanks to the use of a closed magnetic circuit in some cases, but it is doubtful whether any of those produced so far have a lower resistance than could be obtained from a rather more bulky air-cored coil. With a high permeability core much less wire is required for a given inductance, so that many of the medium wave coils are wound with Litz wire. In addition the R.I. "Micrion" coils have an adjustable core controlled by a screw so that if a single coil in an existing receiver is replaced the Micrion coil can be adjusted to the same inductance as the old one; but in constructing a new receiver with several ganged circuits it would be preferable to have coils accurately matched by the manufacturer. It is interesting that Igranic are using their core material even down to 13 metres, the advantages claimed on short waves being reduction of external field, and better control of regeneration.

Complete tuning units including a set of "iron" cored coils and a gang condenser are available, and Colvern and Lissen have "iron" cored coils for I.F. amplifiers. Since several receiver manufacturers are at present using air-cored Litz windings for intermediates, there should be scope for the new coils here, particularly as the core losses will be even lower at the intermediate frequency than at the higher frequencies.

* Description of Ferrocart in *The Wireless Engineer*, April, 1933, p. 183.

A sequel to the development of these iron powder cores is permeability tuning, in which the capacity of the tuned circuit remains constant while the inductance is varied by sliding a core of fairly high permeability in or out of the coil former. The difficulty has been to obtain a sufficiently high ratio of maximum to minimum inductance and at the same time to avoid making the motion of the core too critical. Sovereign Products have succeeded in producing single tuners, and Varley have an experimental 3-gang model in which there are actually two windings for each medium-wave coil linked together. With this type of tuner one has the advantage of a maximum L/C ratio throughout the wave-band, and the core losses help to keep the selectivity reasonably constant.



Varley permeability tuner.

Audio-frequency Amplifiers

The latest luxury is a tone-and-volume compensator. It is well known that as the volume of sound is decreased the human ear becomes less sensitive to the extreme high and low frequencies, so that reproduction at a low volume level appears to have an excess of the middle frequencies; so in some receivers an A.F. filter is connected across part of the post-detector volume control potentiometer so as to reduce the response to the middle register when volume is decreased. Another type of tone correction is illustrated by the Varley "compensating resistance coupling unit." This has an inductance between the coupling condenser and the following valve which resonates with the input capacity of the valve at a frequency of the order of 5,000 c/s and thus compensates for side-band cutting in the R.F. stages of the receiver.* The cut-off frequency can be lowered if desired by shunting a minute capacity across the input of the following valve. In the Marconi 7-valve receiver there is a tone control which has a clearly defined normal position, giving as nearly as possible linear response, and a variable attenuation of either high or low notes which is worked in conjunction with the A.F. transformer following the detector. The Marconi 5-valve receiver, on the other hand, has fixed tone compensation in the anode circuit of the detector valve using the circuit shown in Fig. 3, which produces a cut-off at 5,500 c/s and a bass response with a maximum at about 80 c/s.

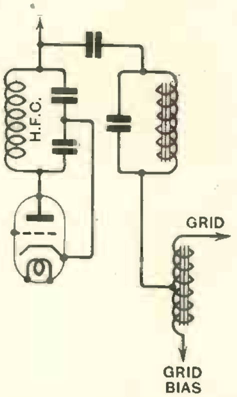


Fig. 3.—*Tone correction in the Marconi 5-valve receiver.*

The R.G.D. model 1201 radiogram is also noteworthy, since it uses the paraphase system of A.F. amplification which aims at perfect reproduction of transients by the use of resistance coupling throughout and at the same time secures the advantages of push-pull amplification.

The biggest development in A.F. amplification has been the perfection of H.T. economy circuits for battery receivers. First came the Quiescent Push-Pull system, which can be very efficient but necessitates careful matching of the valves used. For this purpose the Marconi and Osram small pentodes are now graded and marked with a code letter so that matching of any two specimens can be obtained simply by applying to each the screen voltage corresponding to its letter. (On Columbia receivers this is known as "Constant Quality Amplification," while on the Marconi range it is called the "Parallel Conductance Principle.") The more popular output circuit, however, is the Class "B" in which a double valve is employed so that the matching has already been secured in the manufacture of the valve.

* *The Wireless Engineer*, July, 1933, p. 370 (Correspondence).

Like Q.P.P., the Class "B" stage requires a high impedance anode load and matching to the loud speaker is more critical than with a single triode. To meet this difficulty the majority of loud-speaker manufacturers are producing a Class "B" stage and moving coil speaker as a complete unit for converting existing receivers, the previous small output valve being over-biased and used as driver to the Class "B" stage. The Class "B" principle has, of course, restored the intermediate A.F. valve under the title of "driver valve." The most popular valves here are the small power type, such as the Osram L.P.2, and the L.F. valve such as the Mullard P.M.2DX, but in the Cossor receivers the driver valve is a small pentode (220HPT) which is slightly more economical in anode current.

Although the Class "B" output stage was introduced as a means of bringing good quality reproduction within the capabilities of the dry H.T. battery, there are now a large number of mains units on the market which have been specially designed to give sufficiently good regulation for use with Class "B" receivers. The Heayberd model employs a Cossor neon tube regulator, and in favour of this system it must be mentioned that the regulator tube contributes a great deal to the smoothing; but the majority of units rely upon a metal rectifier (the Westinghouse H.T.13 has been introduced for this purpose) and low-resistance smoothing circuits. In theory the ideal source of current for these special output stages would be the H.T. accumulator, owing to its very low internal resistance; where reliable charging facilities are available for the proper care of the battery, the new and very compact "Block" H.T. accumulator might be a convenient source of current.

The modern receiver is apt to present an awkward problem when an extension loud speaker is required; but for use where terminals are provided across the secondary of the output transformer special units with low-impedance speech coils and no input transformer are available. It seems now to be the general principle for the external speaker terminals to be on the output side of a transformer, and the R.I. Radiogram is exceptionally well equipped in having an entirely separate transformer to feed the external speaker.

For those who require a larger output than is obtainable from the domestic receiver, there is a whole range of Tannoy amplifiers and speakers, including the "Lantern" speaker which is designed to radiate the sound in all directions as uniformly as possible. The amplifiers all have an input impedance of 600 ohms, and the Tannoy radiogram chassis has an output matched to 600 ohms, so that it can be connected immediately to a power amplifier of any desired capacity.

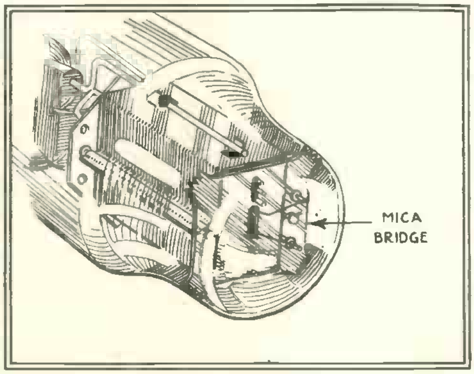
Short-wave Apparatus

The simplest method of short-wave reception employs a "converter" for attachment to an ordinary broadcast receiver. This usually employs two valves, a screened grid valve as "separator" between the aerial and the tuned circuit feeding the second valve, which is an autodyne frequency changer. The "separator" valve avoids trouble from aerial resonances, and makes the calibration of the tuning dial possible; the regeneration of the autodyne valve can be fixed, with possibly a compensating device ganged to the tuning condenser, so that the receiver is completely controlled by a single tuning dial. There are one or two all-wave tuning units consisting of a set of coils covering the most popular wave-bands between about 15 and 2,000 metres controlled by a selector switch; but these would obviously be very difficult to apply to a modern receiver employing several ganged tuning circuits. For the ultra-shorts there is an Eddystone 5-metre transmitter which may be suspended in the air to avoid the use of long aerial feeders.

The Baird Kerr cell.

Television

In television receivers the perforated scanning disc has now been replaced by the mirror drum; this is natural since in place of the neon tube which gave a large area source of modulated light, a Kerr cell is used which has only a small aperture. The Baird "Grid Cell Unit" is a convenient mounting carrying a bunched filament lamp, a pair of Nicoll prisms, and a Kerr cell in which each electrode consists of a number of foils, the two sets of foils being interleaved like the plates of a condenser. This cell, which can be purchased separately and has a clear aperture 0.1in. square, works with a polarising potential of about 425 volts and a signal potential of 125 volts peak for full modulation. The mechanical methods of scanning seem quite adequate at present, but if 100 line scanning of television images is ever adopted in place of the present 30, the cathode ray tube will undoubtedly be the ideal receiver, and several firms are preparing tubes suitable for television.



A new type of valve bulb designed to give increased rigidity of electrodes.

Valves

A drastic change in valve manufacture appears in the Marconi and Osram "Catkin" valves, which have no glass bulbs. The use of the anode as the envelope of the valve facilitates cooling, and another feature of these valves is that exceptional rigidity of the electrode system has been secured by the use of insulating distance pieces between its elements. Another development is the use of the American type S.T.12 bulb which is shaped at the top to receive a mica bridge. This gives additional support to the electrodes, but the shape is not so favourable to the mechanical strength of the bulb. To facilitate the dissipation of heat from the anodes of rectifying and power valves it is now a common practice to blacken this electrode ; and the next step is to blacken the inside of the bulb to prevent the glass from reflecting back the radiation.

The new types of valve are the screened high-frequency pentode, the heptode, Class "B," and the various diode-cum-amplifier detectors. Of the latter the commonest is the indirectly heated double-diode-triode ; but Mullard have also an indirectly heated single-diode-tetrode, while Mazda have in addition to the mains type a battery double-diode-triode which is used in the Portadyne battery superheterodyne. There are still larger pentode output valves this year, the Mullard Pen 4VA, Marconi PT 16 and PT 25, and Mazda AC 2 PEN. The latter has the exceptionally high mutual conductance of 8 milliamps. per volt and gives its 3½-watts A.C. output for so moderate an input that it has also been produced in double-diode form (AC 2 PEN DD) for use as a combined detector-output valve which practically abolishes the A.F. amplifier.

Kolster Brandes "Rejectostatic" units.

Accessories

An important step towards eliminating electrical interference is to erect the aerial clear of house wiring, etc., and employ a screened down-lead. For this purpose special low-capacity screened wire has been produced, but even the best of screened cable must introduce appreciable loss in a high impedance circuit, so that where very long screened leads are required a radio-frequency transformer should be used at each end of the lead so that the input can be stepped down to match a low-impedance transmission line and then stepped up again to the receiver input.

"Hivac" quartz oscillator mounted in vacuo.

Kolster Brandes have now succeeded in producing transformer units which will function on both the ordinary broadcast wave-bands without switching ; with the aid of these "Rejectostatic" units, as they are called, it is possible to use hundreds of feet of ordinary lead-covered cable between aerial and receiver without the losses becoming prohibitive.

An interesting exhibit by the High Vacuum Valve Co. was of quartz crystals mounted in vacuo. These can be standardised if required to an accuracy of 1 in 10,000 at any frequency between 600 and 8,000 kc/s, and oscillators of lower frequency will shortly be available.

Passing from standards to testing instruments, we come to the "Radiolab" Valve and Set Tester, which employs a high-grade moving-coil meter to measure current, voltage, and, with the aid of a small battery, resistance as well. A buzzer providing a test signal on about 450 metres will be a very useful feature when checking receivers, and when dealing with power equipment A.C. voltages up to 1,000 can be measured, using the same meter with a metal rectifier.

Measuring Resistances*

By the late W. A. Barclay, M.A.

IT is well known that a high resistance galvanometer or voltmeter may be used to measure resistance by noting the change in the reading when the resistance is connected in series with the instrument. Let us suppose that the maximum scale reading of the instrument—volts or milliamps—is the number N, and that the meter resistance is R_m ohms. (In the case of a milliammeter, R_m is, of course, the value of the known series resistance which we regard as included in the instrument.) Then if, by means of a battery or other suitable device, a steady E.M.F. of E volts is impressed upon the terminals of the instrument, a current of E/R_m amps. will flow, causing the needle of the meter to register a value n_1 on the scale.

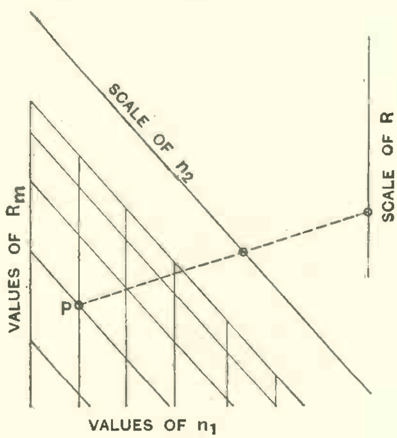


Fig. 1.—*Having found the position of the pivot point P on the $n_1 - R_m$ network, corresponding values of n_2 and R are in alignment with it.*

Next, let the resistance R, whose value is sought, be inserted in the circuit, and let n_2 be the new reading on the scale of the instrument.

Then

$$\frac{n_1}{n_2} = \frac{R_m + R}{R_m} \quad \ldots \quad \ldots \quad (1)$$

and

$$R = \frac{(n_1 - n_2)}{n_2} . R_m \ldots \quad \ldots \quad (2)$$

* MS. received by the Editor July, 1932.

The importance of this result lies in the fact that it does not really matter what the readings n_1 and n_2 represent ; as we have seen, it is immaterial whether they are in volts or milliamps. ; for our purpose they are simply scale readings and nothing more. The value of R_m must, of course, be as accurately known as possible, and where external series resistances are employed these should be of " precision " type.

When several values of resistance have to be estimated by this method, the calculation required by equation (2) becomes tedious, and much labour may be saved by the use of the two " four-variable " alignment charts now presented. The method of use will be apparent from the schematic diagram of Fig. 1. The lower left-hand portion of the diagram consists of a network of slanting and vertical lines, corresponding respectively to values of meter resistance R_m and scale reading n_1. Above this is a diagonal scale carrying values of n_2, while to the right is a vertical scale containing values of the unknown resistance, R. The procedure is to find a point P on the network corresponding to the scale reading n_1 and the meter resistance R_m. Since n_1 depends only on the meter and the battery, the position of this point P is thus fixed for all subsequent work, and can thus be used as a pivot about which the index line connecting n_2 with R may be swung. The connection between the unknown resistance value R and the second scale reading n_2 is thus exhibited with great facility. It will be further evident that if the value of yet another resistance is required, all that is needful is the single observation of n_2 obtained with this resistance in the circuit. The desired value of R is then immediately obtained in alignment with n_2 and the fixed pivot point previously established.

The first Chart (Fig. 2) is designed for a maximum scale reading $N = 6$, while the resistance values run roughly between 1,000 and 10,000 ohms. It is thus suitable for use with the average type of medium resistance voltmeter. The second Chart (Fig. 3) is intended for use with an instrument of maximum scale reading $N = 250$, while the range of resistances catered for is higher, say from 25,000 to 200,000 ohms.

volt. Then the meter resistance will be 250×320, or 80,000 ohms. Then, if a battery of 210 volts be employed, the posi-

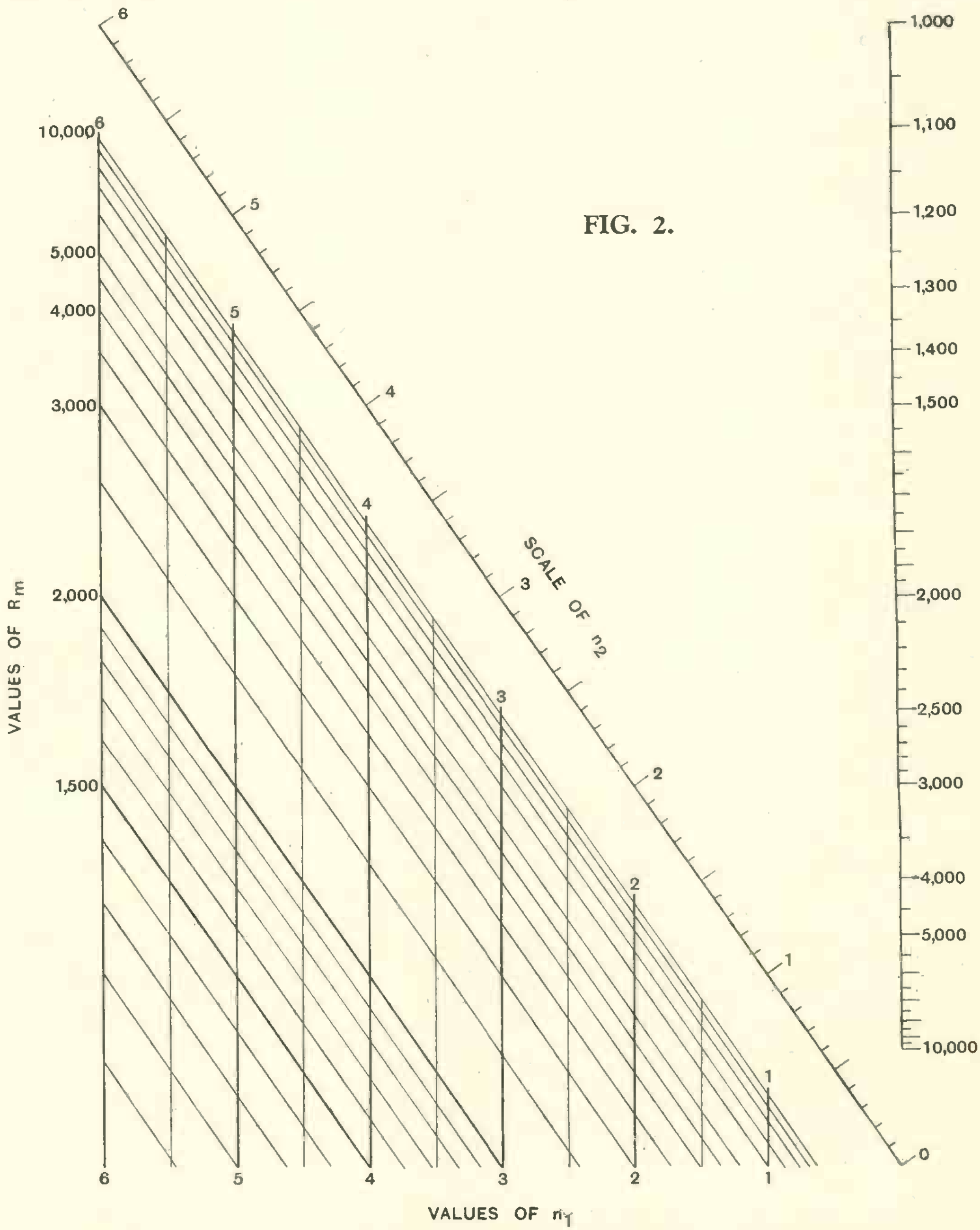


FIG. 2.

As an example of the use of the latter Chart, let us suppose that we are using a 250-volt meter rated at 320 ohms per

tion of the pivot point P will correspond to $n_1 = 210$, $R_m = 80{,}000$. If, now, the reading n_2 consequent upon the insertion of the unknown resistance is 135, we shall find on joining P to 135 on the diagonal scale that the required value of R is 44,000 ohms.

shown upon either of the present Charts. In such a case the remedy is very simple. Select an arbitrary factor k, integral or fractional, such that the value kR_m is con-

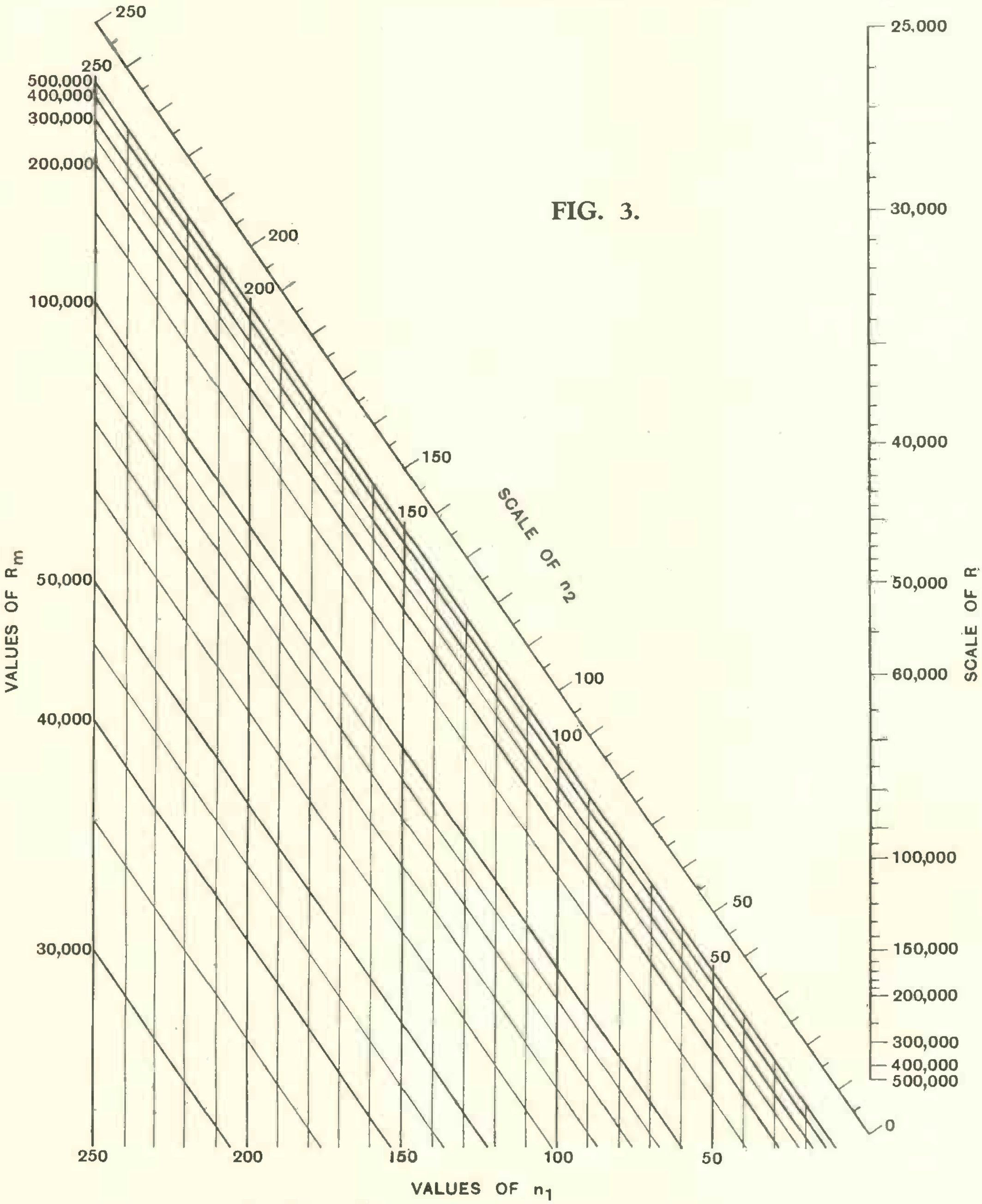


FIG. 3.

It may sometimes occur that the value of the meter resistance, R_m, is not conveniently veniently found on one or other of the charts. When the usual procedure is carried out using kR_m, the resulting resistance value found is kR, and this must therefore be divided by k in order to obtain the desired value of R. As an illustration, let us suppose that our meter resistance was 20,000 ohms, while the readings n_1 and n_2 were 210 and 135. By taking $k = 4$, the pivot point for use with Fig. 3 will be the same as that in the above example, *i.e.*, $n_1 = 210$, $kR_m = 80{,}000$. We must, however, be careful to divide the result, 44,000 ohms, by the same factor, thus obtaining $R = 11{,}000$ ohms. Furthermore, the scale readings n_1 and n_2 may themselves be multiplied by any convenient factors when this may be necessary, so that, *e.g.*, the 6-unit scale of Fig. 2 may be used with instruments having scales up to 12 units, etc. These circumstances, which follow from equation (2), make the method one of extraordinary generality.

In conclusion, it is particularly to be noted that the internal resistance of the source of voltage, E, must be negligibly small as compared with the meter resistance. This will generally be the case when dry batteries and accumulators are used in conjunction with instruments of relatively high resistance.

Correspondence

Letters of technical interest are always welcome. In publishing such communications the Editors do not necessarily endorse any technical or general statements which they may contain.

The Principles of Electromagnetism

To the Editor, The Wireless Engineer

SIR,—Professor Cramp is, I think, mistaken in accusing me (in his letter in your August issue) of saying *definitely* that B and H are the same thing. All that I maintain is that in so far as all experimental laws are concerned they are identical and that any interpretation of these laws which regards these quantities as being fundamentally different, involves conceptions which are additional to the experiments. I do not even agree that it is permissible to introduce the factors $1/\epsilon$ and $1/\mu$ in the statements of the inverse square laws. For, consider the proof of the inverse square law between charges by means of the concentric spheres. The inverse square law that that experiment proves is that the mechanical force exerted between two charges is inversely proportional to the distance apart, quite irrespective of whether the intervening space is air or copper or brass! The result can, of course, be equally well deduced if the factor $1/\epsilon$ is included, but if so, to what does the ϵ apply—to the copper, the brass or the air?

I am sorry I did not mention Professor Cramp by name in my last letter, but my remarks there were intended to be as much a reply to his criticisms as to those of your other correspondents.

Finally, Sir, since I really must not occupy more of your space on this subject, let me say that in my view, it is wholly a matter of choice which interpretation of these laws is adopted by any individual. Some prefer mathematical symmetry, even if they have to introduce additional conceptions to procure it; some like to think in terms of mechanical analogy as Faraday and (according to his professions) Maxwell did; others again, prefer the simplest and most direct interpretation of all, the relevant experiments. Provided that the arguments are strictly logical these three interpretations must necessarily come to the same thing in the end and no one can say that one view is *definitely right* and that another is *definitely wrong*. It is mainly to dogmatic statements of that kind that I object.

C. L. FORTESCUE.

City & Guilds (Engineering) College,
London, S.W.7.

High-frequency Generators

To The Editor, The Wireless Engineer

SIR,—On page 233 in the April, 1933, issue of your journal appeared Patent No. 381087, issued to Cie. Générale de Télégraphie sans Fil under the convention date (France) 9th March, 1931, covering a high-frequency generator operated by making a beam of cathode-ray sweep a circular path with a certain base frequency over the periphery of a toothed disc.

In this connection you may be interested to know that Mr. Mong-Kang Ts'en, a Fellow of this Institute, started in 1930, as a part of his work here, to develop ultra-high frequency generators on the principle that split-phase Barkhausen-Kurz oscillations of about one-meter wavelength are connected to the two pairs of electrodes of a cathode-ray tube in order that the beam of cathode-ray sweeps out a circle and falls alternately on the periphery of a toothed disc and on a metallic ring placed behind. This was first reported in the Second Annual Report of Academia Sinica for the year 1929–1930 (page 85) and again briefly described in the Third Annual Report (page 73). The original text was in the Chinese language. An English version is appended herewith for your reference.

It is evident that both Mr. Ts'en and the Cie. Générale de Télégraphie sans Fil have independently arrived at the same conception of sweeping a beam of cathode-ray over a toothed gear to multiply the frequency, but as far as we can ascertain from scientific publications, Mr. Ts'en seems to have priority in conceiving the idea, working on it and giving it publication. Experiments are still being carried on in the laboratory of this Institute.

Shanghai. S. L. TING,
Director.
National Research Institute of Physics,
Academia Sinica.

(3) *Studies in High-frequency Generation.*

(Translated from the Chinese text, p. 73, Third Annual Report of Academia Sinica.)

As reported before, the devices used in high-frequency generation include such as spark gaps, inverse-connected triodes or magnetron. The wavelengths thus obtained vary from a few meters to a few centimeters. A Fellow of this Institute, Mr. Mong-Kang Ts'en, has proposed a new method, using short-wave magnetic or electric fields to make a beam of electrons emitted by the cathode of a cathode-ray tube sweep out a circle, and intermittently receiving the beam by a toothed-disc. Theoretically, waves of a few centimeters' length can be generated. Experimental work has already been started and is still in progress.

(7) *Studies in High-frequency Generation.*

(Translated from the Chinese text, p. 85, Second Annual Report of Academia Sinica.)

The importance of high-frequency currents has been stated before. They are usually generated by means of spark gaps or vacuum tube oscillators; tube oscillators can ordinarily produce electric waves of about one-meter wavelength, while four-centimeter waves have been obtained with spark gaps. Besides studying the limitations of these two methods, a new method of high-frequency generation is hereby proposed. Split-phase high-frequency oscillations from a tube generator are connected to the two pairs of electrodes or the two coils of a cathode-ray tube, making the cathode ray sweep out a circle. The electrons in the ray are to be received by two metal discs placed one behind the other; a circular ring of holes are made on the front disc so that the electrons, when meeting the holes, will pass through and will be received by the disc at the back. These two plates will thus form a condenser, whose potential difference will vary at a frequency equal to that of the original oscillations multiplied by the number of holes in the front disc. By means of this method it seems possible to obtain waves shorter than 4 cm. But whether there is any practical difficulty will be decided by experiment.

Book Review

Electron Tubes.

By John H. Morecroft, Sc.D. Chapman and Hall. 28s.

The applications of the electron tube, in which term the author includes photocells, gas-filled valves, cathode ray tubes, and thermionic vacuum tubes, are by no means confined to radio transmission and reception, but are finding increasing use in every branch of industrial activity and scientific research. Their widest use is in the field of radio, of course, and it is only natural that the radio engineer should have the greatest knowledge of their operation. He is not necessarily the best person to judge their usefulness in other fields, however, for his outlook is restricted to the specialised problems of radio. One of the chief purposes of this book, therefore, is to give a knowledge of the properties and applications of electron tubes to engineers in general and not the radio engineer in particular. To the latter, much of the ground covered is familiar, but the book is by no means valueless. To the former, it should prove invaluable.

The book opens by discussing the structure of the atom, conductors and insulators, and the various methods by which electrons may be removed from matter or the means of obtaining electronic emission. The operation and characteristics of hot-cathode vacuum tubes, hot-cathode gas-filled tubes, and photoelectric tubes are most adequately dealt with in succeeding chapters, while sufficient space is given to such special devices as cold-cathode tubes, the Magnetron, photo-conductive cells, selenium cells, and photo-voltaic cells.

The rest of the book is devoted to the applications of these devices, and a lengthy explanation is given of the operation of the valve, using the word in its true sense of a one-way device or rectifier and not with the popular meaning of any electron tube. The index discloses that no fewer than six chapters are given to the triode vacuum tube as a power converter, a low-frequency amplifier, a radio-frequency amplifier, an oscillator, a modulator, and a detector, but a closer examination of the book reveals that tetrodes and pentodes are also discussed in this section. The value of the electron tube in measurement work is not overlooked, and the last chapter gives a resume of special applications of electronic devices to clocks, television, stroboscopes, and time-delay relays.

From the point of view of the radio engineer, the chapters on the applications of the triode are the most interesting, for they are not confined entirely to the valve, but deal also with the design of suitable circuits for use with it. The actual design of the associated components, of course, is not touched upon, but formulae are given which enable the required circuit values to be calculated. In most cases, however, the formulae appear more for the purpose of explaining some particular effect than as an aid to design. The book is not "popular," therefore, for in places it is highly technical and mathematical; it should prove readily intelligible to any well-trained engineer, however, with no special knowledge of radio technique.

The book is well bound and unusually free from errors, and it is profusely illustrated, for the 452 pages contain 537 illustrations of which the majority are experimental curves showing the action of electron tubes. There is a good index.

W. T. C.

Abstracts and References

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PROPAGATION OF WAVES

VERSUCHE ÜBER BETRIEBSVERFAHREN FÜR LANGSTRECKEN-FLUGFUNKVERKEHR (Field Tests on Radio Communication over Long-Distance Aircraft Routes [including the Reduction of Short-Wave Fading by "Alternate-Aerial" Transmission or Reception]).—P. von Handel, K. Krüger and H. Plendl. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, pp. 11–20.)

Short-distance tests by the DVL showed a satisfactory decrease of fading by the method of alternate transmission from differently polarised aerials (Abstracts, 1932, p. 156). The present paper describes long-distance tests from a ship sailing from Wilhelmshaven to the Dogger Bank and the coast of Norway, reception being at Berlin (max. distance 1 200 km). Not only was the alternate-aerial system tested, but experiments with periodic frequency-varying transmissions and short-pulse signals were carried out to investigate the selective polarisation changes occurring over long distances.

Dealing first with the alternate-aerial system, the writers point out that the note-frequency alternation necessary for actual service was not used in these tests, since oscillographic observation of the signals from the two aerials separately was desired; the one aerial therefore transmitted a short dash and the other a longer dash, alternating at a rate of 3 times a second. Another change from the short-distance tests was that the two transmitting aerials were a symmetrical horizontal dipole and a vertical aerial, in place of the two crossed horizontal aerials. Reception at Berlin was with two receivers, connected to crossed horizontal aerials or to one horizontal aerial and a vertical aerial. It would appear that while the alternate-aerial system at the transmitting end frequently failed to compensate deep fading, and while the same thing occurred at the receiving end, these failures only very occasionally occurred simultaneously at both ends. The combination of the two systems should therefore give a marked improvement.

Among the various results, it was found that the horizontal transmitting aerial generally gave deeper fading than the vertical; in the long, narrow Norwegian fjords the horizontal transmitting aerial gave stronger field strengths at the receiver than the vertical, while on the open sea the vertical aerial, with its better height above the ship's deck, showed its superiority.

It is also mentioned that the latest DVL tests have shown that the alternate-aerial system is quite applicable to telephony as well as to telegraphy: for satisfactory telephony the switching frequency must be increased to twice the highest frequency which has to be transmitted. Applied to telephony the system has a marked effect in diminishing deep amplitude fading, and also decreases the distortion produced by selective polarisation changes. "Favourable for combined fading compensation (amplitude- and selective-fading) is also the use of the rotating-field principle" [*see* end of abstract, July, pp. 383–384]. Finally, the alternate-aerial system can be applied to spaced, instead of differently polarised, aerials; this plan however would be difficult to carry out for mobile stations.

The methods just described lead to an extensive compensation of fading troubles due to temporal variations of polarisation through the action of the earth's magnetic field. The paper then deals with the frequency-varying and pulse transmissions undertaken to investigate *selective* fading phenomena and to devise ways of combating them. In the frequency-varying tests the ship wavelength of 53 m was periodically changed, its frequency being raised by 1 200 or 800 c/s in about ¾ sec. and then diminished by a like amount in the same time. At regular intervals the horizontal and vertical transmitting aerials were alternated. Reception was on an east-west horizontal dipole and simultaneously on a vertical or a north-south horizontal aerial, the oscillograms of Fig. 6 showing the records from the E-W aerial at the top of the strip and from the vertical or N-S aerial at the bottom. The sharply angular curves running along below the strip indicate the frequency-variation cycle.

In the pulse transmissions a rotating disc and photocell method was used, giving pulses of about 0.7 msec. at a rate of about 13 per sec. Reception, as before, was on two aerials simultaneously; transmission was from the horizontal dipole. Specimen oscillograms are shown in Fig. 7. One result "can hardly be explained otherwise than by wide changes of the angle of the downcoming ray occurring within a period of 10 minutes."

INVESTIGATION OF SELECTIVE POLARISATION CHANGES AND FADING, BY FREQUENCY-CHANGE AND PULSE TRANSMISSIONS.—von Handel, Krüger and Plendl. (*See* preceding abstract.)

CHARACTERISTICS OF ELECTROMAGNETIC RADIATION FROM AIRCRAFT IN FLIGHT.—T. C. Rives and J. C. Coe. (*Trans. Am.I.E.E.*, Dec., 1932, Vol. 51, pp. 981–986.)

The full paper, a summary of which was dealt with in 1932 Abstracts, pp. 575–576.

INTERACTION OF RADIO WAVES [in the Propagating Medium].—Tellegen. (*World-Radio*, 11th August, 1933, Vol. 17, No. 420, p. 165.)

A short article commenting on Tellegen's recent observations (August Abstracts, p. 437) and their possible significance.

SOME CHARACTERISTICS OF FIVE-METRE [Ultra-Short-Wave] TRANSMISSION.—J. D. Kraus. (Summary only in *Proc. Inst. Rad. Eng.*, August, 1933, Vol. 21, No. 8, pp. 1071–1072.)

With a transmitting output of about one watt. "The effects of hills and valleys were very prominently indicated upon the field-strength maps. An antenna system giving a vertically polarised wave gave best results, and apparently regardless of how the wave leaves the antenna, it tends to become vertically polarised at a distance. Resonant receiving antenna systems gave best results, and higher voltages were obtained with long antennas working at harmonics. Phase-shifting circuits located at correct points in the resonant system also proved valuable."

ULTRA-SHORT-WAVE TESTS FROM SUMMIT OF MOUNT SNOWDON [Five-Metre Signals to Hoddesdon, Herts, 200 Miles away].—O'Hefferman and Myatt. (*Daily Mail*, 25th August, 1933, p. 7: paragraph only).

EXPERIMENTAL RESEARCHES ON THE TOTAL REFLECTION OF HERTZIAN WAVES.—G. Beauvais. (*L'Onde Élec.*, May and June, 1933, Vol. 12, Nos. 137 and 138, pp. 213–235 and 273–294.)

Continuation and end of the paper referred to in Abstracts, September, p. 494, l-h column. *See* also August, p. 440, r-h column.

EXPÉRIENCES SUR LA PROPAGATION DES ONDES TRÈS COURTES DANS LES TUNNELS (Experiments on the Propagation of Ultra-Short and Micro-Waves in Tunnels [the Shafts and Galleries of Mines and a Concreted Tunnel]).—A. Arenberg and W. Peicikov. (*L'Onde Élec.*, May, 1933, Vol. 12, No. 137, pp. 250–261.)

The main tests were with wavelengths of 400-500 cm, but 33-cm waves were also used. Not only strong absorption by the walls, but also complex interference effects, render propagation very poor (*cf.* Ritz, 1929 Abstracts, p. 150, l-h col.). The waves behave as if "clinging" to the surfaces of separation of two media, suggesting that the Poynting vector has everywhere a component parallel to the axis of the corridor: this would account for the decrease in possible distance between transmitter and receiver caused by an intersecting gallery.

MITTEILUNG ÜBER DIE VERSUCHE IN DEN PUNKWAHÖHLEN (Report on the Tests in the Punkwa Caves and Tunnels).—V. Fritsch. (*Hochf:tech. u. Elek:akus.*, June, 1933, Vol. 41, No. 6, p. 218.)

The results of the earlier tests (1932 Abstracts, pp. 397–398) led to a survey of that part of the mountain range by radio signal-strength measurements, with a view to tracing as yet undiscovered tunnels. Already a cavern 150 m × 20 m has been charted, and confirmed by actual exploration. The tests are being continued.

CHARACTERISTICS OF THE IONOSPHERE.—J. P. Schafer and W. M. Goodall. (*Nature*, 3rd June, 1933, Vol. 131, p. 804.)

The writers have observed echoes from the ionosphere of wireless pulses emitted vertically, and summarise their results in this letter. Between E region, at a height of 100–120 km, and F region, at a height of 190–300 km, they find an intermediate reflecting region, which they refer to as the M region, at an average height of about 150 km. This was observed on a number of occasions before noon during December, 1932, and Jan. and Feb., 1933. It can be observed only so long as its maximum of ionic density exceeds that of the E region below it.

They also find that ionisation in the F region has a step-like structure during daylight hours, with abrupt ionic density gradients at heights near 200, 240 and 280 km. Erratic variations in ionisation of F region have been found during daylight hours in the past winter (1932–1933). "The abrupt changes found in the F region are not normally present in the E region."

FINE-STRUCTURE OF THE IONOSPHERE.—E. V. Appleton. (*Nature*, 17th June, 1933, Vol. 131, pp. 872–873.)

The maximum ionisation content of the various upper atmospheric regions has been measured at the Radio Research Station, Slough (September Abstracts, p. 494), by finding the critical penetration frequencies for the ordinary ray of the two magneto-ionic components into which the incident wireless beam is resolved by the action of the earth's magnetic field. Curves have been obtained showing the relation between the equivalent path P^1 of the atmospheric waves and their frequency f; such a curve is shown in this letter and deductions from the observations are made and compared with those of Schafer and Goodall (*see* preceding abstract).

Evidence of a region of electrification intermediate between the two main regions E and F is found, particularly in the early morning hours [Schafer and Goodall observe it usually before noon]. Evidence of the existence of a ledge on region F has also been found. From the (P^1, f) curve shown, the maximum ionisation contents in electrons per cc are deduced as follows : region E, 1.8×10^5 ; intermediate region, 2.5×10^5 ; region F ledge, 3.8×10^5 ; region F main, 6.1×10^5. A curve showing qualitatively the most frequent daytime variation of ionisation with height is shown ; it has maxima E^I, E^{II} and F^{II} and a shelf F^I. "The British series of observations suggests therefore that there are four main components in the ionosphere caused by the influence of ultra-violet light from the sun. It is tempting to associate the four components with the four ionisation potentials of oxygen and nitrogen atoms and molecules."

FINE-STRUCTURE OF THE IONOSPHERE.—J. A. Ratcliffe and E. L. C. White. (*Nature*, 17th June, 1933, Vol. 131, p. 873.)

The writers have made automatic records of ionospheric reflections (September Abstracts, p. 495) and have recently found indications of the ionospheric reflecting region between E and F regions found by Schafer and Goodall and by Appleton (*see* preceding abstracts). A record taken on a wavelength of 150 m is given, showing jumps of the two magneto-ionic components from reflection at F region to reflection at the intermediate region and then to reflection at E region, and also simultaneous reflections from the two lower regions. "The fact that the jump from the F region to the intermediate region takes place at different times for the right- and the left-handed components shows that the intermediate region is mainly composed of electrons."

THE IONOSPHERE.—R. A. Watson Watt. (*Nature*, 1st July, 1933, Vol. 132, pp. 13–17.)

A note on our present knowledge of and recent work on the constitution of the ionosphere (*cf.* three preceding abstracts) and on the Royal Society discussion on June 22. A diagram is given of the track of the corpuscular eclipse of Aug. 21, 1933, for an assumed corpuscular velocity of 1 000 km/sec., computed by J. C. P. Miller.

THE EFFECT OF THE EARTH'S MAGNETIC FIELD ON THE PROPAGATION OF SHORT WIRELESS WAVES.—J. A. Ratcliffe and E. L. C. White. (*Phil. Mag.*, July, 1933, Series 7, Vol. 16, No. 103, pp. 125–144.)

For abstracts of papers referring to this subject *see* Abstracts, 1931, p. 143 (Hartree) ; 1932, pp. 155, 400 and 575 (Appleton and Builder : White : Schafer and Goodall) ; January, pp. 30 (Appleton —two) and 29–30 (T. L. Eckersley : Appleton and Ratcliffe) ; and September, p. 495 (Ratcliffe and White). The present paper describes "the construction and use of a circularly polarised receiver which makes it possible to pick out the right- and left-handed circularly polarised components for a wave incident vertically" [*cf.* last reference]. Effects found in continuous records of reflections from E and F regions are explained on the basis of the magneto-ionic theory, and it appears that "electrons are responsible for the deviation of the waves in both these regions." A discussion is also given of simultaneous reflections from the E and F regions and the polarisation of daytime signals.

THE STATE OF POLARISATION OF DOWNCOMING WIRELESS WAVES OF MEDIUM LENGTH [and the Cause of Rapid Fading].—J. A. Ratcliffe and F. W. G. White. (*Phil. Mag.*, Aug., 1933, Supp. No., Series 7, Vol. 16, No. 105, pp. 423–440.)

The method adopted in the experiments described in this paper has already been referred to in 1932 Abstracts, p. 276, l-h col. A suppressed ground-ray aerial system is used to observe the waves and is essentially the same as that previously used by Appleton and Ratcliffe (*Proc. Roy. Soc.*, A, 1927, Vol. 115, p. 315). The adjustments required are investigated theoretically ; the writers also find that the effect of the ground may be completely neglected in the range of wavelengths under consideration (200–500 m). Down-coming waves from some of the B.B.C. transmitting stations are found, in general, to be elliptically polarised with left-handed sense of rotation. The observations are found to agree with conclusions drawn from the Appleton-Hartree formula (*see*, for example, January Abstracts, p. 30, Appleton). Observed variations of the state of polarisation suggest that rapid fading is due to an interference mechanism rather than to absorption effects.

IONISATION DENSITY AND CRITICAL FREQUENCY.—L. Tonks. (*Nature*, 15th July, 1933, Vol. 132, p. 101.)

This letter remarks upon the introduction of the Lorentz polarisation term in recent work on the theoretical relation between ionisation density in the upper atmosphere and critical frequency [*e.g.*, Abstracts, 1929, p. 441, and 1931, pp. 143 and 432 (Hartree) ; 1932, p. 575 (Appleton and Naismith) ; and May, p. 262 (Appleton and Builder)] and states that such a "polarisation" force can only exist "when there is some detailed arrangement of the negative with respect to the positive charges" [in Hartree's work, referred to above, it is, however, shown that the polarisation term is valid for a medium whose ionisation consists of discrete free electrons or positively charged ions].

RECORDING WIRELESS ECHOES AT THE TRANSMITTING STATION.—I. Ranzi. (*Nature*, 29th July, 1933, Vol. 132, p. 174.)

The method described by the writer has already been referred to in 1932 Abstracts, p. 155. No increase of echo amplitude was obtained by increasing the distance between emitting and receiving stations up to 500 m.

MEASUREMENTS OF ATTENUATION, FADING, AND INTERFERENCE [by Atmospherics] IN SOUTH-EASTERN AUSTRALIA, AT 200 KILOCYCLES PER SECOND.—G. H. Munro and A. L. Green. (*Journ. Inst. Engineers, Australia*, June, 1933, Vol. 5, No. 6, pp. 193-199).

"The importance of the lower frequencies for broadcasting depends on the greater range of the direct ground ray ; hence it is of much interest to check by experiment the theoretical formulae within the maximum useful range of the ground ray at these frequencies. From the point of view of providing a broadcasting service it is also necessary to know something of the fading which may be caused by the indirect ray from the transmitter, and of the interference due to fulgurs" [a name, with abbreviation "F's," suggested for replacing "atmospherics" and "X's" when the disturbances are due to lightning discharges, "static" being reserved for man-made electrical interference and for that due to discharges from aerials, etc., caused by high potential gradients, charged rain, and possibly dust storms].

As regards the direct ray attenuation for both inland and coastal districts, the following ground conductivities, in e.m. units, were found:—along coast, path mainly over sea, 10^{-13} to 5×10^{-13}; over flat country, 10^{-13}; flat wooded country, 5×10^{-14}; undulating wooded country, 10^{-14}; country including mountain slopes, 5×10^{-15}.

With regard to fading: for coastal districts, where much of the path is over sea, the 50% fading ring (according to the U.I.R. Madrid Conference the service area of a broadcasting station can be said to be terminated where 50% fading is encountered) is not closer than 550 km to the transmitter; for inland districts, where the intervening country is undulating and wooded, it is first encountered at about 250–350 km from the transmitter, or at 200–250 km if some of the path is over mountain slopes.

Average values of the indirect ray were of the order of 0.05 mv/m for 1 kw radiated, the greatest values being slightly above 0.1 mv/m (T. L. Eckersley's figures for the European 550–1 500 kc/s band being much higher, of the order of 0.3 mv/m).

The general noise level, due to indirect-ray propagation of atmospherics from great distances, was found not to exceed 0.015 mv/m, so that "a broadcasting service, at 200 kc/s, of 1.5 mv/m will be entirely free from atmospheric interference, it being understood that purely local thunderstorms are excepted." Special tests were made to translate the estimates of integrated "fulgur" level to a basis of interference with broadcast reception, and it was found that with the carrier field intensity about 10 times that of the integrated disturbance level, speech was over 90% intelligible but music was marred ("classical music: owing to the high continuity of dance music a much greater intensity of noise is bearable.") A ratio of 100 to 1 was found to be desirable for perfect reception of music.

The field intensity set was substantially of the same design as that described by Green and Wood (*see* under "Measurements and Standards") but a Cambridge thread recorder was substituted for the faster-moving Einthoven photographic equipment, and a vertical aerial was used instead of the loop.

PROPAGATION OF WAVES OF 150 TO 2 000 KILOCYCLES PER SECOND (2 000 to 150 Metres) AT DISTANCES BETWEEN 50 AND 2 000 KILOMETERS [Madrid Sub-Committee Graphs of Average Data].—B. van der Pol, T. L. Eckersley, J. H. Dellinger and P. le Corbeiller. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 996–1002.)

See also Abstracts, August, p. 439, r-h column; also September, p. 518, l-h column.

PROPAGATION OF WAVES: WORK OF SPECIAL COMMITTEE AT LUCERNE [Qualifying and Amplifying Madrid Committee's Reports]. (*World-Radio*, 18th August, 1933, Vol. 17, No. 421, pp. 200 and 198.)

A METHOD OF CALCULATION OF FIELD STRENGTHS IN HIGH-FREQUENCY [Short-Wave] RADIO TRANSMISSION.—S. Namba and T. Tsukada. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 1003–1028.)

Continuation of the work dealt with in May Abstracts, p. 265, r-h col. The theory is summarised and applied to practical cases. The Tokio–Cape Town and Tokio–Melbourne circuits are taken as examples, 15- and 10-Mc/s diurnal transmission characteristics being computed and plotted for the former and 10- and 20-Mc/s for the latter, the power being taken as 1 kw in all cases and the field strength plotted in db above 1 $\mu v/m$. As a third example signals from Bolinas received at Tokio are calculated on the assumption of a radiated power of 20 kw and an aerial-system gain of 20 db. "The calculated result is shown in Fig. 17, which coincides fairly well with our observations." Finally the problem of how the transmitter output and the form of the aerials must be chosen to give 24-hours' high-speed communication on the Tokio–Melbourne service is considered. The writers conclude: "The proposed method is of great use not only for the projection of a new communication service, but also for an investigation of h.f. propagation phenomena."

FIELD-STRENGTH MEASURING SET FOR GROUND AND SKY WAVES, AND SOME RESULTS OF PRACTICAL TESTS.—Green and Wood. (*See* under "Measurements and Standards.")

DISTANT TELEVISION RECEPTION: MULTIPLE IMAGES DUE TO PROPAGATION EFFECTS.—Bodroux and Rivault. (*See* under "Phototelegraphy and Television.")

THE TEMPERATURE OF THE UPPER ATMOSPHERE DEDUCED FROM DAY/NIGHT CHANGE OF HEIGHT OF ABSORPTION LAYER FOR AURORAL LIGHT.—G. Angenheister. (*Sci. Abstracts, Sec. A*, May, 1933, Vol. 36, No. 425, p. 450.)

METEORS AND THE 80–90 KM LAYER OF THE EARTH'S ATMOSPHERE.—Malzev. (*See* under "Atmospherics and Atmospheric Electricity.")

VERTICAL DISTRIBUTION OF OZONE IN THE ATMOSPHERE.—F. W. P. Götz, G. M. B. Dobson and A. R. Meetham. (*Nature*, 19th Aug., 1933, Vol. 132, p. 281.)

A new method is being used to determine not only the centre of gravity of the layer of atmospheric ozone but also the general character of its vertical distribution. The method is "based on observations of the spectrum of the light received from the clear blue zenith sky as the sun is rising or setting." The average height of the centre of gravity at Arosa now appears to be about 20 km, and there seems to be an appreciable amount of ozone in the lower layers.

STUDY OF ATMOSPHERIC OZONE BY A RAPID METHOD OF VISUAL PHOTOMETRY.—J. Gauzit. (*Comptes Rendus*, 10th July, 1933, Vol. 197, No. 2, pp. 178–180.)

The values found during the first six months of

1933 for the thickness of the ozone layer are very considerably higher than those found in the same period in 1931. This large variation in the space of 2 years is comparable with that which occurred in 1912–1914.

THE PHOTOMETRY OF SOLAR ECLIPSE PHENOMENA.—C. H. Sharp and others. (*Journ. Opt. Soc. Am.*, July, 1933, Vol. 23, No. 7, pp. 234–245.)

A NEW METHOD OF CALCULATING THE HYPOCENTRAL DEPTH.—P. Caloi. (*La Ricerca Scient.*, 30th April, 1933, 4th year, Vol. 1, No. 8, pp. 508–511.)

PERIODIC COMPONENTS IN LOVE WAVES [from the 1922 Formosa Earthquake Records].—Y. Labrouste. (*Comptes Rendus*, 24th July, 1933, Vol. 197, No. 4, pp. 344–346.)

REFRACTION OF INFRA-RED RAYS [Ships detected 6 Miles beyond Horizon].—Macneil. (*See* abstract under "Miscellaneous.")

ELLIPSOIDAL FUNCTIONS AND THEIR APPLICATION TO SOME WAVE PROBLEMS.—Hanson. (*See* under "Miscellaneous.")

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

INFLUENCE OF GEOPHYSICAL FACTORS ON THE FREQUENCY OF LIGHTNING STROKES ON AN AREA.—L. N. Bogoïavlensky. (*Nature*, 15th July, 1933, Vol. 132, p. 99.)

This letter describes an investigation which showed that "the points of the lightning strokes always correspond to the places with increased intensity of the [radioactive] earth radiation" and that the latter is connected with a layer of rock of considerable conductivity, lying sometimes at a considerable depth below the surface. For a previous paper by the same writer *see* Abstracts, 1931, p. 494, r-h col., and for other papers on the same subject *see* Jan., Feb. and March Abstracts, pp. 32, 93 and 151, all r-h columns; also 1932, p. 577, l-h column.

RADIO WAVES FROM OUTSIDE THE SOLAR SYSTEM [Direction of Arrival of "Hiss Type" Atmospherics].—K. G. Jansky. (*Nature*, 8th July, 1933, Vol. 132, p. 66.)

This preliminary letter refers to a continuation of experiments on the direction of arrival of high-frequency atmospherics, already referred to in August Abstracts, p. 441, r-h col. The horizontal component of the direction of arrival of "hiss type" atmospherics was there found to change nearly 360° in 24 hrs and the source of the disturbance was assumed to be associated with the sun, but, from records taken for more than a year, it is now thought that the source of noise is located in a region stationary with respect to the stars, with co-ordinates approximating to a right ascension of 18 hours and a declination of $-10°$.

ATMOSPHERICS ["Fulgurs"] IN SOUTH-EASTERN AUSTRALIA, MEASURED ON A FREQUENCY OF 200 KILOCYCLES PER SECOND.—Munro and Green. (*See* abstract under "Propagation of Waves.")

METEORS AND THE 80–90 KM LAYER OF THE EARTH'S ATMOSPHERE.—V. Malzev. (*Nature*, 22nd July, 1933, Vol. 132, p. 137.)

The writer draws attention to the fact that the maxima of brightness of meteor paths are found at a nearly constant height of 85–90 km.

LOW AURORAS AND TERRESTRIAL DISCHARGES.—C. S. Beals. (*Nature*, 12th Aug., 1933, Vol. 132, p. 245.)

"Reports have been received from observers in northern Canada, who have detected the odour of ozone during auroral displays . . . accompanied by sounds." The sounds and low-level displays appear to be due to electrostatic discharges near the earth's surface.

MOTION OF ELECTRONS IN HETEROGENEOUS MAGNETIC FIELDS.—H. Ertel. (*Gerlands Beitr. z. Geophys.*, No. 2, Vol. 38, 1933, pp. 142–146.)

SECULAR CHANGES OF THE MAGNETIC ELEMENTS, OTTAWA, 1500–1930.—W. H. Herbert. (*Canadian Journ. of Res.*, July, 1933, Vol. 9, No. 1, pp. 94–96.)

THE [Continual] FLUCTUATIONS OF THE EARTH'S ELECTRIC FIELD [not only due to Local Irregular Disturbances].—A. Dupérier and G. Collado. (*Comptes Rendus*, 31st July, 1933, Vol. 197, No. 5, pp. 422–423.)

[Establishment of an Important Relation between] THE ELECTRICAL POTENTIAL GRADIENT AND ATMOSPHERIC PRESSURE.—R. Guizonnier. (*Comptes Rendus*, 17th July, 1933, Vol. 197, No. 3, pp. 265–266.)

VARIATIONS IN THE SMALL-ION CONTENT OF THE ATMOSPHERE, AND THEIR CAUSES.—G. R. Wait. (*Journ. Franklin Inst.*, Aug., 1933, Vol. 216, No. 2, pp. 147–155.)

PENETRATING RADIATION FROM THUNDERCLOUDS.—J. E. I. Cairns. (*Nature*, 29th July, 1933, Vol. 132, p. 174.)

The writer has used ionisation methods to detect the penetrating radiation from thunderclouds; his results agree with those of Schonland and Viljoen (August Abstracts, p. 442, l-h column).

AIRPLANE COSMIC-RAY INTENSITY MEASUREMENTS.—L. M. Mott-Smith and L. G. Howell. (*Phys. Review*, 1st July, 1933, Series 2, Vol. 44, No. 1, pp. 4–11.)

An abstract of this paper was dealt with in June Abstracts, p. 322, r-h column.

COMPARISON OF THE ANGULAR DISTRIBUTIONS OF THE COSMIC RADIATION AT ELEVATIONS 6 280 FT AND 620 FT.—T. H. Johnson. (*Journ. Franklin Inst.*, Aug., 1933, Vol. 216, No. 2, pp. 259–267.) *See* July Abstracts, p. 388, r-h column.

Angular Distribution of Low Energy Cosmic Radiation and Interpretation of Angular Distribution Curves.—T. H. Johnson and E. C. Stevenson. (*Journ. Franklin Inst.*, Aug., 1933, Vol. 216, No. 2, pp. 267–270.) *See* July Abstracts, p. 388, r-h column.

The Asymmetry of the Cosmic Radiation at Swarthmore.—T. H. Johnson and E. C. Stevenson. (*Phys. Review*, 15th July, 1933, Series 2, Vol. 44, No. 2, pp. 125–126: *Journ. Franklin Inst.*, Aug., 1933, Vol. 216, No. 2, pp. 276–280.)

The Interpretation of the Azimuthal Effect of Cosmic Radiation.—M. S. Vallarta. (*Phys. Review*, 1st July, 1933, Series 2, Vol. 44, No. 1, pp. 1–3.)

This note gives a discussion based upon the theory of Lemaitre and Vallarta (Abstracts, March, p. 152, l-h col.; April, p. 209, r-h col.; *also* Johnson, August, pp. 442–443, and Alvarez and Compton, p. 442, r-h col.) which indicates that a predominant part of cosmic radiation consists of positive particles.

Azimuthal Investigation of Cosmic Radiation.—S. A. Korff. (*Phys. Review*, 15th July, 1933, Series 2, Vol. 44, No. 2, p. 130: abstract only.)

The Distribution of the Ionising Particles of the Penetrating [Cosmic] Radiation in Relation to the Magnetic Meridian.—J. P. T. Viljoen and B. F. J. Schonland. (*Phil. Mag.*, Aug., 1933, Supp. No., Series 7, Vol. 16, No. 105, pp. 449–456.)

This paper describes an experimental investigation of the direction of arrival of ionising particles associated with the penetrating radiation at sea-level in Cape Town. No significant difference between north and south directions, or between east and west directions, is found; there are small defects from east and west as compared with north and south. The conclusion is drawn that "any charged particles of extra-terrestrial origin are accompanied by a larger number of secondary particles generated in the atmosphere by some radiation which is not affected by the earth's magnetic field. The north-east difference suggests that the majority of the primary particles are positively charged."

Latitude Effect of Cosmic Radiation.—H. Hoerlin. (*Nature*, 8th July, 1933, Vol. 132, p. 61.)

This preliminary letter describes measurements of the intensity of cosmic radiation in different geomagnetic latitudes, made on a voyage from the Strait of Magellan to Hamburg. A graph is given showing the measured intensity in volts per hour as a function of the geomagnetic latitude. The intensity is found to increase by about 12 per cent. when passing from the equatorial region to 55° N geomagnetic latitude. The observations agree in general with those of Clay (Abstracts, January, p. 34), and A. H. Compton (June, p. 322: both l-h columns). The northern and southern parts of the curve are found not to be symmetrical with respect to either the geomagnetic or the geographical equator.

Interaction between Cosmic Rays and Matter.—B. Rossi. (*Nature*, 29th July, 1933, Vol. 132, pp. 173–174.)

This letter describes results obtained by the method of triple coincidences in the investigation of the frequency of occurrence of secondary "showers" generated by cosmic rays passing through matter.

On the Nuclear Disintegration produced by the Penetrating Radiation.—B. Rossi. (*La Ricerca Scient.*, 15/31st May, 1933, 4th Year, Vol. 1, No. 9/10, p. 586.)

PROPERTIES OF CIRCUITS

Über die Resonanzfrequenzen zweier gekoppelter Schwingungskreise (The Resonance Frequencies of Two Coupled Oscillatory Circuits [and a New Method of Frequency Analysis]).—W. Fehr and K. Kreielsheimer. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 14, 1933, pp. 306–308.)

Following on the work of Kossel (1931 Abstracts, p. 378) the writers discuss an electrical circuit which is clearly analogous to Kossel's pendulums. Two closed oscillatory circuits I and II are connected by a coupling link forming part of neither circuit (in Fig. 1 the lower ends of the two inductances are connected by a straight lead, the upper ends by an inductance L_0; the inductances of the two circuits are spaced so as to have no mutual magnetic coupling) and are excited by a third circuit containing two exciting coils, one coupled to the inductance of I and the other to the inductance of II. The conditions resulting from I and II being excited in the same phase, and from their being excited in phase opposition, are investigated.

The writers then show how the properties of such an arrangement enable it to be used for frequency analysis or for measuring non-linear distortion. Thus if the frequency mixture to be investigated is applied to I and II in the same phase, resonance with the fundamental can be found in both circuits and a measure of the amplitude of the fundamental can be obtained. If then, without changing the tuning of I and II, the frequency mixture is applied in phase opposition, resonance points for the higher (or lower) partial frequencies will be found, depending on the value of the coupling inductance L_0 (or coupling capacity C_0).

Another method, which gives a simultaneous measurement of fundamental and partial amplitudes, is to use a one-sided application of the mixed frequencies; *i.e.* to couple the exciting circuit to one circuit only (Fig. 2) and to lead the currents from the two points 1 and 2 to a differential meter.

Frequency of Oscillations in Two Inductively Coupled Circuits [One being in a Valve Anode Circuit: the Theoretical Existence of Three Frequencies].—M. Rousseau. (*Sci. Abstracts, Sec.B*, May, 1933, Vol. 36, No. 425, p. 317.)

SOME GENERAL RESONANCE RELATIONS AND A DISCUSSION OF THEVENIN'S [Pollard's] THEOREM.—J. G. Brainerd. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 1050–1054.)

Author's summary:—It is shown that the maximum possible current which can be obtained through an impedance joining two points of a linear network is in general greater than the short-circuit current between those points; the maximum possible voltage is in general greater than the open-circuit voltage; the ratio of open-circuit voltage to short-circuit current is equal to the ratio of the maximum possible voltage to the maximum possible current, and both are equal to the magnitude of the input impedance of the network, etc. The condition for maximum voltage across a branch of a linear network is derived.

As a preliminary, a form of Thevenin's theorem different from the usual one and of greater usefulness in the analytical solution of some circuit problems is obtained.

OSCILLATORY CIRCUITS [Mathematical Investigation of Toroidal Inductance connected to Condenser].—F. Dacos. (*Sci. Abstracts, Sec.B*, June, 1933, Vol. 36, No. 426, p. 394.)

A NOTE ON NONLINEARITY IN TRANSDUCERS USED IN COMMUNICATION [and Its Correction by a Series Compensating Transducer].—P. Caporale. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 1029–1038.)

Author's summary:—" The characteristic of a nonlinear transducer can usually be expanded in a power series, when it is not simply a single term raised to some power. For those cases where the characteristic may be so expressed, a general law or equation is derived for the characteristic of a compensating transducer, that is, a transducer which in combination with the first transducer will produce over-all linearity. It is shown, moreover, that when the series for the distorting transducer is not sufficiently rapid in its convergence, it becomes impractical to realise the necessary compensating transducer. A simple case of an actual compensating transducer used to correct a square-law characteristic is briefly described."

As an interesting case of a compensating transducer for correcting amplitude distortion, reference is made to Massa's use of an impedance decreasing with current (actually composed of Thyrite—Abstracts, 1930, p. 332, l-h col.) in the plate circuit of the distorting valve (July, p. 397, l-h col.).

EXTENSION OF MAXWELL'S RULE FOR ANALYSING ELECTRICAL NETWORKS.—Y. H. Ku. (*Sci. Abstracts, Sec.A*, June, 1933, Vol. 36, No. 426, p. 621.)

A SIMPLIFIED FREQUENCY-DIVIDING CIRCUIT [using One Pentode Valve].—Andrew. (*See* under " Subsidiary Apparatus and Materials.")

DIODE DETECTION ANALYSIS.—Kilgour and Glessner. (*See* under " Reception.")

TRANSMISSION

DIE ULTRADYNAMISCHE SCHWINGUNGSANFACHUNG DURCH RÜCKKOPPLUNG (The Ultradynamic Excitation of Oscillation by Retroaction [" Inversions " Theory of Ultra-Short Wave Generation by Normal and Retarding-Field Circuits]).—H. E. Hollmann. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, pp. 32–33: long summary only.)

The phenomena occurring in the generation of u.s.w. oscillations in triodes are attributed to the phase displacement between valve current and control potential, caused by the finite electron path-time. The phase angle thus produced is given by $\omega\delta$, and can obviously be made large by choosing a very high frequency ω or a long path-time δ. The term " ultradynamic characteristic " is given to the characteristic curves for $i_a/e_{contr.}$ plotted at these ultra-high frequencies and analogous to Lissajous' figures in that at all phase angles corresponding to uneven multiples of π $\left(\phi = (2n - 1)\pi\right)$ the ultradynamic characteristics become inverted, while at even multiples of π they again agree with the original static characteristic; in the intermediate regions they take on a cyclic-elliptic form.

The summary continues: " For the more precise theoretical treatment of the problem, taking into account the displacement current, the space-charge-controlled triode is traced back to the equivalent circuit of a diode with emission control. From this there result certain deviations from the fundamental ideas of ultradynamic inversions. Thus the inversions maxima denoted by the serial order number n do not proceed simply with π, but have their phase angle represented by $\tan \phi = \phi$. A further effect of the displacement current is that the anode a.c. current gradually sinks (in close approximation with $1/\phi$) as a result of the space-charge maxima collecting between the electrodes more and more abundantly as the serial order number increases. This effect shows itself in a decreasing slope of the ultradynamic curves, which explains the increasing weakness of excitation at the higher frequencies."

The second part of the paper deals with the generation of ultra-high frequencies by retroaction in an ordinary triode with positive anode. All normal retroaction circuits (in u.s.w. work the three-point connection is the most common) give a rising characteristic. From this it follows that in all " back-inversion " zones, in which the ultradynamic characteristics are already ascending, the excitation of the corresponding high frequencies must be possible. Equally, however, it would be expected that in the interlying " inversion " zones a positive excitation would occur *if only the curve-inversion were compensated by the vectorial reversal of the external back-coupling*. In practice such " inversions oscillations," following each other in a series governed by the formula $\lambda^2 E_a = \text{const.}/n^2$, have not so far been obtained; but observations have been reported from other sources which can only be interpreted as inversions phenomena. On the other hand it has been possible, by measuring the excitation of a normal three-point circuit, to show the existence of several positive and negative zones; with constant frequency the ultradynamic phase displacement was gradually increased by variation of the path-time through change of accelerating potential. The dotted curve of Fig. 1 shows such a measurement; the abscissae represent the anode voltage and the ordinates the excitation on an arbitrary scale.

The third part of the paper deals with the oscillation zones in the retarding-field method. Here the case of pure emission-control, assumed in the theory, actually exists. Consideration of the general laws of such oscillation excitation shows that the external back-coupling in retarding-field circuits must be vectorially inverted compared with the normal valve circuit. Applied to the excitation of ultra-high frequencies, this gives the law that the excitation zones of the retarding-potential valve must lie just between those of the normal triode. *Complete experimental confirmation of this law was found*, as is shown by the continuous-line curve in Fig. 1, exactly opposed in phase to the dotted retroaction-valve curve already mentioned.

In retarding-field circuits, as in retroaction-triodes (*see* above), the inversion of characteristic can be compensated by a reversal of the external back-coupling. If the normal triode is represented by $-R$, the retarding-field valve by $+R$ and the external coupling by $\pm K$, the sign of the excitation A is given by the relation sign A = sign $R.K(-1)^n$." The generator arrangements commonly used for u.s.w. production have several degrees of freedom, so that the retroaction-coupling can be positive or negative. In practice, therefore, oscillations occur in zones of all orders, obeying the general law $n^2 \lambda^2 E_g$ = const. On the exact "inversions theory" this formula requires correction, in that the series of whole numbers $n = 1, 2, 3 \ldots$ must be replaced by the values N given by the inversions condition $\tan \phi = \phi$.

With a specially designed valve, whose grid is a spiral freely oscillating as a dipole, a wave of 18 cm can be obtained with a grid voltage of only 128 v. This corresponds to the ninth inversion. "The development of an arrangement with only one degree of freedom led to a generator with 5 watts output on a 50-cm wave. Further confirmation of the inversions theory was given when the external back-coupling was reversed, the wave shortening itself by 30% as a result of its shift into a higher inversion zone."

The paper ends by considering the "inversions" theory in connection with other views on the mechanism of u.s.w. generation, with the result that all theories based on the Barkhausen picture of "electron swings" are to be regarded as special cases of the general theory.

Slightly Damped Ultra-Short Electric Waves [below 10 cm: Experimental Method of Generation].—K. Zakrzewski and M. Miesowicz. (*Sci. Abstracts, Sec. A*, June, 1933, Vol. 36, No. 426, p. 654; *Physik. Ber.*, 15th June, 1933, Vol. 14, No. 12, p. 939.)

"The waves radiated by the oscillator are conducted through a metal tube 50 cm long and of square cross-section with 3.7-cm sides. The waves emerging from the tube have different wavelengths and smaller decrement as compared with those directly radiated from the exciter. A decrement of 0.19, for a 6.6-cm wavelength, was attained."

The Generation of Micro-Waves with Special Valves in a Retarding-Field Connection.—Gossel: Kohl. (*See* abstract under "Valves and Thermionics.")

A Graphical Method for Determining the Transit Times of Electrons in a Three-Electrode Valve under Conditions of Space-Charge Limitation.—J. S. McPetrie. (*Phil. Mag.*, Aug., 1933, Series 7, Vol. 16, No. 104, pp. 284–293.)

The Interdependence of Frequency Variation and Harmonic Content, and the Problem of Constant-Frequency Oscillators.—J. Groszkowski. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 958–981.)

English version of the Polish paper dealt with in July Abstracts, pp. 390–391. The writer's method of establishing the interdependence is first applied to dynatron circuits and then generalised so as to refer to triode circuits with retroaction. It is shown that the ways of proceeding towards the establishment of constant-frequency generators are: (1) operation without harmonics, *i.e.* close to the critical state. But to maintain the critical state the operative conditions must be kept constant—which is already equivalent to maintaining a constant frequency; the only interest in this plan therefore lies in automatic methods. (2) The removal of the harmonics from the oscillatory circuit, the simplest method being by a number of series filters tuned to the corresponding harmonics. In practice it is sufficient to use a few filters for the lowest harmonics only ($k = 2, 3, 4, 5$); the higher ones are shunted sufficiently by the capacity of the oscillatory circuit (this explains the fact that generators whose circuits have a large capacity are less subject to frequency variations due to changes in the operative conditions). (3) The equalisation of the imaginary energy distribution of the harmonics. Under certain circuit conditions it is shown that the second harmonic reduces the frequency, while all higher harmonics raise it. In such a system the action of the higher harmonics can be compensated by the action of the lower ones, and this fact allows a considerably better frequency constancy to be obtained with the help of a few filters only than can be expected from the "shunt-trapping" action of method (2) alone. By the suitable detuning of one filter, the compensation of those harmonics which have not been removed by the filters can be attained.

The Effect of the Curvature of the Characteristic on the Frequency of the Dynatron Generator [Frequency Changes greater than can be accounted for by Curvature alone].—E. B. Moullin. (*Journ. I.E.E.*, August, 1933, Vol. 73, No. 440, pp. 186–195.)

From the author's summary:—"The analysis shows that the fundamental frequency is affected by the phase of the higher-harmonic components of anode potential and that the effect would be zero if the impedance of the circuit could be made purely resistive to all the higher-harmonic currents. A network is described which fulfils closely the required conditions. It is found that the change of frequency which accompanies the change of output is much greater than can be accounted for by the curvature of the characteristic, and hence it is presumed there must be some other cause of instability inherent in the valve. It is suggested [*see* Baker, below] that the electrode capacitance may depend on the condition of the space charge." *See* also Groszkowski, above; *also* Hayasi, September Abstracts, p, 502, r-h column. With regard to the 1923 work of Appleton and Greaves, the writer remarks that his method presents the answer directly in an easier form and makes clear the mechanism involved, thus leading at once to the special form of circuit which renders the effect of curvature innocuous.

THE INTER-ELECTRODE CAPACITANCE OF THE DYNATRON, WITH SPECIAL REFERENCE TO THE FREQUENCY STABILITY OF THE DYNATRON GENERATOR.—G. B. Baker. (*Journ. I.E.E.*, August, 1933, Vol. 73, No. 440, pp. 196–203.)

From author's summary:—"The changes of frequency are such as to indicate that the anode-grid capacitance is a function of the anode potential and is independent of the parameters of the oscillating circuit. The same changes of capacitance are found to occur when the circuit is not oscillating and the valve is used to reduce the power factor of the circuit. The dependence of capacitance on space charge is discussed briefly and outlined analytically. The dynatron characteristic is then analysed and the probable form of the secondary emission-current/anode-potential curve is deduced. This deduced curve indicates the presence of space charge in the operating conditions where the changes of frequency are found to occur." *See* Moullin, above.

SUPPRESSION OF TRANSMITTER HARMONICS.—C. G. Dietsch. (*Electronics*, June, 1933, Vol. 6, No. 6, pp. 167–169.)

THE CRYSTAL DRIVE OF THE EXPERIMENTAL SHORT-WAVE BROADCASTING STATION G5SW.—T. D. Parkin. (*Marconi Review*, May/June, 1933, No. 42, pp. 1–10.)

APPLICATION OF TRANSFORMER-COUPLED MODULATORS [and the Higher Efficiency and Decreased Distortion of Class B Amplification].—J. A. Hutcheson. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 944–957.)

Author's summary:—A brief résumé of Heising's modulator theory is presented together with a discussion of the class B operation of tubes in a push-pull audio-frequency circuit. Several cases of commercial applications of class B audio amplifiers are mentioned. Several general problems involved in the use of class B audio amplifier are discussed, with the conclusion that such an amplifier will produce more audio power for a given tube complement, at higher efficiency, and with less distortion, than amplifiers previously used in commercial applications.

RADIOTÉLÉPHONIE À BANDE LATÉRALE UNIQUE (Single Sideband Radiotelephony [Theory and Methods, including Balanced Modulation by Diodes]).—M. Kolesnikov. (*L'Onde Élec.*, May, 1933, Vol. 12, No. 137, pp. 237–249.)

A NEW METHOD OF OBTAINING FREQUENCY MODULATION [by Varying Resistance through Use of R.F. Transmission Line].—E. D. Scott: Eastman. (Summary only in *Proc. Inst. Rad. Eng.*, August, 1933, Vol. 21, No. 8, p. 1074.)

The two chief drawbacks of frequency modulation are the difficulty of producing linear modulation by means of a variable reactance, and of finding a satisfactory type of detector. The writer develops equations showing that very satisfactory linear frequency modulation can be obtained with a transmission line one-eighth of a wavelength long, with a terminal resistance about equal to the characteristic impedance of the line: this was demonstrated experimentally. He also mentions some work [no details are given here] which he hopes will solve the second difficulty.

FREQUENCY MODULATION AND THE EFFECTS OF A PERIODIC CAPACITY VARIATION IN A NON-DISSIPATIVE OSCILLATORY CIRCUIT.—W. L. Barrow. (*Proc. Inst. Rad. Eng.*, August, 1933, Vol. 21, No. 8, pp. 1182–1202.)

Author's summary:—Certain fundamental characteristics of the theory of frequency modulation for arbitrarily large degrees of modulation and unrestricted modulation frequencies are developed from the differential equation for a dissipationless circuit with fixed inductance and variable capacitance. The several modes of modulating the frequency are discussed and classified; it is shown that they give the same results only when the amount of modulation is very small. The case of "inverse capacity modulation" is then treated in detail. This treatment discloses the possibility of unstable oscillations occurring with certain values of the parameters; the nature and physical significance of these unstable oscillations are determined, and it is explained why they are not ordinarily observable in radio-frequency modulation or in the warble-tone generator. The frequency spectrum of the stable oscillations is found, and a means of calculating the amplitude given. For certain adjustments of the circuit the oscillations may be represented by a true Fourier series, while in general this is not the case. Frequency modulation in radio-telephony, the warble tone, and the special case where the natural period of the unmodulated circuit and the frequency of modulation are of comparable magnitude, represent successively more complicated cases of the same general phenomena; the latter is of special interest. The nature of the phenomena accompanying other than a sinusoidal inverse capacity variation is mentioned.

RECEPTION

AN ANALYSIS OF POWER [Grid] DETECTION [and the Use of a High-Impedance Choke in place of the Grid Leak and of a Tungsten Lamp as Plate Series Resistance].—R. de Cola. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 984–989.)

"The reasons for overloading of detectors as output devices is discussed. It is shown that in grid-circuit rectification replacing the grid leak with a high-impedance choke [about 100 henrys] extends the overload point considerably. Using a 247-type pentode, 800 milliwatts are obtained at the output circuit with 7 % maximum distortion." The writer considers that although his results were obtained by running the valve at space currents somewhat higher than the values recommended by the makers, this should not seriously limit its life; the total plate dissipation is only slightly higher than that specified. The audio output is probably more than the available baffling area in a small set can utilise, and "certainly much more than the average home can generally use." Also, a power detector of this type can supply sufficient power to a class B amplifier without the necessity of an intermediate "driver" valve.

Before arriving at the use of the high-impedance choke, the writer experimented with the employment of a small tungsten-filament 7.5 w lamp as a series resistance, in the plate circuit, which would have comparatively large resistance to protect the valve from abnormal plate current and yet, under an impressed carrier upon the grid, would automatically decrease in resistance to a value proportional to the carrier and thus quite accurately and automatically control the plate current and valve characteristics. The improved form of the plate current thus obtained is seen in Fig. 2. Incidentally it is mentioned that the presence of such a lamp gives a good indication of resonance "and can be used to advantage . . . in place of a tuning meter."

DIODE DETECTION ANALYSIS.—C. E. Kilgour and J. M. Glessner. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 930–943.)

Authors' summary:—This paper gives the current and output relations for the linear and square-law diode detector in terms of the detection efficiency and the detector and load resistances. The square-law case is shown to yield results similar to the linear for large input potentials and reasonable values of load. Employing the rectification-current/input-voltage characteristic, the graphical method is used to show that serious distortion is developed for deep modulation whenever an appreciable audio load is shunted across the diode resistor. It is found that $M = 1 + D(A - 1)$, where M is the modulation ratio at which cut-off begins, D the detection efficiency, and A the ratio of the audio impedance to the direct-current value of the diode load. The value of M is shown for various load conditions in both the linear and square-law cases. The paper shows that the use of a small condenser across the load decreases the detection efficiency but increases the input impedance. The connection to the driving circuit of a second diode for the development of automatic volume control potential is shown to cause distortion when such a tube is used with a delay bias. Mention is made of the importance of considering the impedance of the driving circuit, and attention is called to the failure of any of the methods of analysis to consider all of the factors involved.

H.F. AMPLIFIER WITH HIGH AMPLIFYING POWER [Reduction of Anode-Circuit Damping in a S.G. Stage without Alteration of Tuning, by a 2-Stage Resistance-Capacity Cascade with Output capacitively coupled to Anode Circuit]. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, p. 37: German Pat. No. 571 326, pub. 27th Feb., 1933, von Ardenne.)

A SUPERHETERODYNE RECEIVER WITH SEVERAL FREQUENCY CHANGES IN THE I.F. CIRCUIT. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, p. 37: German Pat. No. 570 682, pub. 18th Feb., 1933, Aigner.)

The first i.f. is led through an amplifier to a frequency-doubling detector. The new frequency $2n_1$ and a fixed second heterodyning frequency N_2 give a sum- or difference-frequency $n_2 = N_2 \pm 2n_1$ which is sent through the same amplifier, doubled by the same detector, and then combined with N_2 again. The resulting frequency $n_3 = N_2 \pm 2n_2$ passes to the output detector.

A LONG-WAVE SINGLE-SIDEBAND TELEPHONY RECEIVER FOR TRANSATLANTIC WORKING: PART I.—C. J. W. Hill and H. Page. (*Marconi Review*, May/June, 1933, No. 42, pp. 13–26.)

A VARIABLE WAVELENGTH AERIAL [Aerial Wire winding on Metal Drum: Improved Short-Wave Reception by Adjusting to Optimum Natural Wavelength].—(*World-Radio*, 18th Aug., 1933, Vol. 17, No. 421, p. 205.)

AUTOMATIC REGENERATION [One Adjustment gives Suitable Regeneration Constant over Whole Tuning Scale].—R. W. Tanner. (*Rad. Engineering*, June, 1933, Vol. 13, No. 6, p. 10.)

"Automatic regeneration has always been the hope of engineers and experimenters. . . . It is now a possibility through a development recently completed. . . . Considerable work is being done with this new idea, applying it to various circuits and with different tubes. . . ." The usual grid coil and the retroaction coil are both tuned to resonance by a two-gang condenser: the coupling between them is both magnetic and capacitive. The former coupling tends to make the plate feed-back currents stronger at the low-capacity end of the scale, the latter at the high-capacity end. By a suitable combination the regeneration is made constant over the whole scale.

ADJUSTMENT OF BAND BREADTH IN A BAND-PASS FILTER BY VARIABLE-COUPLING COILS TENDING TO NEUTRALISE THE FIXED COUPLINGS. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, p. 37: German Pat. No. 572 073, pub. 10th March, 1933, Meissner.)

REFLEX CIRCUIT CONSIDERATIONS.—J. M. Stinchfield and O. H. Schade. (*Electronics*, June, 1933, Vol. 6, No. 6, pp. 153–155.) *See* also "Trends . . .", under "Miscellaneous."

TRENDS IN RADIO DESIGN AND MANUFACTURING. (*See* under "Miscellaneous.")

CUTTING OUT DISTORTED RECEPTION OF OVER-WEAK SIGNALS IN RECEIVERS WITH A.V.C., WITH HELP OF THYRATRON CONTROLLED BY A.V.C. RECTIFIER. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, p. 37: German Pat. No. 572 273, pub. 13th March, 1933, R.C.A.)

AUTOMATIC VOLUME CONTROL FOR SELECTIVE FADING BY SUBDIVISION OF FREQUENCY BAND INTO SEVERAL COMPONENTS EACH WITH ITS OWN CONTROL FREQUENCY. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, p. 37: German Pat. No. 571 237, pub. 25th Feb., 1933, Siemens & Halske and Sedlmayer.)

AUTOMATIC VOLUME CONTROL AND FADING COMPENSATION [Survey of New Methods and Possibilities].—R. Wigand. (*Radio, B., F. für Alle*, August, 1933, pp. 368–378.)

THE "PEOPLE'S RECEIVER." (*Radio, B., F. für Alle*, August, 1933, pp. 341–343.)

On the cheap German receiver dealt with in September Abstracts, p. 505, l-h col. For further comments (including the effect of this receiver on the position of other single-circuit receivers) see *ibid.*, pp. 337 and 338.

NEW PENTAGRID TUBES AND COIL-SWITCHING IN THE AMATEUR-BAND SUPERHET.—H. B. Allen. (*QST*, August, 1933, Vol. 17, No. 8, pp. 12–17 and 72, 74.)

AN UNUSUAL 56-MC [Ultra-Short-Wave] SUPER-REGENERATIVE RECEIVER: DETAILS OF A PORTABLE SET WITH SELF-QUENCHING DETECTOR.—J. G. Haydock. (*QST*, July, 1933, Vol. 17, No. 7, pp. 14–16.)

RADIO DISTRIBUTION SYSTEM FOR APARTMENT BUILDINGS.—C. F. Boeck: Bell Laboratories. (*Rad. Engineering*, June, 1933, Vol. 13, No. 6, pp. 20–21.)

AERIALS AND AERIAL SYSTEMS

THEORIE UND PRAKTISCHE ANWENDUNG DER GERICHTETEN STRAHLUNG (Theory and Practical Application of Directed Radiation [Comprehensive Survey of Beam Aerial Theory: Calculation of Radiation Diagram of Zeesen Short-Wave Broadcasting Aerial. Part I.]).—W. Ochmann and M. Rein. (*Hochf:tech. u. Elek:akus.*, July 1933, Vol. 42, No. 1, pp. 27–32.)

With 53 literature references. For the Zeesen aerial which is taken as an example for calculation, *see* 1932 Abstracts, pp. 525–526.

OPERATION OF THE NEW ["Concentrator" Directive Broadcasting] ANTENNA AT KYW. (*Rad. Engineering*, June, 1933, Vol. 13, No. 6, p. 10.)

See August Abstracts, p. 449, l-h col. Since January, 1933, the "exciter antenna" has been worked as a quarter-wave aerial instead of half-wave, rendering it little affected by weather conditions and capable of being tuned and adjusted at the base of the mast, and avoiding induction into the wooden mast itself. *Cf.* also Telefunken Company, April Abstracts, p. 215, l-h column, and cross references (Wilmotte).

"THE CALCULATION OF THE RADIATION CHARACTERISTICS AND RADIATION RESISTANCES OF AERIAL SYSTEMS": CORRECTION OF A FORMULA.—Bechmann. (*Hochf:tech. u. Elek:akus.*, June, 1933, Vol. 41, No. 6, p. 219.) *See* 1931 Abstracts, p. 155, r-h column.

FIELD TESTS ON RADIO COMMUNICATION OVER LONG-DISTANCE AIRCRAFT ROUTES [including the Reduction of Short-Wave Fading by Alternate-Aerial Transmission or Reception].—von Handel, Krüger and Plendl. (*See* under "Propagation of Waves.")

THE PICKARD DIPOLE SYSTEM FOR ULTRA-SHORT-WAVES, USING UNTUNED FEEDER WITH SPECIAL COUPLING TRANSFORMER.—G. W. Pickard. (*See* Leonard and Hadlock, *QST*, August, 1933, Vol. 17, No. 8, pp. 23–25.)

For the transformer, heavy insulated wire is wound into a 3-turn flat spiral, a tap being taken at the last (outside) turn. Winding is continued inwards to give a second, similar spiral, with a tap at the inside, and still further (outwards) for a third spiral. The three coils are bound together side by side; the dipole is connected to the two tappings and the feeder to the two ends.

CABLE-TYPE H.F. FEEDERS [Buried, for Transmitting and Receiving Aerials].—L. Lambin. (*Sci. Abstracts, Sec. B*, June, 1933, Vol. 36, No. 426, p. 390.)

TWISTED-PAIR FEEDERS FOR THE TRANSMITTING ANTENNA.—G. Grammer. (*QST*, July, 1933, Vol. 17, No. 7, pp. 17–20.)

A VARIABLE WAVELENGTH AERIAL [Aerial Wire winding on Metal Drum: Improved Short-Wave Reception by Adjusting to Optimum Natural Wavelength].—(*World-Radio*, 18th Aug., 1933, Vol. 17, No. 421, p. 205.)

BUCKLING LOADS IN LATTICE MASTS, PARTICULARLY IN HIGH RADIO TOWERS.—L. Föppl. (*Sci. Abstracts, Sec. B*, June, 1933, Vol. 36, No. 426, p. 390.)

VALVES AND THERMIONICS

MESSUNGEN AN ULTRAKURZWELLENRÖHREN (Measurements on Valves for Generating Ultra-Short Waves [Micro-Waves down to 5 cm: including a Special Duplex Valve]).—E. Gossel. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, pp. 1–10.)

A continuation of the work of Hornung and of

Collenbusch (Abstracts, 1929, p. 269; 1932, pp. 403–404) using valves of Kohl's type with special spiral grid (1929, p. 508; 1930, p. 41—two; also August, pp. 445 and 450—two, l-h cols.) connected in a retarding-field circuit. Among the results obtained are the following :—(1) the grid circuit (formed of the spiral grid and its supports—a bow, or in one type an identical spiral with connecting lead to its mid-point) has a determining influence on the frequency, and its mechanical and electrical properties govern the merit and output of such u.s.w. valves. (2) The grid/anode Lecher system forms a circuit which, according to its tuning, can extract energy from the oscillation circuit. No marked effect on the *wavelength* of the oscillation circuit, by the grid/anode system, could be found. (3) While all the various circuits act as extractors of energy and by their tuning greatly influence the output, the coupling of the heating circuit to the oscillation circuit has an especially important influence on the energy available for radiation. (4) The position of the zones of oscillation depends on the ratio of grid-radius to anode-radius. (5) The relation between oscillation energy and emission current i_g to the positive grid shows a resonance effect which changes with the grid voltage. (6) The sharpness of resonance in the curves showing the influence of the anode potential on the oscillatory energy (Fig. 19) decreases with increased emission current i_g. (7) Preliminary experiments with a special valve type UK 416 (Figs. 20 and 21) with two complete electrode systems galvanically coupled but led out separately (except the grid potential lead), indicated that the energy conditions are distinctly more favourable than in a single valve; but a close study of such a duplex valve will be necessary in order to obtain a really satisfactory energy increase.

RAUMLADUNGSSTRÖME BEI HOHEN FREQUENZEN (Space-Charge Currents at High [and Ultra-High] Frequencies.—C. Protze. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, pp. 20–21.)

At low or medium frequencies the convection current in the space-charge zone at any moment can be ascertained with sufficient accuracy from the Langmuir-Schottky theory or from the static anode-current characteristics. The paper gives the results of an investigation into the changes produced by increasing the frequency, tests being carried out on triodes, and triodes connected as diodes, at wavelengths of 3 000 m and in the range 125 to 6.1 m. For the sake of uniform accuracy of measurement at all the various frequencies, the quantity measured was the rectified current; unfortunately, owing to the integrate character of this current, only limited conclusions as to the current strength at any moment can be drawn. The sinusoidal peak voltages were measured by a compensation method.

Preliminary tests having shown that the current curve for 3 000 m could be regarded as identical with that derived from the static characteristic, the curves at the higher frequencies are all compared with the 3 000 m curve, and in Figs. 5 and 6 the ordinates represent the ratio of the current at the high frequency to the corresponding value at the standard frequency; the abscissae, as in the previous curves, representing the peak voltages. The former diagram shows especially clearly the effect of increasing frequency, the curves displaying an increasing tendency to a "hump," with a maximum around 75 v (for the particular diode concerned) where the ratio of the currents rises to over 1.6 for the 6.1-m wave, compared with less than 1.3 for the 75-m wave. This effect is explained by considering the diagram of potential distribution in a diode (Fig. 7); at high frequencies a displacement current is superposed on the convection current, increasing in effect as the frequency is raised. The result is that the sagging curve due to the convection current is progressively tautened, the potential minimum in front of the cathode decreases, and the current increases.

A THEORY OF AVAILABLE OUTPUT AND OPTIMUM OPERATING CONDITIONS FOR TRIODE VALVES.—M. V. Callendar. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 909–929.)

From the Lissen laboratories. Author's summary :—"The output characteristics of triode and pentode valves have been investigated in the past by many workers, using either the static method of plotting a whole family of curves, or the dynamic method of measurement with a harmonic analyser: these have not, however, led to many simplifying generalisations, and are cumbersome and difficult methods if they are to be applied to each individual valve. In this paper, the form of the triode curves is first investigated experimentally, and the allowable limits of dynamic swing thus determined for any given per cent. harmonic: on this basis, a series of expressions are mathematically developed giving the required output characteristics in terms of an easily obtained valve constant (*i.e.*, the valve alternating-current resistance at $V_a = 100$, $V_g = 0$; this is the standard figure quoted by English manufacturers). Curves are given for output and correct plate current with various values of resistive load and of per cent. harmonic limit, with or without conditions of limited anode dissipation. The case of the practical load with low direct-current resistance is examined, and the results are checked with a harmonic analyser; the paper concludes with a few practical rules. It is hoped in a future paper to extend the analysis to cover push-pull circuits, the pentode valve, and the practical inductive load."

DIE GRAPHISCHE KLASSIFIKATION DER ELEKTRONENRÖHREN (The Graphical Classification of Valves [Valve Diagrams including "Güte"]). —S. J. Zilitinkewitsch. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 3, 1933, pp. 606–616.)

See also Gundlach, January Abstracts, p. 41, l-h col. Author's summary :—"Starting with two generally known main equations linking the four principal valve parameters, $R_p = \mu/S$ and $G = \mu S$, the writer makes use of the fact that these can be represented in logarithmic form by a rectangular double-co-ordinate system with a mutual inclination of 45°. In this way a network diagram is obtained, formed of the following four axes: the 'amplification axis' (μ), the 'resistance axis' (R_p), the 'mutual conductance axis' (S) and the 'Güte axis' (G). Each point of this network corresponds to a definite combination of characteristic valve parameters, which allows these valves to be arranged conveniently in the network.

"Such a classification greatly simplifies the comparison of one valve with another and their choice for any particular practical purpose. The writer points out that the progress in valve design is linked up with the position along the 'Güte axis' in the direction of higher values of G." The specimen diagram given includes transmitting and receiving valves of prominent types made in Russia, America and Germany.

VACUUM TUBE CHARACTERISTICS IN THE POSITIVE GRID REGION BY AN OSCILLOGRAPHIC METHOD.—H. N. Kozanowski and I. E. Mouromtseff. (*Proc. Inst. Rad. Eng.*, August, 1933, Vol. 21, No. 8, pp. 1082–1096.)

Authors' summary:—A method determining "complete" plate and grid characteristics of vacuum tubes in the positive grid region by means of oscillographic recording has been developed. A condenser of high capacity furnishes a single pulse of grid excitation which can be made to cover the entire region from any desired positive grid voltage to zero. Owing to the rapidity of this excitation, instantaneous power input to the tube of twenty to thirty times nominal rating has been recorded without danger to the tubes.

Several typical complete charts of plate and grid characteristics obtained by this method for an experimental tube of the so-called "50-watt" type are given. The experimental procedure in obtaining these characteristics is discussed in detail. Also the circuit for obtaining oscillographically the highly important "composite diode line," with $E_p = E_g$, is described. The inadequacy of the usual logarithmic extrapolation of zero-grid characteristics into the positive grid region is discussed.

The complete plate and grid current charts, which can be obtained accurately only by an oscillographic method, are practically indispensable in precalculation of class B and class C performance. The method has been successfully used in studying the characteristics of the smallest and the largest existing tubes in this country.

COEFFICIENT OF AMPLIFICATION OF TRIODES [Discussion of Chief Methods of Measurement].—C. Dei. (*Sci. Abstracts, Sec. B*, June, 1933, Vol. 36, No. 426, p. 396.)

"Discusses the three chief methods . . . those of Miller, Appleton, and lo Surdo. The last method, devised in 1931, places a diode in parallel with the electrostatic voltmeter in the plate circuit of the triode to keep the plate current steady."

NEW VALVES AT THE BERLIN RADIO EXHIBITION: BINODES AND 9-WATT PENTODES. (*Radio, B., F. für Alle*, August, 1933, pp. 343–347.)

Both ordinary and screen-grid "binodes" are described and their circuits explained. The pentodes discussed are the directly and indirectly heated type, both having the feature that the screen-grid potential is the same as the anode potential, which simplifies the design of the set.

"ELECTROMETER" VALVES *versus* ORDINARY TRIODES IN VALVE VOLTMETERS WITH HIGH INPUT IMPEDANCE.—McFarlane. (*See* abstract under "Measurements and Standards.")

VALVES FOR SOUND PICTURE SYSTEMS.—Kelley. (*See* abstract under "Acoustics and Audio-frequencies.")

A MEASURING SYSTEM FOR MICROPHONIC NOISE CURRENTS.—Kelley. (*Ibid.*)

A STUDY OF HUM GENERATION IN VACUUM TUBES AS AFFECTED BY HEATER DESIGN.—J. J. Glauber and A. G. Campbell. (*Rad. Engineering*, June, 1933, Vol. 13, No. 6, pp. 12–14 and 17.)

The paper concludes: "The hum in both types of tubes employing the double-hairpin construction for 6.3 v operation is less than for all other types of heaters examined. . . . It may be concluded that all new tubes could and should be designed around this type of heater, except in special cases."

EMISSION FROM OXIDE-COATED CATHODES. II.—M. Benjamin and H. P. Rooksby. (*Phil. Mag.*, Aug., 1933, Supp. No., Series 7, Vol. 16, No. 105, pp. 519–525.)

For reference to Part I *see* June Abstracts, p. 329, r-h col. The writers find that in the case of a cathode activated with BaO/SrO, "the constituent oxides can exist in all states ranging from a simple mixture to a homogeneous solid solution; and there exists a definite relationship between the physical state of the oxides and the thermionic emission obtained from them."

THE PROCESSING OF THORIATED TUNGSTEN FILAMENTS.—M. A. Ausman. (*Rad. Engineering*, June, 1933, Vol. 13, No. 6, pp. 15–17.)

SECONDARY EMISSION OF ELECTRONS FROM MOLYBDENUM.—P. L. Copeland. (*Journ. Franklin Inst.*, May, 1933, Vol. 215, No. 5, pp. 593–598.)

An account of an experimental determination of the number of secondary electrons to primary electrons of various energies incident on a molybdenum plate.

OBSERVATIONS OF A BARIUM CATHODE, SPUTTERED ON NICKEL, WITH AN ELECTRON MICROSCOPE.—E. Brüche and H. Johannson. (*Zeitschr. f. Physik*, 1933, Vol. 84, No. 1/2, pp. 56–58.)

THE APPLICATION OF GRAPHITE AS AN ANODE MATERIAL TO HIGH-VACUUM TRANSMITTING TUBES.—E. E. Spitzer. (*Proc. Inst. Rad. Eng.*, August, 1933, Vol. 21, No. 8, pp. 1075–1081.)

The higher radiation emissivity gives lower glass temperatures and therefore less danger of glass electrolysis and strain cracking. Anode warping is avoided, giving much greater electrical uniformity. With proper manufacturing methods, there is no sacrifice in valve life when graphite is substituted for molybdenum.

A LIFE-TEST POWER SUPPLY UTILISING THYRATRON RECTIFIERS.—H. W. Lord. (*Proc. Inst. Rad. Eng.*, August, 1933, Vol. 21, No. 8, pp. 1097–1102.)

Author's summary :—Thyratron rectifiers for supplying high-voltage direct current to radio transmitting tube life-test racks are superior to motor-generator sets where quietness, flexibility, low operating cost, and safe operation over long intervals of time are desirable.

An installation for supplying typical voltages, in conjunction with usual forms of electric power supplies, is described. This consists of two high-power rectifiers for 425 and 1 000 volts d.c. plate supplies and a low-power 125-volt d.c. rectifier for bias voltage. A control circuit provides complete protection against faults detrimental to tube operating conditions such as low filament voltage, low bias, and resumption of power after failure, ensuring a maximum of life-testing hours available, consistent with safe operation.

DIRECTIONAL WIRELESS

THE CATHODE-RAY COMPASS.—W. Ende and M. H. Gloeckner : A.E.G. (*Zeitschr. f. Flugtechnik u. Motorluftschiffahrt*, 28th Oct., 1932, Vol. 23, No. 20, pp. 603–609.)

Including some constructional details of the compass dealt with in 1931 Abstracts, p. 271, r-h col.—two, Salmony : Brüche. The systematic interpretation of the varying indications is discussed, and the influence of the nearness of the magneto. A test calibration is compared with that of a magnetic compass. For a special A.E.G. low-voltage cathode-ray tube *see* 1932 Abstracts, p. 653, l-h col., and for Schwerin's "electronic compass" *ibid.*, p. 350, r-h col.

EIN NEUES STROBOSKOPISCHES EIGENPEILGERÄT (A New Stroboscopic Direction Finder [for use on Moving Craft, particularly Aircraft]). —R. Hardy. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, pp. 35–36.)

Long summary of a *L'Aeronautique* paper on the instrument dealt with in April Abstracts, p. 216, r-h col. An accuracy of one-sixth of a degree is claimed.

RADIO SYSTEM FOR LANDING AIRCRAFT DURING FOG : INSTALLATION AT NEWARK AIRPORT. —H. Diamond. (*Electronics*, June, 1933, Vol. 6, No. 6, pp. 158–161.) *See* also September Abstracts, p. 508, l-h column, and below.

RADIO SYSTEM FOR BLIND LANDING OF AIRCRAFT. —Bureau of Standards. (*Journ. Franklin Inst.*, May, 1933, Vol. 215, No. 5, pp. 599–601.)

A note on practical tests of the radio system for the blind landing of aircraft, carried out at Newark, N.J. *See* also Diamond, above.

ACOUSTICS AND AUDIO-FREQUENCIES

MESSUNG MECHANISCHER WIDERSTÄNDE BEI DREHBEWEGUNGEN (The Measurement of Mechanical Resistances to Rotary Motion [and an Electrical Method of producing Mechanical Resistances of Any Desired Value and Kind]).—E. Paolini. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 14, 1933, pp. 332–335.)

After discussing the growing importance in acoustics of mechanical filters (*e.g.* in gramophone technique and sound analysis) and mentioning the various ways of obtaining dissipative resistance (vanes in oil or glycerine ; rubber rods ; eddy current braking, etc.) the writer describes his method of measuring such resistances, defined as the ratio of torque to rate of angular displacement, for a frequency range of about 20–100 c/s. Two rigidly connected rotating-coil systems are used, one acting as the torque producer while the other, by the voltage generated in it, measures the rate of angular displacement produced by the torque ; the voltage is determined with the help of a Larsen compensator and an amplifier, dry-plate rectifier, and d.c. meter combination. The torque-producing system is fed by a heterodyne note-generator. Specimen measurements of a vane in oil and in a special very viscous fluid are shown, and the feeble dissipative resistance yielded by eddy-current devices is mentioned. This leads to an outline of the writer's method of obtaining large and adjustable resistances by the amplification, correct as to phase, of the potentials generated in a short-circuited coil and the application, with the right polarity, of the amplified potentials to a coil system rigidly connected to the first coil. Such an arrangement is very suitable for use as the terminal resistance for a mechanical filter system, without which a smooth curve in the pass-band zone of the system cannot be obtained, as is shown (Fig. 7) by the curves of transmission equivalents with and without a terminal resistance.

USE OF CATHODE-RAY OSCILLOGRAPH FOR OBTAINING FREQUENCY-RESPONSE CURVES [of Loud-Speakers].—A. H. Davis. (*Phil. Mag.*, Aug., 1933, Supp. No., Series 7, Vol. 16, No. 105, pp. 408–410.)

In this circuit an oscillator of variable frequency and constant voltage supplies the loudspeaker with an e.m.f. of constant magnitude but variable frequency ; the acoustical output of the loudspeaker is measured by a microphone circuit, uniformly responsive at all frequencies, whose rectified output is applied to one pair of plates of a cathode-ray oscillograph, giving a vertical deflection. "The same oscillator supplies current to a weighting network so adjusted that the output, when rectified and smoothed, is closely related to the logarithm of the frequency of the exciting current." This output is applied to the other pair of plates of the oscillograph, so that the horizontal deflection of the spot is determined by the frequency of the note concerned. As the frequency is varied the spot traces a curve giving the relation between the pitch of the note and the loudspeaker output.

VOLUME CONTROL BY POTENTIAL DIVIDER CONSISTING OF A SERIES OF MUTUALLY DECOUPLED INDUCTANCES EACH WITH THE SAME TIME CONSTANT AS THE PICK-UP.—(*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, p. 37: German Pat. No. 570 703, pub. 18th July, 1933, Bethenod.)

ÉCOUTEUR TÉLEPHONIQUE ÉLECTROSTATIQUE (Electrostatic Telephone Receiver).—G. Longo. (*L'Onde Élec.*, May, 1933, Vol. 12, No. 137, pp. 262–272.)

The writer first enumerates the various factors which decrease the effectiveness of electrostatic loudspeakers—the necessarily thin diaphragm (for lightness) and consequent tight stretching (for stable equilibrium): the need for damping (to reduce the natural frequencies of the diaphragm) and the small gap (causing non-linear distortion for any but very small amplitudes). "These objections, which would substantially be found in any electrostatic telephone receiver constructed on the same principles, seem to be avoided almost completely in the proposed system, which should give a response curve practically rectilinear and horizontal over the whole range of frequencies generally desired to be reproduced."

A number of small (1.1 × 1.2 cm) thin metallic (aluminium) plates, each rectangular and with a side lug for connection, are arranged in a pile as in a multi-plate condenser, each being separated from its neighbour by a U-shaped spacing piece of mica, *e.g.*, oriented alternately so that successive inter-plate airgaps are open to the air at opposite edges of the pile. By suitable location of the lugs, the plates are connected in 3 groups, 1, 5, 9 . . . connected to a constant +ve potential, 3, 7, 11 . . . to a constant − ve potential, and the even numbers connected to the varying potential. The pile is mounted in the telephone receiver case so that one set of openings faces the ear, the other set having free access to the air. The behaviour of such a receiver is examined quantitatively for telephony. For c.w. telegraphy it can be used without detection, by modulating the polarising voltage at a suitable audio-frequency; but here of course the advantages of fidelity over the whole frequency range are not made use of, and a tuned single-diaphragm design would probably be more efficient.

ELLIPSOIDAL FUNCTIONS AND THEIR APPLICATION TO SOME WAVE PROBLEMS [including Transmission of Waves through a Circular Aperture and Scattering of Waves by a Circular Disc].—Hanson. (*See* under "Miscellaneous.")

VACUUM TUBE AND PHOTOELECTRIC TUBE DEVELOPMENTS FOR SOUND PICTURE SYSTEMS.—M. J. Kelley. (*Bell Tel. System Monograph* *B*-694, 21 pp.)

Including a description of the 262A, an indirectly-heated triode making the use of a.c. possible in amplifiers with flat frequency characteristics and over-all gains of the order of 100 db. A measuring system for microphonic noise currents is described; also the Western Electric 263A rectifier for mains supply of the sound lamp (usually fed from accumulators) and valve filaments of reproducing systems. The high-sensitivity caesium-oxygen-silver photo-electric cell type 3A is also discussed (*see* also 1932 Abstracts, pp. 592 and 648).

A THEORY OF AVAILABLE OUTPUT AND OPTIMUM OPERATING CONDITIONS FOR TRIODE VALVES.—Callendar. (*See* under "Valves and Thermionics.")

DETECTORS AS OUTPUT VALVES GIVING 800 MW: POWER GRID DETECTION WITH HIGH-IMPEDANCE CHOKE IN PLACE OF GRID LEAK.—de Cola. (*See* abstract under "Reception.")

DAS GRUNDPROBLEM DER ELEKTROAKUSTIK (The Fundamental Problem of Electro-Acoustics [the Conditions for Fidelity of Reproduction of the Original Sound]).—A. Koerts. (*Hochf: tech. u. Elek:akus.*, June, 1933, Vol. 41, No. 6, pp. 214–218.)

The writer evolves a general theory by which the reproduction of any sound phenomenon by any transmission system can be represented. Every system possesses a characteristic function, combining all its properties, which can only in isolated cases be given clearly by calculation but which can always be determined experimentally by the cathode-ray oscillograph. For any "complete" sound the conditions for subjective identity between primary and reproduced sound are the same as for objective identity; but for sounds represented by trigonometrical series with slowly changing coefficients, subjective fidelity depends on a quantity [*see* text below equation 12] which is closely connected with the ordinary frequency characteristic. In this latter class come human speech and all music.

Sounds which last a very short time, on the other hand, can be reproduced with subjective fidelity if the dampings of the natural movements of the transmitting system are greater than those of the "physical" (as contrasted to the "physiological") ear. In a later paper the writer hopes to discuss the various practical transmission systems in the light of his theory.

A NOTE ON NONLINEARITY IN TRANSDUCERS USED IN COMMUNICATION [and Its Correction by a Series Compensating Transducer].—Caporale. (*See* under "Properties of Circuits.")

AMPLITUDE DISTORTION COMPENSATED BY IMPEDANCE DECREASING WITH CURRENT [Thyrite] IN PLATE CIRCUIT OF DISTORTING VALVE.—Massa. (*See* preceding reference.)

BESTIMMUNG DES SCHLUCKGRADES BEI SCHRÄGEM SCHALLEINFALL MIT HILFE STEHENDER WELLEN (Measurement of the Acoustic Absorption Percentage at Oblique Incidence, with the Help of Standing Waves).—L. Cremer. (*E.N.T.*, July, 1933, Vol. 10, No. 7, pp. 302–315.)

For normal incidence, the "absorption percentage" of a material ($a = 1 - R^2$, where R is the ratio of reflected to incident amplitude) can conveniently be measured by the standing-wave procedure using a Kundt's tube; for oblique incidence, however, the method fails owing to its essentially one-dimensional nature. But the use of standing waves is still practicable if the tube is abandoned and the exploration carried out in free space. This entails the use of a large expanse of homogeneous wall of the material investigated, an equally homogeneous plane wave-train which can be directed on to the wall at any desired angle and can produce an interference field, a very small receiver by which this field can be explored, and above all an absence of other wave-trains encroaching on the field and upsetting the interference patterns.

The writer describes an equipment for carrying out such measurements. The last requirement—the screening of the explored field from disturbance—is fulfilled by an elaborate system of rock-wool mats. As the mobile suspended microphone moves from point to point of the field, the corresponding pressure amplitudes are recorded on a strip moving about 5 cm per minute; the microphone explorations are controlled by hand in time with a metronome. The equipment not only enables the variation of the absorption percentage with the angle of incidence to be determined, but also allows a general investigation of standing waves in space to be carried out. Various tests on commercial insulating substances, both rigid (*e.g.* celotex) and soft porous materials such as the rock-wool mats used for the screening, are described. With the former the absorption percentage increases as the incidence becomes more oblique; with the latter it decreases.

Variation of Acoustical Absorption Coefficients of Porous Bodies with the Angle of Incidence and the Frequency.—V. Kühl and E. Meyer. (*Sci. Abstracts, Sec.A*, June, 1933, Vol. 36, No. 426, pp. 618–619.)

The Resonance Frequencies of Two Coupled Oscillatory Circuits [and a New Method of Frequency Analysis and Non-Linear Distortion Measurement].—Fehr and Kreielsheimer. (*See* under " Properties of Circuits.")

A New Mains-Operated Audio-Frequency Oscillator [20–10 000 c/s Range, with Good Stability and Waveform].—C. H. W. Brookes-Smith. (*Journ. Scient. Instr.*, Aug., 1933, Vol. 10, No. 8, pp. 251–255.)

Problem relating to the Theory of the Rayleigh Disc.—M. Kotani. (*Sci. Abstracts, Sec.A*, June, 1933, Vol. 46, No. 426, p. 617.)

Measurements of Amplitude and Phase of the Octave in a Tuning Fork [Quantitative Confirmation of Helmholtz's Theory of Combination Tones: Mechanism of the Formation of the Octave].—B. Derjaguin. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 3, 1933, pp. 574–585.)

Stroboscopic Demonstration of Tones [Modification of Scripture's " Strobilion "].—W. Anderson and H. Lowery: Scripture. (*Journ. Scient. Instr.*, July, 1933, Vol. 10, No. 7, pp. 203–204.)

On the Properties of Japanese Vowels and Consonants [Determination of the " Formanten " from Oscillograms].—J. Obata and T. Tesima. (*Japanese Journ. of Physics*, Vol. 8 [1932], pp. 1–24, with 20 Figures.)

Zur Schalleistung eines Flügels (The Sound Output of a Grand Piano).—E. Lübcke and K. H. Wernicke. (*Hochf:tech. u. Elek:akus.*, June, 1933, Vol. 41, No. 6, pp. 212–214.)

The output powers for single notes of a " concert grand " were measured in a hall. The resulting spectrum is discussed, together with reasons for the differing powers on the various notes. When the tests were repeated in an entirely different type of room, the spectra agreed quite well (at least with the piano open) so that the method employed should be useful in practice.

Range of Sound Intensity in Music.—K. W. Wagner. (*Sci. Abstracts, Sec.A*, June, 1933, Vol. 36, No. 426, pp. 619–620.) *See* also April Abstracts, pp. 218–219.

Acoustic Method of Distance Measurement.—H. Yagi and S. Matusuo. (*Sci. Abstracts, Sec.B*, June, 1933, Vol. 36, No. 426, p. 397.)

" The frequency of an emitted sound-wave is made to vary linearly with time. A receiver picks up the out-going wave and also the wave reflected from a wall, the distance of which is derivable from the beat note produced."

Influence of Supersonic Waves on Chemical Processes.—H. Beuthe. (*Sci. Abstracts, Sec. A*, May, 1933, Vol. 36, No. 425, p. 489.)

Über einige Beobachtungen an schwingenden Piezoquarzen und ihrem Schallfeld (Some Observations on Oscillating Piezoquarz Crystals and their Acoustic Field).—K. Bücks and H. Müller. (*Zeitschr. f. Physik*, 1933, Vol. 84, No. 1/2, pp. 75–86.)

Voice Transmission on a Beam of Light [Demonstration Apparatus].—R. R. Ramsey. (*Science*, 4th Aug., 1933, Vol. 78, No. 2014, p. 105.)

PHOTOTELEGRAPHY AND TELEVISION

Sur quelques Réceptions lointaines des Émissions de Radio-Vision de Londres (Some Distant Receptions of Television Transmissions from London [and the Occurrence of Multiple Images]).—D. Bodroux and R. Rivault. (*Comptes Rendus*, 17th July, 1933, Vol. 197, No. 3, pp. 231–232.)

To decide whether the frequent occurrence of multiple (5 or 6) images was due to propagation phenomena or to reflection effects in the amplifier, a special receiver was constructed with a pass-band of 25–30 kc/s and without any iron-cored components. This gave much finer images but did not eliminate the multiple effects. The size and brilliancy of the pictures were progressively increased first by replacing the original Nipkow disc by a Brillouin lens disc and a " point " neon lamp (yielding a satisfactorily bright image 14 × 35 cm) and then by replacing the neon lamp by a Kerr cell and a low-voltage lamp with 100-watt filament (giving a good white-light image 25 × 58 cm). The writers thus had at their disposal either a large, sufficiently bright image or a very bright small image, and were therefore in a position to photograph the various results in order to measure the observed delays. Unluckily these measurements have been prevented, up to the present, by interference from the Frankfort Station, which since 8th April has continued its programmes up to midnight.

New Optical Assembly for Television Projection Receivers [Kerr Cell Equipment using both Ordinary and Extraordinary Rays: Overall Efficiency Greatly Increased].—N. Levin. (*Marconi Review*, May/June, 1933, No. 42, pp. 11–12.)

Polarising Louvres and Their Application [to replace Nicol's Prisms].—C. F. Smith. (*Journ. Scient. Instr.*, July, 1933, Vol. 10, No. 7, pp. 212–214.)

The Iconoscope [Three Million Photocells scanned by Cathode Ray].—Zworykin. (*World-Radio*, 4th Aug., 1933, Vol. 17, No. 419, p. 135.)

Paragraph giving some details of the "electric eye" television transmitter referred to in August Abstracts, p. 453, r-h column.

Good Matching Conditions for Low-Resistance Barrier-Layer Photocell by use of Magnetron in First Amplifier Stage. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, p. 37: German Pat. No. 570 599, pub. 17th Feb., 1933, Zeiss Ikon.)

Comparison of Photo-Emissive, Photo-Conductive and Photo-Voltaic Cells.—A. J. McMaster. (Summary in *Electronics*, June, 1933, Vol. 6, No. 6, p. 171.)

Caesium-Oxygen-Silver Photoelectric Cell of High Sensitivity, for Sound Picture Systems.—Kelley. (*See* abstract under "Acoustics and Audio-frequencies.")

Thermische und photoelektrische Emission von Cäsium–Cäsiumoxydkathoden und deren Beeinflussung durch Einbau von Cäsiumatomen in das Dielektrikum (Thermal and Photoelectric Emission from Caesium–Caesium Oxide Cathodes and the Influence Exerted on Emission by Inclusion of Caesium Atoms in the Dielectric [*i.e.* in the Oxide Film: Both Emissions Improved]).—J. H. de Boer and M. C. Teves. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 7/8, pp. 521–533.)

Photoelectric Effect of Caesium Vapour.—J. Kunz. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, p. 1052: abstract only.)

Internal Photoelectric Absorption in Halide Crystals.—R. W. Gurney. (*Proc. Roy. Soc.*, 3rd July, 1933, Vol. 141, No. A 843, pp. 209–215.)

The Crystal Photoeffect.—A. Joffé and A. F. Joffé. (*Nature*, 29th July, 1933, Vol. 132, pp. 168–169.)

The writers of this letter describe experiments testing the fundamental equations of the diffusion theory of the photoelectromotive force. They also conclude that the carriers of the photocurrent are different from the heat electrons. For recent papers on the subject *see* Abstracts, 1932, p. 232 (Dember); July, p. 400 (Teichmann); August, p. 455 (Joffé and Joffé); all l-h columns. *Also* Deaglio, below.

Photoelektrischer Effekt bei Monokristallen von Cuprit (Photoelectric Effect in Single Crystals of Cuprite).—R. Deaglio: Dember. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 3/4, pp. 179–183.) *See* also August Abstracts, p. 455, l-h column.

The Photoelectric Effect of Crystals of Argentite, Proustite and Pyrargyrite.—G. Athanasiu. (*Comptes Rendus*, 3rd July, 1933, Vol. 197, No. 1, pp. 42–44.)

Winkelabhängigkeit des Photoeffektes an Isolatoren im polarisierten Licht (Angular Variation of the Photoelectric Effect on Insulators in Polarised Light).—S. M. Spies. (*Zeitschr. f. Physik*, 1933, Vol. 82, No. 5/6, pp. 355–371.)

The experiments described in this paper confirm and extend results obtained by Wehnelt and Schmerwitz (1930 Abstracts, p. 401, r-h column).

Remark on the Paper by Q. Majorana: "On a New Photoelectric Experiment."—A. Etzrodt: Majorana. (*Physik. Zeitschr.*, 15th April, 1933, Vol. 34, No. 8, pp. 338–340.)

For references to the paper referred to and others *see* March Abstracts, p. 170. The writer of this note attributes Majorana's results to the effect of heat radiation on the electrical resistance of the conducting metal, rather than to a photoelectric effect, and describes experiments in support of his view. On p. 340 Majorana replies that he does not consider that the experiments of Etzrodt exclude the possibility of the photoelectric effect being present.

Über die Bestimmung der lichtelektrischen Grenzwellenlänge am Rhenium (The Determination of the Limiting Photoelectric Wavelength for Rhenium).—A. Engelmann. (*Ann. der Physik*, 1933, Series 5, Vol. 17, No. 2, pp. 185–208.)

Die optische Absorption an lichtelektrisch zweifach selektiv wirkenden Oberflächenschichten [The Optical Absorption at Surface Films with Doubly Selective Photoelectric Effect).—W. Kluge. (*Physik. Zeitschr.*, 15th June, 1933, Vol. 34, No. 12, pp. 465–472.)

Theory of the Complex Photoelectric Effects [Liberation of More than One Electron by a Photon falling on a Multi-Electron Atom].—L. Goldstein. (*Comptes Rendus*, 24th July, 1933, Vol. 197, No. 4, pp. 304–306.)

Extension of Fowler's Theory of Photo-electric Sensitivity as a Function of Temperature.—A. T. Waterman and C. L. Henshaw. (*Phys. Review*, 1st July, 1933, Series 2, Vol. 44, No. 1, pp. 59–60.)

MEASUREMENTS AND STANDARDS

Die Messung hochfrequenter Spannungen mit dem Fadenelektrometer (The Measurement of [Ultra-] High-Frequency Potentials with the Thread Electrometer).—G. Ulbricht. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, pp. 21–24.)

The writer points out that the thread electrometer, a particularly suitable and simple instrument, is far too little used. For medium potentials (20–300 v), such as are encountered in small valve transmitters, the two-thread type is preferable; for small and for high potentials the single-thread type, without polarising voltage.

As regards its use at very high frequencies, the fact that it has a certain capacity may lead to errors; the writer therefore investigates this point. He derives, with the help of the telegraphy equations, a formula showing the variation with frequency of the potential acting at any point on the filament, and particularly at the important mid-point, whose movement is observed; thus the frequency can be calculated at which, for a given thread, a fixed percentage error is produced. Applied to a certain double-thread instrument with a 6-cm Wollaston thread 4μ thick, this gives the curve of Fig. 3, which shows that the instrument can be used down to a wavelength of 2.7 m if an error of 1% is tolerated. Care, however, must be taken that with high voltages at such wavelengths the thread is not burnt out by the capacity currents flowing in the electrometer. The use of short, thick threads should allow still lower wavelengths to be dealt with, but a limit is set by the capacity at the leading-in insulators. Fig. 6 shows the calculated behaviour of a 4-cm thread of thickness 8μ (capable of standing a capacity current of 50 mA such as might be produced by a voltage of 200 v at a wavelength of 1.86 m) from which it appears that even at a wavelength of 150 cm, the error would be only 1%. The short, thick filament, however, would naturally decrease the sensitivity of the instrument. *See* also next abstract.

Das Zweifadenelektrometer als Wechselspannungsmesser für hohe Frequenzen (The Double-Thread Electrometer as an A.C. Voltmeter at High [and Ultra-High] Frequencies).—H. F. Nissen. (*Ibid.*, pp. 24–26.)

See also Ulbricht, above. The present writer recommends the two-thread type exclusively, for frequencies of 10^7 c/s upwards, on account of its freedom from asymmetrically arranged electrodes. "At very high frequencies the double-thread electrometer shows certain errors, which must be considered in designing the instrument and which limit the frequency range in which it can be employed." Dealing in succession with the various causes of these errors, he begins with the voltage drop along the thread: the latter, for the sake of sensitivity, must be very thin, but as the voltage-drop error increases with the square of the frequency it is necessary to keep the resistance low. This is also necessary to prevent burning-out. Thin silver or aluminium strips are suitable.

Another component of the error at very high frequencies is that due to the electrodynamic forces between the threads, caused by displacement currents. Since these forces increase with the square of the frequency, while the electrostatic forces are independent of frequency, this error, like the voltage-drop error, increases with the square of the frequency; it varies very little with the voltage. Another source of error is the alteration of capacity with the deflection; since this change can be measured a correction can be made for it; but in certain cases (*e.g.* if the change has a marked effect on the resonance curve of an oscillatory circuit) this effect makes the electrometer unusable.

The potential rise due to a long connection to the instrument is considered to be negligible provided the length, including the electrometer system, does not exceed 0.05 λ. Finally, influences tending to impair the accuracy of observations are examined: to reduce vibration a suitable mounting and the choice of a thread with the least possible mass are necessary. Elastic hysteresis would diminish the accuracy, but in the tests mentioned below no sign of any error due to this was found.

The paper ends with a description of a special instrument (resembling a Wulf electrometer) and its testing. The silver strips are lengthened downwards by non-conducting threads connected to an elastic bow of quartz; this plan not only increases the sensitivity but also allows the microscope objective to be brought closer to the uncharged threads than it could be to the strips. The various types of error were found, by calculation from the data of this instrument, to be as follows:—no appreciable error due to voltage-drop can occur until wavelengths very much shorter than 6 m are reached; electrodynamic forces can cause a 1% error at a wavelength of 90 cm; the capacity change for a deflection of 0.7 mm amounts to 0.04 $\mu\mu$F; the error due to potential rise along the connecting lead would reach about 1% at a wavelength of 1.5 m.

Comparing the thread electrometer with other potential measuring methods for high frequencies, the writer says that valve-voltmeters, Kerr effect devices and cathode-ray tubes all fail, or require involved corrections, at wavelengths below about 30 m. Rohde's voltmeter (1931 Abstracts, p. 393) seems the only rival, but takes longer to use.

Arrangement for Measuring the Amplifying Power of H.F. Amplifiers.—(*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, p. 37: German Pat. No. 570 683, pub. 18 Feb., 1933, Telefunken and Runge.)

The output is connected to the input through an attenuator in the form of a variable inductive coupling, and the amplification is measured by the coupling necessary to produce oscillation.

A Field-Intensity Set [for Field-Strength Measurements on both Ground and Sky Waves, and Some Results].—A. L. Green and H. B. Wood. (*Journ. Inst. Engineers, Australia*, Jan., 1933, Vol. 5, No. 1, 8 pp.)

Authors' summary:—"Following the Kennelly-

Heaviside layer investigations at Jervis Bay, distant 140 km from the sending station, it became desirable to continue the work at much shorter distances from the transmitter, of the order of 20 km. This called for short investigation of sky wave and ground wave field-intensities, for which apparatus was developed.

"The paper describes a field-intensity set for both ground and sky waves. The development of a vacuum-tube millivoltmeter enabled the components of the artificial signal injection apparatus to be calibrated directly; the accuracy of the complete assembly therefore depends only on the precise measurement of the geometrical dimensions of the loop aerial, and on the calibration of the millivoltmeter. The use of a substantially linear vacuum-tube voltmeter, following the amplifier in the receiver, greatly facilitated the measurement of low field-intensities.

"A few results are given of practical tests with the apparatus in measuring field-intensities of both ground and sky waves, from which the conclusion is drawn that a suitable set of conditions for subsequent Kennelly-Heaviside layer studies is the combination of a distance between sender and receiver of about 25 km, with a transmission frequency of about 1 500 kilocycles." *See* also Munro and Green, under "Propagation of Waves."

APPLICATION OF COMPENSATED VALVE-VOLTMETER TO MEASUREMENTS OF GLASS ELECTRODE POTENTIALS [without Use of "Electrometer" Valves].—A. S. McFarlane. (*Journ. Scient. Inst.*, July, 1933, Vol. 10, No. 7, pp. 208–212.)

The writer's voltmeter (Abstracts, 1932, pp. 650–651, and July, p. 401, r-h col.) does *not* employ "electrometer" valves but ordinary triodes. The voltage sensitivity is considerably greater than that of electrometer valve instruments, and the instrument is more sensitive, and has a more stable zero, than other instruments using ordinary valves. Its maximum grid-input impedance is 5 000 megohms.

With regard to electrometer valves the writer considers that the transference of the grid to the opposite side of the filament from the anode can have little effect on Metcalf and Thompson's "six factors" (1931, p. 98, r-h col.) and that the high grid impedance is largely to be attributed to the high degree of evacuation and to the fact that anode voltages are used which are below the critical ionisation potential of the residual gas. It is significant that in the Metcalf and Thompson valve (grid impedance 10^{16} ohms) no such alteration is made.

THE DIFFERENT OSCILLATION RÉGIMES OF A PARALLELEPIPED OF QUARTZ [and the Cause of Rotation of a Pivoted Crystal].—A. de Gramont. (*Comptes Rendus*, 10th July, 1933, Vol. 197, No. 2, pp. 101–103.)

The writer considers a parallelepiped with surfaces parallel to the electrical, optical and mechanical axes, the dimensions along these axes being *e*, *o* and *m* respectively; the crystal is set in vibration along the mechanical axis, *f* being the frequency obtained. The coefficient $f \times m$ is denoted by K_m.

The experimental curve shows that so long as *m* is large compared with *o*, K_m is practically constant, so that *f* is inversely proportional to the length *m*: tests on a large number of crystals give an average value $K_m = 2\,706$, near to the value given by Hund. If, other things being constant, *m* is gradually decreased, K_m begins to decrease when m/o is about 2; when $m/o = 0.52$, the limit of oscillation along the mechanical axis is reached, K_m being then just above 1 600. A further diminution of *m* produces at first a quite unstable régime; then, for $m/o = 0.36$, a new régime begins with the oscillations now along the electrical axis. The coefficient $K_e = f \times e$ tends, as *m* decreases, towards a limiting value (round 2 800) at $m/o = 0.14$. "We have proceeded no further: the crystal, having then hardly 1 mm along *m*, is difficult to maintain vertical between the plates."

For such a crystal the velocity of propagation along *e*, calculated from the frequency, was 5 504 m/s, agreeing with Cady's anticipated value of 5 500 m/s. Variations of thickness along *e* have little effect. In crystals of dimensions corresponding to the zone of discontinuity (*i.e.* the unstable régime for values of m/o between 0.52 and 0.36) the simultaneous oscillations along two orthogonal axes produce considerable mechanical tensions; their study is a delicate matter since they frequently shatter the crystal. The resulting electric charges are responsible for the movements of rotation described elsewhere (September Abstracts, p. 518, r-h column). The fact that these rotations are not of aerodynamic origin is proved by exhausting the space around the rotating crystal; at first the motion slows down owing to the ionising of the gas, luminous feathers appearing; then, as the vacuum increases, it speeds up and becomes faster than in open air. In air the electric wind due to the electric charges may add its action to that of the latter and thus mask the true cause of the phenomenon.

ÜBER EINIGE BEOBACHTUNGEN AN SCHWINGENDEN PIEZOQUARZEN UND IHREM SCHALLFELD (Some Observations on Oscillating Piezo-quartz Crystals and their Acoustic Field).—K. Bücks and H. Müller. (*Zeitschr. f. Physik*, 1933, Vol. 84, No. 1/2, pp. 75–86.)

THE CONVERSE PIEZOELECTRIC EFFECT IN MIXED CRYSTALS ISOMORPHOUS WITH ROCHELLE SALT.—S. Bloomenthal. (*Physics*, May, 1933, Vol. 4, No. 5, pp. 172–177.)

To explain the peculiar behaviour of Rochelle salt near 25°C, several experimenters have postulated a critical temperature for this dielectric analogous to the Curie point for ferromagnetic materials. The writer obtains confirmatory evidence by showing that the critical temperature shifts with the introduction of isomorphous impurities, just as the Curie point shifts when the ferromagnetic material is alloyed with a second element.

ELECTRICAL PROPERTIES OF ISOMORPHOUS CRYSTALS OF ROCHELLE SALT AND SODIUM AMMONIUM TARTRATE.—M. Eremejew and B. Kurtschatow. (*Physik. Zeitschr. der Sowjetunion*, No. 3, Vol. 3, 1933, pp. 304–320.)

THE LOWER CURIE POINT IN ROCHELLE SALT.—B. Kurtschatow and I. Kurtschatow. (*Ibid.*, pp. 321–334.)

ON THE DETERMINATION OF SOME OF THE ELASTIC CONSTANTS OF ROCHELLE SALT [Piezoelectric Resonators] BY A DYNAMICAL METHOD.—R. M. Davies. (*Phil. Mag.*, July 1933, Series 7, Vol. 16, No. 103, pp. 97–124.)

MODES OF VIBRATION OF PIEZOELECTRIC CRYSTALS.—N. H. Williams. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 990–995.)

Author's summary :—(a) A crystal is made to oscillate by subjecting it to the action of an air wave produced at a considerable distance from the crystal by a jet of air escaping from a small tube. The piezoelectric charge developed on the surface of the crystal as a result of the oscillation is mapped out by means of a tuned amplifier, and the vibration is analysed into a fundamental and many overtones. For crystals that are long in one dimension, the overtones are nearly exact harmonics.

(b) Exciting the crystal electrically by means of two tubes and especially designed electrodes, any harmonic up to the tenth can be produced. The crystal usually has only one mode of vibration for each pair of electrodes.

MULTIVIBRATOR CIRCUIT WITH TWO TRIODES, OR ONE TETRODE, WITH PIEZOELECTRIC CRYSTAL REPLACING A CONDENSER.—(*Hochf: tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, p. 36 : German Pat. No. 571.235, pub. 25th Feb., 1933, Telefunken.)

" A frequency is generated for which the crystal possesses a minimum impedance, so that electrode- and lead-capacities have no influence on the frequency."

MEASUREMENTS OF THE LOGARITHMIC DECREMENTS OF MAGNETOSTRICTION RESONATORS : SECOND COMMUNICATION.—E. A. Kopilowitsch. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 3, 1933, pp. 561–566.)

Continuation of the work dealt with in 1932 Abstracts, p. 355, r-h col. The resonators investigated were of nickel, elinvar and a nickel-iron alloy. The frequency employed was about 80 kc/s. Among other points the need of a good fixing method, in order to obtain a small decrement, is established.

THE MICROMETER FREQUENCY METER.—G. F. Lampkin. (*QST*, July, 1933, Vol. 17, No. 7, pp. 10–13.)

ROBOT CLOCK ANNOUNCES TIME FROM THE PARIS OBSERVATORY.—E. Esclangon : Belin. (*Science*, 26th May, 1933, Vol. 77, No. 2004, Supp. pp. 11–12.)

" In clear, human tones the exact time, correct to a small fraction of a second," will be heard by anyone ringing up a certain telephone number in Paris.

TABLES FOR THE CALCULATION OF THE MUTUAL INDUCTANCE OF ANY TWO COAXIAL SINGLE-LAYER COILS.—F. W. Grover. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 1039–1049.)

" The tables and formulae here presented enable the mutual conductance of any two coaxial solenoids whatever to be calculated from a single formula. Examples make clear that a five-figure accuracy may be attained with concentric coils and even with poorly coupled coils the error does not exceed a few parts in ten thousand."

THE FUNDAMENTAL AND HARMONIC FREQUENCIES OF MULTI-LAYER INDUCTANCE COILS.—A. Korn. (*Zeitschr. f. angewandte Math. u. Mech.*, Feb., 1933, Vol. 13, pp. 32–35.)

THE CALCULATION OF IRON-FREE CHOKING COILS [Simplified Method allowing for Heating Effects].—R. Edler. (*Bull. Assoc. Suisse d. Élec.*, 31st March, 1933, Vol. 24, pp. 149–157.)

SKIN EFFECT IN A STRATIFIED CYLINDER OF CIRCULAR SECTION.—J. Fischer and M. J. O. Strutt. (*Hochf:tech. u. Elek:akus.*, June, 1933, Vol. 41, No. 6, p. 219.)

The simultaneous and independent researches of the two writers (March and May Abstracts, pp. 171 and 269) are compared, and for the sake of those who wish to employ the various formulae the reason for any apparent differences are explained.

ENGINEERING CALCULATION OF INDUCTANCE AND REACTANCE [at Low Frequencies] FOR RECTANGULAR BAR CONDUCTORS.—O. R. Schurig. (*Gen. Elec. Review*, May, 1933, Vol. 36, No. 5, pp. 228–231.)

FIRST COMPARISONS OF THE NATIONAL STANDARDS OF ELECTRICAL RESISTANCE, CARRIED OUT AT THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASUREMENTS.—A. Pérard and M. Romanowski. (*Comptes Rendus*, 1st May, 1933, Vol. 196, No. 18, pp. 1288–1291.)

NOTE ON AN IMPROVED FORM OF AN INDUCTION COIL BUZZER [as A.C. Source for Resistance Measurements using Special A.C. Galvanometer as Null Indicator].—H. Mukherjee. (*Physik. Ber.*, 15th June, 1933, Vol. 14, No. 12, p. 920.)

SUBSIDIARY APPARATUS AND MATERIALS

DIE RÜCKWIRKUNG METALLISCHER SPULENKAPSELN AUF VERLUSTE, INDUKTIVITÄT UND AUSSENFELD EINER SPULE (The Influence of a Metallic Cover on the Losses, Inductance and External Field of a Coil).—H. Kaden. (*E.N.T.*, July, 1933, Vol. 10, No. 7, pp. 277–284.)

Further development of the work dealt with in Abstracts, 1932, p. 654, l-h col. Methods of calculation depending on treating the cover as the secondary winding of a transformer (May, p. 281, Hillers) can only give qualitative results, since they neglect the influence of current and flux skin effect, so important at high frequencies. For obtaining exact results applicable at all frequencies, even the highest, it is necessary to integrate the Maxwellian differential equations of the electromagnetic field for the whole space. In his previous paper the writer showed that the important factors in the screening effect of a metallic cover, besides the frequency and the constants of the material, were simply the wall-thickness and a single further quantity defining the external dimensions, the actual *shape* of the cover playing a subordinate rôle. In his present paper he therefore simplifies the problem by replacing the practical form of cover by a hollow sphere of the same wall-thickness with a diameter which is the geometrical mean of the cover measurements along the three co-ordinates. A further simplification is given by the assumption of quasi-stationary conditions: "the dimensions of the coil with its cover, even at high frequencies, is small compared with the wavelength of the field."

It is found that the screening effect of the cover against the field of the coil inside it is exactly equal to its screening of the space inside against an external field. Therefore the mutual screening of two coils, each with a cover, is equal to the product of the screenings of the two covers taken separately. An important point is the calculation of the effect of the cover on the inductance and phase angle of its coil. This is possible with the help of the formulae derived, which cover all the variable factors—frequency, constants of the material, dimensions of cover and of coil. They are valid at "all" frequencies. Among other results it is shown that the losses in the cover decrease as the fourth power of the reciprocal cover-diameter. A numerical example is given of a cylindrical coil with a cylindrical manganin cover; the volume of the coil is 34 cm^3, that of the equivalent spherical shell 270 cm^3. By the application of formula 9 the ratio of the inductance with cover to that without cover is found to be 0.88; from formula 8 the phase angle due to the cover is 7×10^{-3}. The corresponding measured values are 0.87 and 6.3×10^{-3}, which show good agreement.

THE ESSENTIALS OF WIRELESS COMPONENTS. PART I: HIGH-FREQUENCY CHOKES.—M. G. Scroggie. (*World-Radio*, 11 Aug., 1933, Vol. 17, No. 420, pp. 163 and 165.)

A NEW TYPE OF IMPEDANCE UNIT [Compact and Cheap Filter Unit from Quarter-Wavelength Line of Twisted Pairs of Conductors Encased in Shielding, Coiled Up and Inserted in Can].—F. S. Allen. (Summary only in *Proc. Inst. Rad. Eng.*, August, 1933, Vol. 21, No. 8, p. 1074.)

THE CONDUCTIVITY OF COMPRESSED MERCURIC SULPHATE [with Zinc and Platinum Electrodes: Rectifying Action].—W. Ścislowski. (*Physik. Ber.*, 15 June, 1933, Vol. 14, No. 12, p. 933.)

THE IGNITRON—A NEW CONTROLLED RECTIFIER [Arc started by Spark between Carborundum (e.g.) and Mercury, during Conducting Half-Cycle: Output varied by Phase-Shift of Control Voltage].—D. D. Knowles: Westinghouse Company. (*Electronics*, June, 1933, Vol. 6, No. 6, pp. 164–166.)

PHYSICAL PROCESSES IN LOW-PRESSURE MERCURY-VAPOUR ARCS [Mercury-Vapour Rectifiers]. —E. Lübcke. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 14, 1933, pp. 297–304.)

THE USE OF THYRATRONS AS RELAYS IN HEATER SETS [for Crystal Incubators: the Use of Anode Voltage Supply for Grid Control, after Rectification, thus eliminating D.C. Control Battery].—(*Marconi Review*, May/June, 1933, No. 42, p. 27.)

A LIFE-TEST POWER SUPPLY UTILISING THYRATRON RECTIFIERS.—H. W. Lord. (*Proc. Inst. Rad. Eng.*, August, 1933, Vol. 21, No. 8, pp. 1007–1102.)

DER STROMRICHTER BEI KAPAZITIVER LAST (The Current Rectifier with Capacitative Load). —H. Klemperer and K. Strobl. (*Archiv f. Elektrot.*, 1st July, 1933, Vol. 27, No. 7, pp. 485–488.)

ÜBER DIE ZÜNDBEDINGUNG VON NIEDERVOLTBOGEN UND GITTERGESTEUERTEN NIEDERVOLTBOGEN. I. (On the Sparking Condition of Low Voltage Arcs and Grid-Controlled Low Voltage Arcs [Thyratrons]. I).—F. Klaiber. (*Physik. Zeitschr.*, 1st June, 1933, Vol. 34, No. 11, pp. 441–447.)

VOLTAGE STABILISATION: THE MECHANISM OF VOLTAGE REGULATION BY MEANS OF GAS DISCHARGE TUBES.—F. M. Colebrook. (*World-Radio*, 23rd and 30th June, 1933, Vol. 16, Nos. 413 and 414, pp. 829 and 862–863.)

THE PROVISION OF SEVERAL DIFFERENT ANODE VOLTAGES BY THE "STABILIVOLT" GLOW-DISCHARGE TUBE.—(*Hochf:tech. u. Elek:akus.*, April, 1933, Vol. 41, No. 4, p. 150: German Pat. No. 565 125, pub. 26th Nov., 1932, Körös.) *See* April Abstracts, p. 226, l-h column.

NOTE ON THERMAL INSTABILITY IN CYLINDRICAL CONDENSERS DUE TO DIELECTRIC LOSSES [Calculation of Electric Intensity giving Instability].—B. L. Goodlet. (*Proc. Camb. Phil. Soc.*, 30th July, 1933, Vol. 29, Part 3, pp. 401–404.)

ÜBER EINE UNIPOLARE FORM DER GLEITKORONA (A Unipolar Form of "Gliding Corona" [a Kind of Glow Discharge: at Voltages down to 200 v: and a Criticism of Gemant's "Electrophotography" of the Porous Structure of Insulating Materials]).—A. Coehn and W. Ziegler. (*Zeitschr. f. tech. Phys.*, No. 6, Vol. 14, 1933, pp. 246–249.) For Gemant's paper *see* 1931 Abstracts, p. 396, l-h column.

DIRECT PROOF OF THE SPACE CHARGE IN OILS.— A. Gemant. (*E.T.Z.*, 18th May, 1933, Vol. 54, No. 20, pp. 468–469.)

Is the Breakdown of Insulating Liquids a Heat Process ?—F. Koppelmann. (*Archiv f. Elektrot.*, 1st June, 1933, Vol. 27, No. 6, pp. 448-453.)

Further development of the work referred to in Abstracts, 1931, p. 111, and 1932, p. 47, r-h columns.

Die elektrische Festigkeit flüssiger Isolierstoffe bei hohen Frequenzen (The Electrical Strength of Liquid Insulating Materials [Oil and Xylol] at High Frequencies [and the Thermal Breakdown Effect]).—W. Schlegelmilch. (*Physik. Zeitschr.*, 1st July, 1933, Vol. 34, No. 13, pp. 497–507.)

The Theory of Glow Discharge Valve Tubes [for Protecting Devices: Possibility of Using Greater Electrode Gaps].—L. Heer. (*Archiv f. Elektrot.*, 15th March, 1933, Vol. 27, pp. 196–205.)

"Wax-Operated Switches" and Metallised Wax Strips as Fuses for Instruments, Fractional-H.P. Motors, etc.—A. G. Bullen. (*Sci. Abstracts, Sec. B*, May, 1933, Vol. 36, No. 425, pp. 281–282.)

The Performance of Relays [as regards Variability in Time of Operation: and a Reed-Armature Relay with Lag not exceeding 0.1 Millisecond].—G. A. Tomlinson. (*Journ. Scient. Instr.*, July, 1933, Vol. 10, No. 7, pp. 204–208.)

A Simplified Frequency-Dividing Circuit [using One Pentode Valve: for Frequency-Measuring Equipments].—V. J. Andrew. (*Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, pp. 982–983.)

The control grid and screen grid are used together as grid and plate of a normal triode, and are connected to a piezo-oscillator circuit. The suppressor (collector) grid and the plate are used as grid and plate of a second triode forming a l.f., self-excited oscillator. "Since the electron current which operates the outer triode has passed through the inner triode, it has been modulated by the frequency of the piezoelectric oscillator. This electron coupling is sufficient to make the l.f. oscillator 'lock-in' at a sub-harmonic of the crystal frequency." The arrangement has been found to work excellently when division by a small integer (say not over 4) is desired.

A New Method of Frequency Analysis applicable to Acoustic and Radio Frequencies.—Fehr and Kreielsheimer. (*See* abstract under "Properties of Circuits.")

On Electron Optics [Survey of the Magnetic and Electrostatic Focusing of High-Vacuum Electron Beams].—V. K. Zworykin. (*Journ. Franklin Inst.*, May, 1933, Vol. 215, No. 5, pp. 535–555.)

Simultaneous Traces with Cathode-Ray Oscillograph [with Single Ray: the Use of a Synchronised Rotary Switch].—C. Bradner Brown. (*Electronics*, June, 1933, Vol. 6, No. 6, p. 170.)

Use of Cathode-Ray Oscillograph for obtaining Frequency-Response Curves.—Davis. (*See* under "Acoustics and Audio-frequencies.")

Special Lens and Oscillogram Camera for Cathode-Ray Tubes.—M. von Ardenne. (*Hochf:tech. u. Elek:akus.*, July, 1933, Vol. 42, No. 1, pp. 37–39.)

Designed with a view to a great reduction of the cost of the auxiliary apparatus of a c.r. oscillograph. The lens gives just the right definition for the purpose; by dispensing with unnecessarily perfect definition a reasonable price is possible in spite of the high light admission and other desirable qualities. The usual expensive drum-recording equipment, with its attendant dark room, is replaced by a spring-driven slider device, in which the speed with which the plate or film is projected across the image slit is regulated (up to a maximum of 4–5 m/s) by the tension of the spring. This speed attains its maximum before the slit is reached; the brake is applied after it is passed, so that during exposure the speed is constant. It is indicated on the record by the trace given by a small lamp lit off the a.c. network.

Elektronenmikroscopische Beobachtungen an der Barium-Aufdampfkathode (Observations of a Barium Cathode, sputtered on Nickel, with an Electron Microscope).—E. Brüche and H. Johannson. (*Zeitschr. f. Physik*, 1933, Vol. 84, No. 1/2, pp. 56–58.)

The Variation of the Intensity of Fluorescence with the Wavelength of the Exciting Radiation [and the Effect of the Solvent].—W. Fabrikant. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 3, 1933, pp. 567–573.)

Synchronisation of Motors: the Prevention of Hunting [using an Elastically-Connected Flywheel, a Photoelectric Cell and Thyratrons].—Lichine: Béghin. (*Comptes Rendus*, 17th July, 1933, Vol. 197, No. 3, pp. 223–224.)

Kurven zur Berechnung der Permeabilität und der Verluste im Blech (Curves for the Determination of the Permeability of, and Losses in, Iron Sheet).—W. Arkadiew. (*E.N.T.*, May, 1933, Vol. 10, No. 5, pp. 220–222.) *See* also June Abstracts, p. 340, l-h col.

Magnetic Properties and Chemical Linkage in Alloys.—J. Dorfman. (*Physik. Zeitschr. der Sowietunion*, No. 4, Vol. 3, 1933, pp. 399–417: in German.)

The Magnetic Properties of Electrolytic Iron [in Very Thin Layers].—K. W. Grigorow. (*Ibid.*, pp. 418–420: in German.)

A Compact [Oil-Cooled] Electromagnet for General Purposes [giving 32 500 Gauss].—L. F. Bates and B. J. Lloyd-Evans. (*Proc. Phys. Soc.*, 1st May, 1933, Vol. 45, Part 3, No. 248, pp. 425–433.)

A PERMANENT OXIDE MAGNET AND ITS CHARACTERISTICS [Specially High Coercivity: Poles located at Any Point: Specific Gravity Very Low: etc.]—Y. Kato and T. Takei. (*Journ. I.E.E. Japan*, May, 1933, Vol. 53 [No. 5], No. 538: English summary p. 37, Japanese paper pp. 408–412.)

THE PROBLEM OF UNIPOLAR INDUCTION AND THE ELECTRICAL SURFACE CHARGES ON ROTATING MAGNETS.—L. Slepian. (*Physik. Zeitschr. der Sowietunion*, No. 5, Vol. 3, 1933, pp. 469–486: in German.)

THE "FER-X" [Iron-Cored] H.F. Transformers.—G. Budich Company. (*Hochf:tech. u. Elek: akus.*, July, 1933, Vol. 42, No. 1, p. 39.)

A MAGNETIC FLUX RECORDER.—O. von Auwers. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 14, 1933, pp. 316–319.)

COMPOSITION OF GRIDS FOR POSITIVE PLATES OF STORAGE BATTERIES AS A FACTOR INFLUENCING THE SULPHATION OF NEGATIVE PLATES [and the Effect of the Presence of Antimony].—Vinal, Craig and Snyder. (*Bur. of Stds. Journ. of Res.*, June, 1933, Vol. 10, No. 6, pp. 795–808.)

A RESISTANCE-COUPLED [Two-Stage] AMPLIFIER FOR MEASURING IONISATION CURRENTS [down to 10^{-13} Ampere].—L. F. Curtiss. (*Bur. of Stds. Journ. of Res.*, May, 1933, Vol. 10, No. 5, pp. 583–589.)

ELECTRO-MECHANICAL DETERMINANT MACHINE.—A. Weygandt. (*Sci. Abstracts, Sec.A*, June, 1933, Vol. 36, No. 426, pp. 544–545.)

A CALCULATING RULE OF HIGHLY ELASTIC RUBBER. (*Electronics*, May, 1933, Vol. 6, No. 5, p. 143.)

A NEW COUPLING FOR ELECTRIC DRIVE, WITH OVERLOAD RELEASE.—AEG. (*E.T.Z.*, 15th June, 1933, Vol. 54, No. 24, p. 584.)

ON THE DRIVING MECHANISM OF RECORDING APPARATUS.—J. Baltzer. (*E.T.Z.*, 20th April, 1933, Vol. 54, No. 16, pp. 377–379.)

SPECIAL FLEXIBLE SHAFT FOR REMOTE CONTROL.—(*Electronics*, June, 1933, Vol. 6, No. 6, p. 174.)

STATIONS, DESIGN AND OPERATION

THE LUCERNE FIGHT OVER THE RADIO WAVES.—(*Radio, B., F. für Alle*, August, 1933, pp. 347–351.)

THE PROSPECTS OF LONG-WAVE BROADCASTING IN SOUTH-EASTERN AUSTRALIA.—Munro and Green. (*See* abstract under "Propagation of Waves.")

A METHOD OF CALCULATION OF FIELD STRENGTHS IN HIGH-FREQUENCY [Short-Wave] RADIO TRANSMISSION.—Namba and Tsukada. (*See* under "Propagation of Waves.")

LAND-LINE CIRCUITS FOR BROADCASTING: EQUALISATION OF LAND-LINE CIRCUITS. (*World-Radio*, 4th and 11th Aug., 1933, Vol. 17, Nos. 419 and 420, pp. 131 & 133 and 167 & 165.)

GENERAL PHYSICAL ARTICLES

THE COMPLEXITY OF THE PROTON AND THE MASS OF THE NEUTRON [Proton composed of Neutron and Positive Electron].—I. Curie and F. Joliot. (*Comptes Rendus*, 17th July, 1933, Vol. 197, No. 3, pp. 237–238.)

ELECTROSTATIC DEVIATION AND SPECIFIC CHARGE OF THE POSITIVE ELECTRON.—J. Thibaud. (*Comptes Rendus*, 7th Aug., 1933, Vol. 197, No. 6, pp. 447–448.)

QUANTUM THEORY OF INELASTIC COLLISIONS OF ELECTRONS.—L. Goldstein. (*Ann. de Physique*, April, 1933, Vol. 19, pp. 305–420.)

QUANTUM THEORY OF DISPERSION (CONTINUED). PARTS VI AND VII.—G. Breit. (*Reviews of Mod. Phys.*, April, 1933, Vol. 5, No. 2, pp. 91–140.)

RITZ'S ELECTRODYNAMIC THEORY.—W. Hovgaard. (*Sci. Abstracts, Sec.A*, March, 1933, Vol. 36, No. 423, p. 304.)

NOTES ON SOME ELECTRONIC PROPERTIES OF CONDUCTORS AND INSULATORS.—R. H. Fowler. (*Proc. Roy. Soc.*, 3rd July, 1933, Vol. 141, No. A 843, pp. 56–71.)

"The paper is a critical survey of certain current views on the nature of crystalline insulators and their electronic properties."

AN ELEMENTARY THEORY OF ELECTRONIC SEMI-CONDUCTORS, AND SOME OF THEIR POSSIBLE PROPERTIES.—R. H. Fowler. (*Proc. Roy. Soc.*, 1st June, 1933, Vol. 140, No. A 842, pp. 505–522.)

THE ELECTRONIC CONDUCTIVITY OF THE COPPER OXIDES. II.—M. Le Blanc, H. Sachse and H. Schöpel. (*Ann. der Physik*, 1933, Series 5, Vol. 17, No. 3, pp. 334–344.)

PHASE BOUNDARY POTENTIALS OF ADSORBED FILMS ON METALS. PARTS I, II AND III.—Whalley and Rideal: Jacobs and Whalley. (*Proc. Roy. Soc.*, 1st June, 1933, Vol. 140, No. A 842, pp. 484–504.)

SUPERCONDUCTIVITY OF TIN AT RADIO FREQUENCIES.—F. B. Silsbee, R. B. Scott, F. G. Brickwedde and J. W. Cook. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, pp. 1050–1051: abstract only.)

ON THE INFLUENCE OF A TRANSVERSE MAGNETIC FIELD UPON THE RESISTANCE OF LIQUID METALS.—I. Fakidow and I. Kikoin. (*Physik. Zeitschr. der Sowietunion*, No. 4, Vol. 3, 1933, pp. 381–392: in English.)

CORONA AND SPARK DISCHARGE IN GASES.—J. D. Stephenson. (*Journ. I.E.E.*, July, 1933, Vol. 73, No. 439, pp. 69–82.)

THE INFLUENCE OF CIRCUIT CONSTANTS AND FREQUENCY ON CHARACTERISTICS OF GAS DISCHARGES AT LOW PRESSURES (PART VI). —Y. Asami. (*Journ. I.E.E. Japan*, June, 1933, Vol. 53 [No. 6], No. 539: English summary pp. 46–48.)

MEASUREMENT OF THE TOWNSEND COEFFICIENTS FOR IONISATION BY COLLISION.—F. H. Sanders. (*Phys. Review*, 15th July, 1933, Series 2, Vol. 44, No. 2, p. 129: abstract only.)

RECOMBINATION RADIATION IN THE CAESIUM POSITIVE COLUMN.—F. L. Mohler. (*Bur. of Stds. Journ. of Res.*, June, 1933, Vol. 10, No. 6, pp. 771–780.)

MISCELLANEOUS

ELLIPSOIDAL FUNCTIONS AND THEIR APPLICATION TO SOME WAVE PROBLEMS.—E. T. Hanson. (*Phil. Trans. Roy. Soc. Lond.*, *A*, Vol. 232, No. 713, pp. 223–283.)

Results of importance in the theory of ellipsoidal functions are obtained in this paper, including the expansion of an arbitrary function in a series of ellipsoidal functions and an expression suitable to represent a divergent wave. Among the applications considered are the scattering of plane waves incident normally on a thin circular disc and the transmission of waves through a circular aperture.

EXTREME WERTE VON VEKTOREN EINER ORTSKURVE (Limiting Values of Vectors of a Locus Curve [Application to the Simple Calculation of Maxima and Minima, in place of Differential Calculus]).—H. Kind. (*E.N.T.*, July, 1933, Vol. 10, No. 7, pp. 285–286.)

As an example of the method, which postpones to the last, or avoids completely, the involved treatment of real and imaginary quantities, the writer takes the simplified equivalent diagram of a transformer and finds the frequency at which the impedance vector has the smallest phase-displacement, and how this frequency varies with the load.

MECHANICAL MODELS FOR ELECTRICAL PROCESSES.—R. Weller. (*Radio, B., F. für Alle*, May, 1933, pp. 199–211.)

THE WORK OF THE INSTITUTE FOR THE APPLICATIONS OF CALCULATION [including Problems connected with Oscillation Transformers, Thermionic Currents, etc.].—(*L'Elettrotec.*, 5th May, 1933, Vol. 20, No. 13, pp. 285–293.)

ROYAL SOCIETY CONVERSAZIONE—RADIO AND OTHER EXHIBITS.—(*Electrician*, 26th May, 1933, Vol. 110, No. 2869, pp. 671–672.)

PUBLICITY AND THE PHYSICIST.—R. D. Potter. (*Review Scient. Instr.*, May, 1933, Vol. 4, No. 5, pp. 261–263.)

SURVEY OF THE MOST IMPORTANT DEVELOPMENTS IN RADIO ENGINEERING AND ACOUSTICS IN 1932.—Elektrotechnischer Verein. (*E.T.Z.*, 18th May, 1933, Vol. 54, No. 20, pp. 480–483.)

SOME ELECTRICAL METHODS OF REMOTE INDICATION.—C. Midworth and G. F. Tagg. (*Journ. I.E.E.*, July, 1933, Vol. 73, No. 439, pp. 33–48.)

THE RADIO CORPORATION OF AMERICA AND ITS RAMIFICATIONS.—H. Winkler. (*E.T.Z.*, 15th June, 1933, Vol. 54, No. 24, pp. 585–587.)

ENGINEERING ORGANISATION.—R. F. Shea. (*Rad. Engineering*, June, 1933, Vol. 13, No. 6, pp. 18–19 and 21.)

TRENDS IN RADIO DESIGN AND MANUFACTURING [Binaural Transmission: Hill-and-Dale Gramophone Recording: Reflex Circuits: etc.].—(*Electronics*, June, 1933, Vol. 6, No. 6, pp. 151–152 and 161.)

"The future may see radios sold in double units, the tuning mechanism housed in a small . . . cabinet, an external loud speaker with sufficient baffle to provide good bass reception." The recent demonstration of binaural transmission has shown that this "was not an idle dream." "Those who long for high-class home entertainment will find further encouragement in the possibility that the long-playing vertically cut records of Dr. Frederick (Bell Laboratories) may be available to the public" [hill-and-dale recording, 10 000 c/s or more with wide range of volume: Abstracts, 1932, p. 101; May, p. 275; June, p. 332; all r-h cols.]. "The long-dead reflex is being revamped [*see* Stinchfield and Schade, under 'Reception'] . . . Together with the electron-coupled oscillator, the reflexed tube will permit a 7-tube set to be compressed into 4 tubes. Even the power tube may be worked twice in some sets, once at i.f." "First announcement of the Osram Catkin all-metal receiving tubes in England must be taken seriously in this country. . ." "There is a strong possibility that the rapid increase in tube types may cease as a result of another English tube development which appears to simplify appreciably tube construction. . . ."

WHAT THE INDUSTRY BRINGS TO THE BERLIN RADIO EXHIBITION.—(*Radio, B., F. für Alle*, August, 1933, pp. 338–341.)

SHORT-WAVE WIRELESS COMMUNICATION.—A. W. Ladner and C. R. Stoner. (Book Review in *Proc. Inst. Rad. Eng.*, July, 1933, Vol. 21, No. 7, p. 1054.)

DIRECT DETERMINATION OF THE MEAN PRESSURE IN HEAT ENGINES [Varying Curvature of Thick Metallic Membrane alters Divergence of Light Beam reflected on to Photocell-Microammeter Combination].—A. Labarthe. (*Comptes Rendus*, 7th Aug., 1933, Vol. 197, No. 6, pp. 440–442.)

THE USE OF PIEZOELECTRIC CRYSTALS IN RESONANT OSCILLATION FOR THE MEASUREMENT OF PRESSURES [New Piezoelectric Dynamometer].—A. Guerbilsky. (*Comptes Rendus*, 31st July, 1933, Vol. 197, No. 5, pp. 399–401.)

Ordinary piezoelectric dynamometers require extraordinarily careful insulation when constant or slowly varying pressures are to be measured. By using the crystal in a state of resonant oscillation, in an absorption circuit similar to that of the writer's piezoelectric microphone (Sept. Abstracts, p. 508, r-h col.) a very practical arrangement is obtained, for pressures of several kilogrammes or some tens of grammes.

AN IMPROVED PHOTOELECTRIC RECORDER.—C. W. La Pierre. (*Gen. Elec. Review*, June, 1933, Vol. 36, No. 6, pp. 271–274.) For previous papers *see* 1932 Abstracts, p. 539, r-h column.

THE POSOPHOTOMETER [Photographic Exposure Meter using Photoelectric Cell].—Établissements Filmograph. (*Rev. Gén. de l'Élec.*, 29th April, 1933, Vol. 33, No. 17, p. 538.) In an article on the French Physical Society's Exhibition.

PHOTOCELL CONTROL AGAINST PAPER BREAKAGE IN NEWSPAPER PRINTING [with Precautions against Variable Factors].—(*Electronics*, April, 1933, Vol. 6, No. 4, p. 102.) *See* also May Abstracts, p. 288, r-h column.

PHOTOELECTRIC CELLS IN PHOTOMETRY.—J. W. T. Walsh. (*Illuminating Engineer*, March, 1933, Vol. 26, pp. 64–71.)

PHOTOELECTRIC CELLS IN INVESTIGATIONS OF THE RANGE OF LIGHTHOUSES WITH REVOLVING BEAMS.—A. Blondel. (*Rev. Gén. de l'Élec.*, 10th June, 1933, Vol. 33, No. 23, pp. 747–758.)

MAKING MEASUREMENTS WITH THE PHOTOCELL.—R. C. Walker. (*Wireless World*, 23rd June, 1933, Vol. 32, pp. 445–446.)

This article outlines the circuits used in colorimeters, optical density meters and similar devices, and describes the Electrometer Triode.

PHOTOELECTRIC CONTROL OF WELDING, RIVET, AND VALVE-STEM HEATERS: OF AMOUNT OF CHLORINE INTRODUCED INTO WATER SUPPLY.—(*Electronics*, April, 1933, Vol. 6, No. 4, p. 103.)

AN INTEGRATING [Photoelectric] PHOTOMETER FOR X-RAY CRYSTAL ANALYSIS.—B. Wheeler Robinson. (*Journ. Scient. Instr.*, Aug., 1933, Vol. 10, No. 8, pp. 233–242.)

LAUNDRY CONVEYOR OPERATED BY PHOTOCELL.—[*Electronics*, June, 1933, Vol. 6, No. 6, p. 162.)

COLOUR MATCHING IN AUTOMOBILE PLANT [by Photocells: for Parts finished in Different Places or Other Factories].—(*Ibid.*, p. 162.)

PHOTOCELL ENSURES PERFECT JIG-SAWS.—(*Ibid.*, p. 163.)

REPORT ON THE TESTS IN THE PUNKWA CAVES AND TUNNELS [Charted by Radio Field-Strength Measurements].—Fritsch. (*See* under "Propagation of Waves.")

THE APPLICATION OF RADIO TECHNIQUE TO THE TESTING OF MATERIALS: THE MEASUREMENT OF THE INTERNAL FRICTION OF METALS.—L. Polotowsky. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 3, 1933, pp. 555–560.)

THE USE OF A CONDENSER-RESISTANCE COMBINATION AS TIMING CIRCUIT FOR GRID-CONTROLLED RECTIFIERS USED IN WELDING.—(*Electronics*, April, 1933, Vol. 6, No. 4, p. 105.)

THE RÔLE OF VACUUM TUBES IN A TUBE FACTORY [Measuring Low Mutual Conductances: Automatic Control of Cathode Spray Gun: Protective Circuits for Meters, etc.].—W. P. Koechel. (*Electronics*, May, 1933, Vol. 6, No. 5, pp. 121–123.)

VALVE METHOD OF MEASURING THE MOISTURE CONTENT OF WHEAT.—H. E. Hartig and B. Sullivan. (*Electronics*, April, 1933, Vol. 6, No. 4, p. 110: summary only.)

STUDY OF THE WING BEATS OF A BIRD OR INSECT BY THE USE OF A HOT WIRE AND CATHODE-RAY OSCILLOGRAPH.—A. Magnan and C. Magnan. (*Comptes Rendus*, 8th May, 1933, Vol. 196, No. 19, pp. 1369–1372.)

BRUSH DISCHARGE IN AIR AFFECTS ENGINE PERFORMANCE.—(*Bur. of Stds. Tech. News Bull.*, April, 1933, No. 192, p. 40.) *See* also July Abstracts, p. 405, r-h column.

MOSQUITOES ATTRACTED BY ULTRA-VIOLET LAMPS AND THEN TRAPPED OR ELECTROCUTED.—(*World-Radio*, 19th May, 1933, Vol. 16, No. 408, p. 674.) *See* also acoustic method, February Abstracts, p. 117, r-h column.

INVESTIGATIONS OF THE TRANSPARENCY TO LIGHT OF FOG.—Born, Dziobek and Wolff. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 14, 1933, pp. 289–293.)

INFRA-RED FOG-EYE PICKS UP SHIPS BELOW HORIZON [Refraction of Infra-Red Rays: Ships detected 6 Miles beyond Horizon: Naval Aeroplane detected at 4½ Miles and Course easily followed].—P. H. Macneil. (*Electronics*, June, 1933, Vol. 6, No. 6, pp. 162–163.)

SOME REMARKS ON THE QUESTION OF THE RESISTANCE OF THE BODY TO HIGH-FREQUENCY CURRENTS.—N. N. Malov. (*Hochf:tech. u. Elek:akus.*, April, 1933, Vol. 41, No. 4, pp. 138–141.)

Further results in the work dealt with in 1932 Abstracts, pp. 540–541. The effect of certain illnesses and of radioactive baths, in changing the "normal" resistance of the human body, is referred to.

A METHOD FOR THE INVESTIGATION OF THE IMPEDANCE OF THE HUMAN BODY TO AN ALTERNATING CURRENT.—M. A. B. Brazier. (*Journ. I.E.E.*, August, 1933, Vol. 73, No. 440, pp. 204–209.)

THE ROTATION OF A QUARTZ CRYSTAL.—de Gramont. (*See* abstract under "Measurements and Standards.")

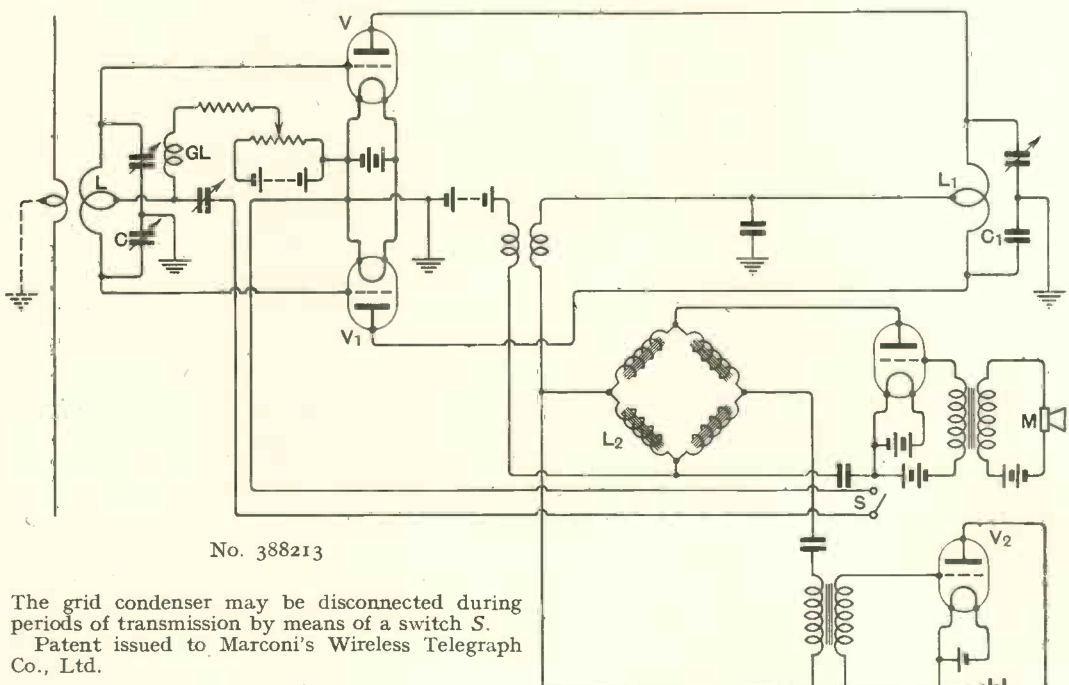
Some Recent Patents

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

COMBINED TRANSMITTER AND RECEIVER

Convention date (U.S.A.), 4th March, 1931.
No. 388213

A short-wave set is arranged to generate strong oscillations which are used (*a*) for transmission and (*b*) also to assist reception by super-regenerative action. The valves V, $V1$ are arranged in push-pull across the input circuit L, C, which is back-coupled to a similar output circuit $L1$, $C1$. A leaky grid system GL is adjusted to " quench " the oscillations at supersonic frequency. A choke $L2$ in the plate supply circuit forms one arm of a Wheatstone bridge. Modulated signals are applied across a diagonal of the bridge from a microphone M, whilst received signals are taken off from the other diagonal to an amplifier $V2$ and headphones.



No. 388213

The grid condenser may be disconnected during periods of transmission by means of a switch S.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

TELEVISION SYSTEMS

Application date, 18th August, 1931. *No.* 388404

The picture, preferably a kinematographic film, is scanned by a drum fitted with tangential mirrors, which throw a series of images over several, say three, scanning-apertures, all co-operating with a single photo-electric cell. Successive images are displaced relatively, in a direction at right-angles to their traverse, so that each aperture serves in turn to scan different portions of the picture. The photographic film is moved intermittently, and certain of the mirrors on the scanning-drum are blackened so that no reflection occurs during the actual movement of the film.

Patent issued to The Gramophone Co., Ltd., and G. E. Condliffe.

VISUAL TUNING INDICATORS

Application date, 15th December, 1931. *No.* 388516

A visual indicator, particularly adapted for sets furnished with automatic volume control, consists of a glow-discharge lamp inserted across the anode and cathode of the detector valve, and connected in series with a resistance of, say 20,000 ohms to the H.T. supply. The presence of an incoming signal reduces the voltage drop across the anode resistance until the lamp " strikes." The cathode of the lamp is a relatively long rod so that variations in the discharge current are indicated by the relative length of glow. Preferably the lamp has an auxiliary anode which is connected to the full H.T. voltage through a high resistance so as to maintain a " priming " discharge.

Patent issued to The General Electric Co., Ltd., N. R. Bligh and N. L. Harris.

SCREEN-GRID AMPLIFIERS

Convention date (Germany), 29th April, 1931.
No. 388600

In a resistance-coupled screen-grid amplifier, reaction is obtained by means of a coil inserted in the screen-grid lead and back-coupled to the input coil supplying the control grid. The degree of reaction is controlled either by varying the coupling between the coils or by varying the biasing voltage applied to the screening-grid. The arrangement is particularly suitable for circuits using valves of the multi-stage type.

Patent issued to S. Loewe and P. Kapteyn.

WAVE-CHANGE SWITCHING

Convention date (Denmark), 3rd September, 1931.
No. 388632

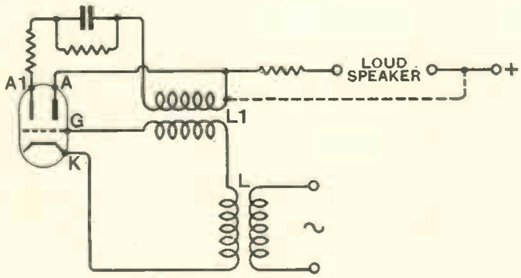
A rotatable drum-switch is employed for waveband changing and is provided with surface contacts which serve the purpose of connecting the various tuning-coils either in series, parallel, or series-parallel as required. All the windings are in circuit at each setting, i.e., for long, medium, or short-wave working.

Patent issued to F. M. Frederiksen.

GAS-FILLED AMPLIFIERS

Convention date (Germany), 22nd May, 1930.
No. 388730

Relates to gas-filled amplifiers designed to use from 15 to 20 volts on the main anode with a heated cathode, or a higher anode voltage with a cold cathode. According to the invention the input circuit *L* feeding the grid *G* is coupled at *L*1 to an



No. 388730

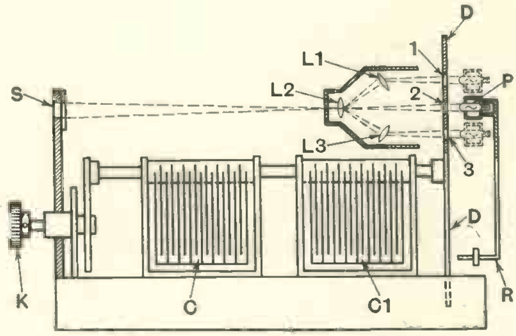
auxiliary anode *A*1, which serves to divert some of the main discharge-stream between the cathode *K* and the main anode *A* in rhythm with the input.

Patent issued to Dubilier Condenser Co. (1925), Ltd.

TUNING DIALS

Convention date (Germany), 18th December, 1931.
No. 388938

Means are provided to throw the names of broadcasting stations covering three different wavebands on to a common projection screen, according to the position of the wave-change switch and the setting of the tuning condenser. The tuning-knob *K*, which controls the ganged condensers *C*, *C*1, rotates a disc *D* on which the various stations (or alternately the degree divisions) are marked on three concentric circles, 1, 2, 3. The wave-change switch, as it is



No. 388938

operated, simultaneously moves a rod *R* carrying a lamp *P* into alignment with the corresponding markings 1, 2, 3. A system of lenses *L*1, *L*2, *L*3 is arranged to project the name of the particular station being received on to a viewing-screen *S* located on the front panel of the receiver.

Patent issued to Ideal Werke Akt. für drahtlose Telephonie.

SHORT-WAVE RECEIVERS

Application date, 29th August, 1931. *No.* 388755

For the reception of the waves below ten metres, the anode is maintained at cathode potential whilst the grid is biased positively. The anode and grid leads are fitted with telescoping inductances which are connected at the other end across a tuning condenser. The valve is intended to be operated at a point just short of self-oscillation, reaction being controlled by means of a filament rheostat. Diode rectification occurs between the cathode and positively-charged grid.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and E. W. B. Gill.

Convention date (U.S.A.), 16th January, 1931.
No. 389225

For receiving wavelengths of the order of 10 metres, a pair of valves are arranged in push-pull across tuned input and output circuits, symmetrically arranged, the whole system being maintained in strong oscillations at the carrier frequency. An adjustable grid-leak is inserted in parallel with both valves, and draws considerable current. This serves periodically to " quench " the local oscillations and produce a super-regenerative effect. The rectified signals are fed to a low-frequency amplifier through a coil connecting a centre tapping on the common output coil to the H.T. supply.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

RADIO-RECEIVING CIRCUITS

Convention date (U.S.A.), 31st May, 1930.
No. 388732

The circuit is characterised by the omission of any standard type of rectifier, the high-frequency signals after passing through at least three stages of H.F. amplification being applied directly to an electrostatic speaker. Since the force applied to a speaker of this type is at all times equal to the square of the applied E.M.F., the effective pressure is invariably in the same direction and has an average amplitude corresponding to the envelope of the orthodox curve of rectification.

Patent issued to Dubilier Condenser Co. (1925), Ltd.

PENTODE MODULATORS

Application date, 29th August, 1931. No. 388756

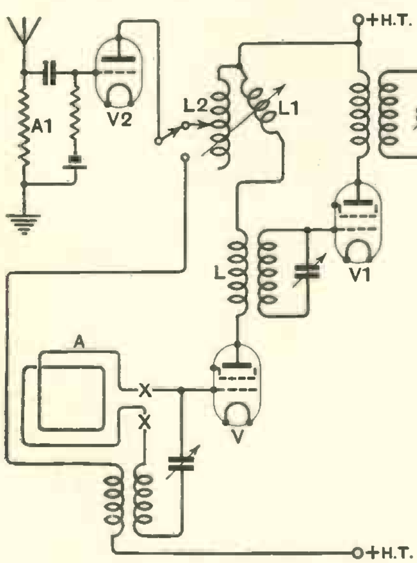
A valve of the pentode type is used as a modulator. The H.F. carrier frequency is applied between the innermost grid and cathode, and the microphone current between the middle grid and cathode. The outermost grid, instead of being connected directly to the cathode, is suitably biased to offset the tendency to develop a "falling" characteristic.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and H. J. Round.

DIRECTION-FINDING RECEIVERS

Application date, 4th September, 1931. No. 388816

A factor which tends to blur the theoretical zero-point in D.F. reception is inherent "pick-up" by the tuning-coils. The invention consists in



No. 388816

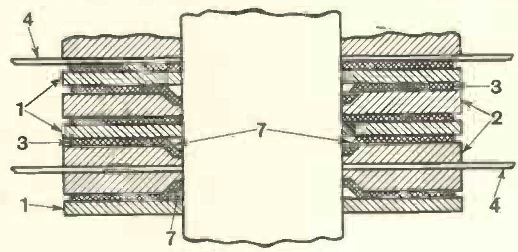
applying, at one or more suitable points in the receiving circuit, a balancing component of such magnitude and phase as to eliminate undesired signals due to this effect. The ordinary rotating frame aerial *A* is coupled to the first H.F. amplifier *V*, the anode circuit of which is coupled at *L* to the next amplifier *V*1. The output circuit also comprises a coil L1 which is so mounted that both the degree and sense of its coupling to a third coil *L*2 can be varied at will. The desired balancing component is derived from an auxiliary aerial *A*1 through an amplifier *V*2. In operation the D.F. set is first carefully tuned to the desired signal. The frame aerial *A* is next disconnected at the points marked *X*, and the coils *L*1, *L*2 are adjusted until any inherent pick-up signal disappears. If the frame aerial *A* is now again connected in circuit, a clear-cut zero is obtained.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and F. Woods.

DRY-CONTACT RECTIFIERS

Application date, 8th September, 1931. No. 389096.

In order to prevent accidental short-circuiting between the metal bodies of the oxide-coated rectifying discs 1 through the interposed soft-metal



No. 389096

washers 2, particularly at the inner edges where the washers may come into contact with the uncoated (unoxidised) portions of the discs, auxiliary washers 3 with inturned ends 7 are inserted, as shown, between the rectifying elements 1 and the lead washers 2. The usual cooling-fins are shown at 4.

Patent issued to R. G. Sell and The Westinghouse Brake and Saxby Signal Co., Ltd.

SUPERHETERODYNE RECEIVERS

Convention date (U.S.A.), 13th February, 1931.
No. 389026

A superheterodyne circuit with automatic volume control is described in detail, the radio-frequency circuits being made sharply selective whilst the intermediate frequency stages are deliberately given a broad resonance curve, in order to cover the essential side-bands and at the same time to tolerate a moderate amount of "mistracking" between the H.F. and local-oscillator tuning. The first two valve-stages in the I.F. amplifier are coupled together by a doubly-tuned and tightly-coupled transformer, whilst the second stage consists of a singly-tuned transformer adjusted to have a sharp resonance peak located between the double humps of the resonance curve of the first I.F. coupling.

Patent issued to Hazeltine Corporation.

MAGNETIC-WIRE SOUND-RECORDERS

Application date, 4*th September*, 1931. *No.* 388821

Instead of passing the tape or wire of a magnetic sound-recorder through the gap between two electro-magnets of the open type, it is taken between two projecting pole-pieces of a circular or other closed-circuit core, so that the recording-tape shunts a magnetic flux closed on itself. This avoids over-saturation of the iron parts, and consequent distortion. In addition the mechanical force on the record is comparatively small, so that undesirable vibrations and their resultant magnetic reactions are reduced to a minimum.

Patent issued to G. Liguori.

WIRED WIRELESS SYSTEMS

Application date, 13*th January*, 1932. *No.* 388901

Audio-frequency currents as used in L.F. broadcast rediffusion are supplied at low voltage (for instance a maximum of 4 volts) over an A.C. distribution network carrying a normal load of 220 volts in single or multi-phase. Harmonic filter circuits are provided, and comprise couplings anti-resonant at power frequency, in series with couplings resonant at power frequency. The inductances of the anti-resonant couplings may be provided with secondary windings which are energised from the power supply.

Patent issued to E. Hallowell and Northern Utilities Trust, Ltd.

LOUD SPEAKERS

Convention date (*U.S.A.*), 4*th October*, 1930. *No.* 389839

In moving-coil speakers with a direct-acting diaphragm, the latter is usually designed to act as a piston over the lower range of frequencies up to say 800 cycles, and as a wave-type radiator for the higher frequencies. Usually the mass reactance of the vibrating system is the predominating impedance, resulting in a " mass controlled " device. In such an arrangement the efficiency is inherently low, most of the applied force being expended in accelerating the vibrating system, and but little in the useful work of producing sound. According to the invention the diaphragm is given the form of the surface of revolution of a straight or curved line, and the scalar magnitude of the mechanical impedance of the driving coil and its input circuit is made equal to the scalar impedance of the vibrating parts, at a frequency between the lowest frequency at which the diaphragm operates as a piston and that at which it breaks up into a complex or wave motion. The arrangement is stated to improve the overall efficiency, and also to suppress the main diaphragm " resonance " effect.

Patent issued to Electrical Research Products Inc.

SHORT-WAVE GENERATORS

Application date, 21*st January*, 1932. *No.* 389233

A 3-metre generator of the magnetron type comprises a split-anode surrounding an incandescent cathode, the two electrodes being subjected to a strong magnetic field. The parallel leads from each half of the anode are bridged, inside the valve, by a movable cross-piece to form a tuned Lecher circuit, which is completely enclosed in the glass bulb. The bridge-piece is supported on an extended glass fork, which is notched at intervals to allow the bridge to be moved from point to point to vary the tuning. In operation the valve is mounted horizontally so that the bridge-piece is brought close to, without actually touching the anode leads, so as to form a capacity shunt.

Patent issued to The M-O Valve Co., Ltd., and E. C. S. Megaw.

Convention date (*Germany*), 11*th July*, 1931. *No.* 389346

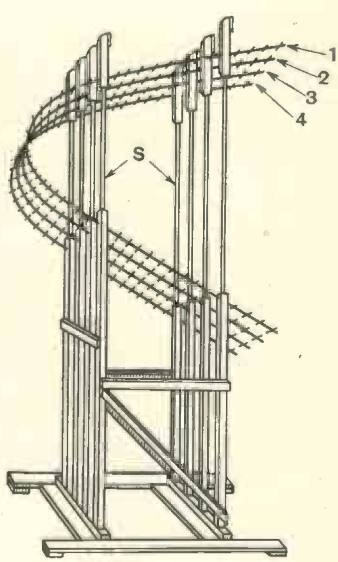
A valve oscillator of the Barkhausen-Kurz type, for generating wavelengths measured in centimetres, is tuned by means of an extended Lecher circuit which is characterised by the provision of variable shunt capacities at each of the several voltage nodes. The capacities may be formed by suitably bending the Lecher wires at the points in question.

Patent issued to Telefunken Ges. für drahtlose Telegraphie m.b.h.

SHORT-WAVE AERIALS

Application date, 11*th September*, 1931. *No.* 389142

A short-wave directional aerial consists of one or more wires or tubes 1, 2, 3, 4, bent into parabolic form, and mounted on an insulating stand *S*, as shown. Each of the main wires is fitted with a series of transverse radiators, after the fashion of a herring - bone. The transverse radiators may be fitted with adjustable end-pieces for tuning purposes, or small end-discs may be provided to increase the capacity - coupling between one parabolic aerial and another. The system may be directly energised, or it may serve as a reflector for a single energised oscillator located at the focal point. Steam or hot water may be circulated through the main tubes when it is necessary to dry them out or to thaw off frost or snow.



No. 389142

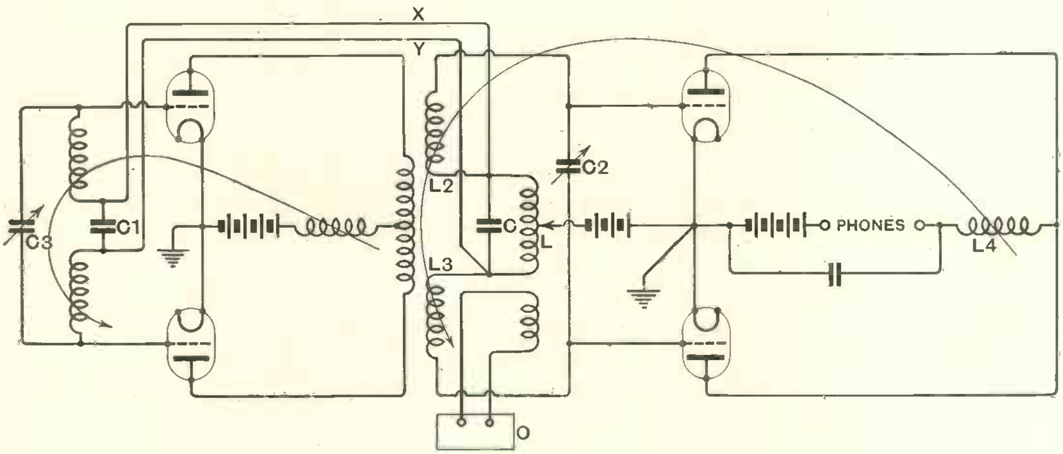
Patent issued to Marconi's Wireless Telegraph Co., Ltd., and G. A. Mathieu.

SUPER-REGENERATIVE RECEIVERS

Convention date (U.S.A.), 12th June, 1931.
No. 389326

Two super-regenerative amplifiers are coupled in direct cascade, a common "quenching" frequency being applied to both stages simultaneously. The quenching oscillations from a generator *O* are fed to a coil *L* tuned to the same frequency by a fixed condenser *C*, which is connected in parallel through leads *X*, *Y* with a similar fixed condenser *C*1 in the input of the first stage. The coils *L*2, *L*, L3 in the input circuit of the second stage are tuned to the signal frequency by a variable condenser *C*2, while the split coils of the first input are similarly tuned by a condenser *C*3. The output coil *L*4 of the second stage is back-coupled to the input coils to maintain the system in self-oscillation, a similar back-coupling being effective between the output and input coils of the first stage. Both stages operate on the push-pull principle, the grids of each pair of valves being "quenched" alternately.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.



No. 389326

D.F. INSTALLATIONS

Convention date (Germany), 16th July, 1931.
No. 389351

Relates to aircraft apparatus of the type in which the critical bearing is determined by switching two separate aerials alternately into circuit in different "senses." In flight it is desirable to maintain the aerial in fixed orientation with the fore-and-aft line of the vessel, so as to minimise wind resistance and facilitate stream-lining. The usual rotatable frame aerial is accordingly replaced by a fixed one, and means are provided to apply a compensating factor, when, for instance, the machine is being flown so as to compensate for wind-drift. This may be effected either by inserting suitable resistances in the coupling-circuits, or by varying the relative duration of the switching periods as between one "sense" and the other.

Patent issued to Telefunken Ges. für drahtlose Telegraphie m.b.h.

PHOTO-ELECTRIC CELLS

Convention date (Germany), 11th December, 1930.
No. 389198

In order to increase the response of a photo-electric cell to a given light stimulus, the cell is made in two divisions. One part contains the sensitive material in a high vacuum whilst the other is gas-filled. The two chambers or divisions are separated by a thin metal foil, which is ordinarily gas-tight but is capable of being penetrated by high-velocity electrons. In operation the electrons emitted from the photo-sensitive material are accelerated by a highly-positive anode, and pass through the foil membrane into the gas-filled chamber, where they ionise the gas molecules and liberate a copious supply of secondary electrons, thereby augmenting the effective output from the cell.

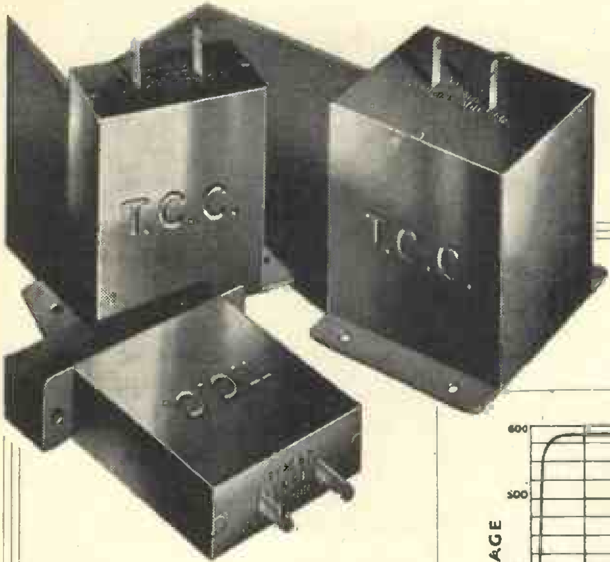
Patent issued to Telefunken Ges. für drahtlose Telegraphie m.b.h.

SUPERHETERODYNE CIRCUITS

Application date, 17th September, 1931. *No.* 389505

Relates to a superheterodyne receiver fitted with a simple switching scheme to render it suitable for receiving signals on wavelengths between 200–2000 metres and also between 10–70 metres. For normal reception the first valve operates as a high-frequency amplifier, the second as a first detector, and the third as an intermediate-frequency amplifier, a separate local oscillator being provided. When switched over to the short-wave band, the first valve operates as a combined first detector and oscillator, whilst the second becomes the first I.F. amplifier. Simultaneously the short-wave coil short-circuits the normal input coil, and the grid of the local oscillator valve is connected to ground to prevent heterodyning.

Patent issued to Kolster Brandes, Ltd., and W. S. Percival.



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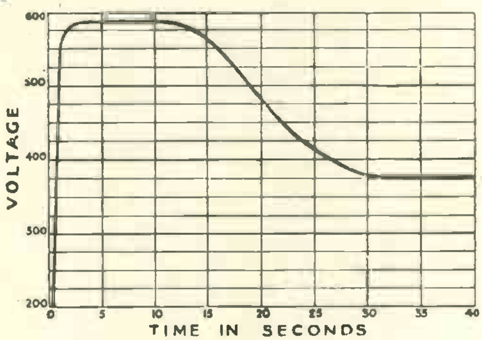

The above graph shows voltage overload when an A.C. Receiver is switched on.

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