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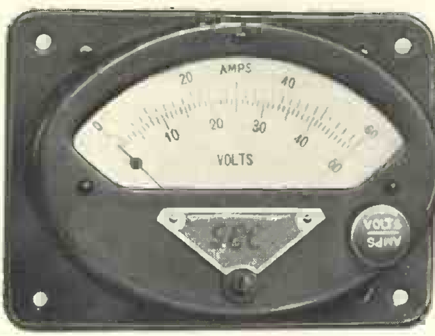

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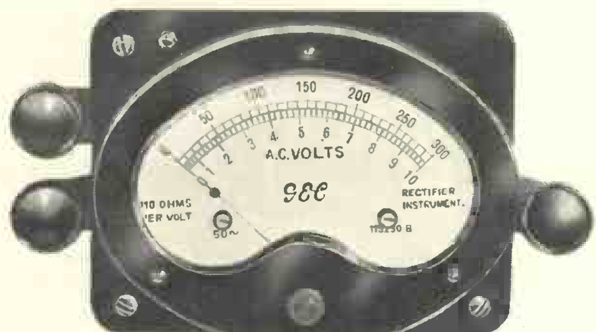

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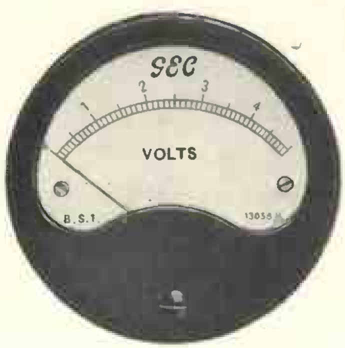

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THE

WIRELESS ENGINEER

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VOL. X. FEBRUARY, 1933. No. 113

Editorial

The Principles of Electromagnetism

A BOOK with this title, written by Mr. E. B. Moullin, has recently been published by The Oxford University Press (pp. vii + 279, price 17s. 6d.). In the preface the book is said to be a preliminary and companion volume to a book on the Dynamo which the author hopes to publish shortly, and is also stated to be intended primarily for those students who have an engineer's turn of mind. It is divided into five chapters dealing respectively with (1) the elements of magnetism; (2) the second law of electrodynamics; (3) iron in a magnetic field; (4) equations of electromagnetism and some special problems; (5) Maxwell's equations and the electromagnetic field.

In writing a textbook of electromagnetism one must decide whether an electric charge or an electric current or magnetism shall be taken as the fundamental conception from which the system is to be developed. Historically, magnetostatics and electrostatics were developed as two independent systems along parallel lines, the one based on a unit magnetic pole and the other on a unit electric charge. The distinction between these two basic conceptions is important. Definite electric charges can be given to small spherical conductors and these charges are unchanged by immersing the spheres in a liquid or gaseous dielectric. The formula $f = e_1e_2/\kappa r^2$ thus gives a definition of the dielectric constant of the medium. We are not discussing experimental difficulties, but conceptions. In basing our definitions on electric charges—or on electric currents—we are dealing with realities of a fundamental nature. When, however, one attempts to build up a similar system starting from unit magnetic pole one finds oneself floundering in a world of make-believe. Instead of the basic simplicity of an electric charge one has the complexity of permanent magnetism and the assumption of a north pole concentrated at a point without any disturbing south pole. This imaginary pole is supposed to have something called pole strength which is defined by the formula $f = m_1m_2/r^2$ in a vacuum. If now the poles are immersed in a medium of permeability μ the formula is written $f = m_1m_2/\mu r^2$, but it should be pointed out that this does not give a definition of μ because we do not know what happens to the strength of the poles when a permanent magnet is immersed in a medium of another permeability. To say that it is assumed that a unit pole still remains unit pole is meaningless since this is equivalent to saying that if it were removed from the medium to a vacuum it would still repel a similar pole 1 cm. away with a force of 1 dyne. Polarity is not a definite quantity of something like an electric charge, but merely a condition which may change—and presumably does change—when a permanent magnet is transferred to a different medium. If one defines μ in some other way then the formula $f = m_1m_2/\mu r^2$ can be taken as a definition of pole strength in the medium. If, on the other hand, one says that by the strength of the pole remaining unchanged in another medium, he means that the total magnetic flux remains the same, he has thereby deserted the unit pole in favour of a system based on a definition of magnetic flux.

Although then the unit pole as a mathematical abstraction may have useful applications in developing the theory of magnetic fields, the actual pole of a permanent magnet, even when idealised, forms a very unhappy foundation on which to build a system of units or from which to develop the principles of electromagnetism. It is interesting to consider how electromagnetic science, its conceptions and its units, would have developed if there had been no such thing as permanent magnetism. The magnetic field would have been regarded from the first as an electrical phenomenon and would undoubtedly have been defined electrically without reference to unit poles.

A "Repugnant" Definition

We opened the book under review hoping to find that the author had adopted some such plan, but we were soon disillusioned, for his opening section is quite pre-Oersted; he even says that the *magnetism* is mainly concentrated in small regions near the ends of the bar. It is true that almost the whole of page 2 is devoted to explaining that the unit pole is make-believe, but these two pages must strike a thoughtful student as a very unreal basis from which to develop a very real and accurate science. There is a discrepancy between the text and the diagram on p. 6 where H_1 is the whole magnetic force in the diagram, but only a component of it in the text, and θ in the formula should be θ_1. On p. 8 it is stated that over the curved walls of a tube of force H is zero; this is using the symbol H in a very unusual manner, viz., to designate a force at right-angles to that usually designated by H. It would be interesting to learn what authority the author has for the statement on p. 13 that it was about the year 1805 that Oersted discovered that a magnetic field is produced if the terminals of a voltaic cell are joined by a wire. The vagueness of the "about" and the shifting of one of the outstanding milestones of electromagnetic science by fifteen years are both inexcusable. The following footnote on p. 14 shows that the author realised the disadvantages of this magnetic method of approach. "This definition and description of current contains no reference to the idea of flow of electric charges along the wire, and consequently is repugnant to a true electrician. . . . However, the author hopes the reader will recognise this description of current as a logical and possible one, although undesirable because of other known facts of electricity which do not concern us at present." We certainly agree with the author as to the repugnance and undesirability—and we trust that this will be counted to us as a sign of true electricianship—but we wish now to discuss another matter which the author has treated in a way not entirely to our liking.

The Wave Analogy

The term "electromagnetic waves" suggests the propagation of electromagnetic disturbances through space in a way analogous to that in which mechanical waves are transmitted through gaseous, liquid, or solid media. Now, in all these cases the mechanism and velocity of propagation depend upon two properties of the medium, by virtue of which energy can be stored in two different forms; by virtue of its elasticity energy can be stored by a static displacement and by virtue of its mass energy can be stored by motion. The velocity of wave propagation depends upon these two properties, each of which can only be expressed as the relation between two phenomena which it is convenient to regard as cause and effect. Elasticity is expressed as the relation between stress and strain, and these must be of different natures, otherwise the relation between them would be a pure numeric and not a property of the medium. Similarly, mass can be expressed as the relation between force and acceleration which again must be of different natures.

Now surely we are justified in applying this analogy to form a mental concept of the mechanism of propagation of electromagnetic waves. Energy can be stored in a medium in two forms, one electric and the other magnetic. The only way of expressing the two properties of the medium which are here concerned is as the relation between two phenomena which may conveniently be regarded as cause and effect. The one property is known as the dielectric constant which may be defined as the relation between electric force E and electric displacement D, which must then be of different natures. The other property is known as permeability and is the relation between magnetising force H and magnetic induction B, which also must be of different natures. The velocity of wave-propagation depends on these two properties of the medium or space through which the wave is propagated.

It is possible, of course, to use the terms dielectric constant and permeability to designate merely the relative values of these properties for any material medium as compared with a vacuum, and when so used they become mere numerics. When Mr. Moullin says, on p. 274, "μ is a mere number" and adds a footnote, "For a contrary view, see Heaviside Electromagnetic Theory, vol. 1, p. 349," both views are correct; it all depends on what one means by μ. If μ is regarded as a mere number and B and H therefore of the same nature it is a pity to waste two letters of the alphabet on them with resulting confusion, for from this point of view H is merely the value of B in a vacuum and might with advantage be called B_0. This would remove all doubt and discussion, for everyone would agree that B and B_0 were magnitudes of the same nature and their ratio μ a mere number. Most electrical engineers regard H as a symbol for $4\pi/10$ times the ampere-turns per cm. and as representing the magnetising force which produces B_0 and B. This, we think we may safely say, represents Heaviside's interpretation of Maxwell's conception.

The Engineering Point of View

When a load of so many tons is applied to a specimen in a testing machine, the mechanical engineer pictures the strain at any point as being caused by a stress acting at that point. The load on the specimen is the integral of all the stresses. In a somewhat analogous way when a current passes round a magnetising or field coil, the electrical engineer pictures the magnetic induction or flux density B at any point as being produced by a magnetising force H acting at that point, and the total magnetomotive force or ampere-turns is the integral of H around the magnetic circuit. Although the mechanical engineer may not be able to measure the stress, but have to deduce it from the strain which it produces, the two conceptions are quite distinct, and electrical engineers are equally justified in regarding as two entirely distinct conceptions of different natures the magnetic induction B and the magnetising force H which produces it, although the units of measurement may be so chosen that in a vacuum they are numerically equal.

All this is quite outside any theories of the nature of magnetisation and dielectric polarisation. When an engineer states Young's modulus he regards the material as perfectly homogeneous and does not think of molecular structure or the nature of atomic cohesion. Similarly, when an electrical engineer states permeability or dielectric constant, he regards the medium as homogeneous and is not concerned with its molecular structure, nor with the impenetrable riddle of empty space, nor with the nature of the molecular mechanism whereby the permeability or dielectric constant of a material is increased. Our fear that Mr. Moullin's point of view might represent the teaching of the Cambridge School was dispelled on turning to the treatise on Wireless by Mr. L. B. Turner, a lecturer at Cambridge University. There, on p. 17, we find two separate sections, one headed "stress in medium," under which H is defined, and another headed "strain in medium," under which B is defined. We were also pleased to note that Mr. Turner emphasised that "the magnetic pole, unlike the electric charge, is purely a mathematical abstraction." What happens to a pure mathematical abstraction when it is transferred to another medium?

The recognition of H as the cause of B has led to the use by many writers of the term magnetising force in preference to the older and less definite magnetic force, but Mr. Moullin appears to use the two terms indiscriminately; both forms appear on p. 109, for example, within a few lines. The author says on p. 110, "Some writers object to treating B and H as quantities of the same character, though they do not object to the equation $B = H + 4\pi I$." In our opinion this should always be written $B = B_0 + 4\pi I$.

Modern Views on H and B

Lest readers might suppose that our views on this subject differed from those of other electrical engineers, we venture to quote from several recent publications. In his "Continuous Wave Wireless Telegraphy," Dr. Eccles says, "It has been found necessary or at least convenient to conceive that magnetic force produces wherever it acts a phenomenon called magnetic flux or induction, formally analogous to electric strain, and the connection between force and flux density has been settled in accordance with the equation $B = \mu H$." He also says, "From mechanical analogy we picture the strain to be due to electric stress. The *stress* is called electric force by some authors, electric intensity by others. The strain was called electric induction by Faraday, displacement by Maxwell, polarisation by J. J. Thomson."

After working at the subject for some years a Committee of the Verband Deutscher Elektrotechniker published a report on Magnetic Definitions and Units in 1930 (*see E.T.Z.*, April 24th, 1930). In this Report B and H are regarded as magnitudes of essentially different natures, the relation between them in a vacuum being called the induction constant of space; moreover, unit magnetic pole is never mentioned except in a footnote as follows, "The Committee decided not to define pole strength or quantity of magnetism, because of the impossibility of fixing the so-called distance between the poles in a way free from objection. If the proposed system of definitions is accepted there is no further need for such a definition."

In the Kelvin Lecture on the Work of Oliver Heaviside, recently delivered by Dr. Sumpner, we read, "H is reckoned per unit length, B per unit area of cross-section . . . B and H differ in physical nature as much as an ampere does from a volt. A current and a voltage can be made numerically equal by adopting suitable units, but no choice of units can possibly make an ampere the same kind of thing as a volt."

The Oersted and the Gauss

At the last meeting of the International Electrotechnical Commission it was decided to give different names to the units of magnetising force and magnetic induction, Oersted and Gauss being the names recommended.

These questions are, of course, matters of opinion, but we think that in writing a book intended for electrical engineers, the author should have realised that the point of view of Oliver Heaviside, from which he dissents, has been generally adopted, and forms the basis of current conceptions and nomenclature not only in this country but in other countries where Heaviside is honoured as one of the great interpreters of Maxwell. In our opinion Mr. Moullin, who has recently removed from Cambridge to Oxford—" that home of lost causes,"—shows a tendency towards forcing post-Maxwellian wine into pre-Maxwellian bottles.

In the preface the author thanks a Mr. B. C. Hague for permission to reproduce figures from a book entitled, "Electromagnetic Problems in Electrical Engineering," but we would point out that not only many figures, but also considerable portions of text appear to have been taken with very little modification from the well-known book by Dr. B. Hague bearing the same title, and we are very surprised not to find anywhere in Chapter IV so much as a footnote of reference to the fact. This is an oversight which should be rectified on the first opportunity.

Although we have discussed at some length those features of the book with which we do not agree we would emphasise that the greater part of the book contains standard material treated in an admirable manner.

An excellent feature is the large number of examination questions together with answers at the ends of the first four chapters; these will be of special advantage to students.

G. W. O. H.

Grid Current Compensation in Power Amplifiers*

By W. Baggally

WHEN valves are used in the output stage of an amplifier in the ordinary manner to deliver undistorted power to some kind of load, say, a loud speaker, the grid acceptance (or permissible grid swing), and hence the amount of power delivered without appreciable distortion, is limited by several factors, one of which is the grid current which flows when the grids swing beyond zero volts into the positive region.

Assume that the grid is being driven by a generator of voltage $e = E \sin pt$ and internal impedance Z; then if the maximum instantaneous grid current is I, the positive peak of grid voltage is E-IZ volts above the operating point, whereas the negative peak is E volts below.

The difference between the positive and negative amplitudes is IZ volts; this represents the distortion of the input waveform, and for a given valve and applied voltages it is proportional to Z.

It follows that the amount of grid current distortion depends entirely on the properties of the input circuit and that it is a mistake to think of this distortion as taking place in the valve; for example, if the impedance of the input generator were zero, there could be no grid current distortion at all, no matter what the actual current in the grid circuit might be.

In order to find out what is happening in any particular case, it is necessary to plot grid current curves; this is, however, complicated by the fact that the shape of the grid current curve depends on the value of the load in the anode circuit, and that in trying to plot the static curves of a large valve with positive bias on the grid, the anode would probably melt before we had time to take any readings.

This latter difficulty may be obviated by putting a suitable negative bias on the grid and superimposing an alternating voltage to take the grid into the positive region on the peaks.

Then we can measure the peak voltage with a slide-back meter, and the maximum instantaneous current by shunting the slide-back meter across a resistance in the grid circuit and measuring the maximum P.D. across the resistance.

Plotting the peak current against the peak volts will give the required curve without damaging the valve and we can repeat the process for different anode loads if desired; also by dividing the voltage by the current at each point and plotting the result against the corresponding voltage we get a curve connecting the input swing with the minimum instantaneous grid-to-filament resistance.

The problem of designing a power amplifier which shall be free from grid current distortion divides itself into three parts as follows: first, to determine the optimum load and operating voltages for the valve (it is to be noted that these are not in general the same as those obtaining when the grid swing is confined to negative voltages); second, to determine the grid acceptance and minimum instantaneous resistance of the grid-filament path under these optimum conditions; third, to design an input circuit (penultimate stage) which is capable of driving this grid circuit without appreciable distortion.

A practical example will help to make the matter clear and give some idea of the order of magnitude of the various quantities involved.

Consider the case of two DA60 valves connected in push-pull; the permissible anode dissipation is 60 watts and maximum anode voltage is 500, A.C. resistance and voltage factor are 835 ohms and 2.5 respectively.

Having arranged the input circuit as presently explained so as to avoid grid current distortion, the grids were fed with pure sine A.C. at 1,000 cycles frequency and the output power measured for various values of the output load resistance, the amount of distortion being adjusted by variation of the A.C. voltage on the grid to

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

5 per cent. total harmonics in each case by means of a suitable distortion meter; the anode voltage and current were 445 volts and 140 mA. and negative grid bias 100 volts during the tests, the results being shown in Fig. 1 (*A*), from which it is seen that the optimum load for the two valves is about 5,000 ohms (2,500 ohms per valve), the output being 50 watts.

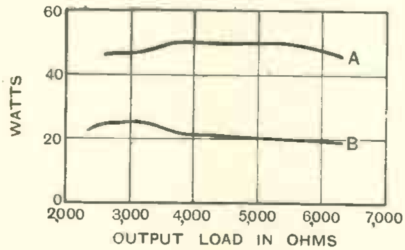


Fig. 1.

For comparison, Fig. 1 (*B*) shows the result when the same two valves are operated in the normal manner (no grid current), anode voltage, anode current and grid bias remaining as before, from which it will be seen that an increase of 100 per cent. in the output has been obtained by legislating for grid current, without any increase in the power supply.

Setting the output load at 5,000 ohms and plotting the grid current curve as shown above, gives rise to Fig. 2, which also shows the minimum instantaneous resistance curve.

The voltage swing on each grid required to put out 50 watts into 5,000 ohms is found to be 175 volts peak, while the negative bias is 100 volts; this, together with Fig. 2, gives all the data required to design the input circuit.

In order to get some idea of the order of magnitude of the distortion introduced by the finite impedance of the input circuit, let us assume that the positive voltage wave is depressed an amount *d* by the flow of grid current; *i.e.*, the positive and negative waves are both sinusoidal but of different amplitudes, the difference being equal to *d* volts.

This probably represents the worst possible case, since we are virtually assuming zero grid bias and a constant grid-filament resistance on the positive wave equal to the minimum value reached.

If we neglect the effect of the voltage wave distortion on the current, we have that $\frac{d}{E} = R/(R + R_g)$; where R = internal resistance of input circuit and R_g = grid-filament resistance of valve, the Fourier harmonic series of the wave form under discussion being

$$e = E \cos \omega t - d\left\{\frac{1}{\pi} + \frac{1}{2}\cos \omega t + \frac{2}{1 \cdot 3 \cdot \pi}\cos 2\omega t - \frac{2}{3 \cdot 5 \cdot \pi}\cos 4\omega t + \ldots\right\}$$

Inserting the value of d and evaluating the coefficients we have

$$e = E\left[\cos \omega t - \frac{R}{R + R_g}\{.318 + .5 \cos \omega t + .212 \cos 2\omega t - .0424 \cos 4\omega t + \ldots\}\right]$$

in which the only important harmonic is the second.

The percentage second harmonic is given by $H = 42.4R/(R + 2R_g)$ and when $R = R_g/4$ it amounts to 4.7 per cent., which may be taken as a maximum allowable figure in most cases.

We see from Fig. 2 that in our example $R_g \doteq 4{,}000$ ohms with the grid 75 volts positive, so that the input circuit resistance must not exceed 1,000 ohms and must deliver a total voltage excursion of 350 volts without appreciable distortion.

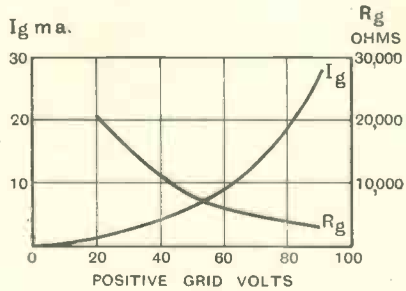


Fig. 2.

These requirements are very severe, and if we attempt to comply with them in an amplifying stage of normal design, we shall probably be compelled to use in the penultimate stage, nearly as large a valve as in the power stage which we are trying to drive, thereby sacrificing most of the advantages of the method.

It might be thought that we could reduce the impedance of the drive circuit by using a step-down transformer, but although this is done in the American "Class B" amplifiers, using special high magnification output valves, it is not usually easy to get sufficient undistorted voltage from the secondary of the transformer to swing our British low impedance triodes.

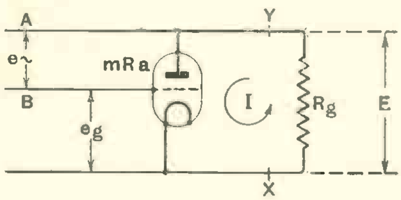


Fig. 3.—*External voltage applied between grid and anode.*

The arrangements now to be described have the advantage of virtually reducing the impedance of the penultimate stage to a low value without in any way interfering with the voltage handling capacity, though when used in this way, the stage does not amplify the applied voltage, but in fact introduces a small amount of attenuation.

This is not usually of any consequence, as it merely involves increasing the gain of the previous amplifying stages somewhat.

Consider Fig. 3, in which the externally applied voltage is between grid and anode and R_g represents the grid-filament path of the power valve, and let R be the resistance when looking to the left into the network from the points XY, also let $k = R_g/(R_g+R_a)$ and the suffix 1 signify that value of the quantity which obtains when R is made infinite, then the following relations obtain :

$$e + e_g + E = 0$$

$$E = mke_g = -mk(e + E) = -emk/(1 + mk)$$

$$k_1 = 1$$

$$\therefore \quad E_1 = -em/(1 + m) \qquad \text{(1)}$$

$$I = E/R_g = -emk/R_g(1 + mk)$$

$$R + R_g = E_1/I = -emR_g(1 + mk)/(-emk(1 + m)) = R_g + R_a/(1 + m)$$

$$\therefore \quad R = R_a/(1 + m) \qquad \text{(2)}$$

It is thus seen that the A.C. resistance of the valve is but $1/(1 + m)$ of its usual value, and that instead of amplifying the voltage m times, the stage reduces it in the ratio of m to $m + 1$ (if R_g is infinite).

An LS5A valve, whose normal A.C. resistance and voltage factor are 2,750 ohms and 2.5 respectively, will thus have an effective resistance of 785 ohms in the above case and will drive the DA60 comfortably.

The design of circuits to fulfil the above conditions presents no difficulty, though care should be taken to see that the direct component of the grid current does not upset the bias of the power valve by having to flow through high resistances in the grid circuit, and also that the compensating action does not peter out at the lower frequencies where it is most likely to be required owing to the large amplitudes.

It is also to be noted that both the input terminals (A B in Fig. 3) are at alternating potentials above earth, so that in most cases it is necessary to feed the network through a transformer, the capacity between the windings of which might possibly have some influence on the action at high frequencies in certain cases.

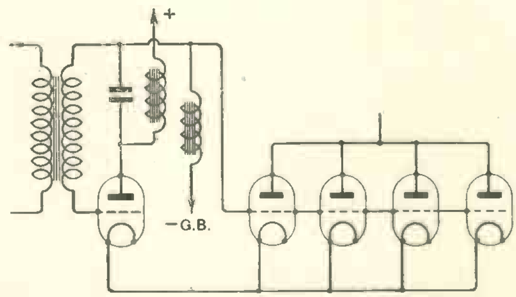


Fig. 4.—*Grid bias common to driving and output valves.*

When it is desired to drive several valves in parallel from a valve of the same type, we can use the simple circuit of Fig. 4, in which common grid bias is applied to the driving valve and the output valves ; of course, we can match up the anode currents by putting cells in the grid leads, and for push-pull we use two similar circuits back to back.

If the driving valve and power valve are of different types and require different bias voltages, we shall use some such arrangement as Fig. 5.

Finally, the following method of calculating the optimum load and power output of a grid current amplifier gives a good approximation to the measured values and does not involve much labour.

Let R = output load resistance.

I = maximum permissible instantaneous current in R

E = maximum permissible instantaneous voltage across R

consistent with freedom from distortion.

P = power in R

E_p = plate volts (D.C.)

I_p = plate current (D.C.)

$E_{min.}$ and $I_{min.}$ = minimum current and voltage in anode circuit for linear operation (determined by inspection of characteristic curves)

D = maximum anode dissipation of valve.

Then P will be given by $I^2R/2$ or $E^2/2R$, whichever is least; as R changes, one of these quantities increases whilst the other decreases, so that P will have its maximum value when they are equal.

Equating them we have

$$R = E/I \quad \ldots \quad (3)$$

which is not a statement of Ohm's law!

Further, a little consideration will show that $E = E_p - E_{min.}$ and $I = I_p - I_{min.}$, also that $I_p = D/E_p$, so that $I = D/E_p - I_{min.}$; substitution in (3) gives

$$R = (E_p - E_{min.})/(D/E_p - I_{min.}) \quad \ldots \quad (4)$$

we also obviously have

$$P = EI/2 = \tfrac{1}{2}(E_p - E_{min.})(D/E_p - I_{min.}) \quad (5)$$

Reverting to the example of the DA60 valve, $E_{min.}$ and $I_{min.}$ are found from the

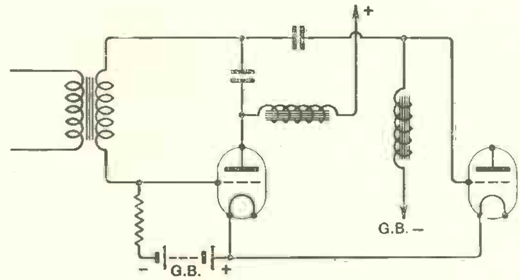


Fig. 5.—*Circuit where different values of bias are required.*

characteristic curves to be about 100 volts and 15 mA. respectively; by evaluating equations (4) and (5) we find R = 2,800 ohms and P = 20 watts; the measured values for a single DA60 being R = 2,650 ohms and P = 19.5 watts, which is sufficiently close.

The reason for the larger power in Fig. 1 (50 watts) is, of course, that in push-pull there is a cancellation of the second harmonic permitting the valves to deliver more power before exceeding the 5 per cent. distortion limit.

The application of high frequency currents in medical and surgical diathermy was an interesting feature of the Marconi Company's display at the recent Physical Society Exhibition. The special oscillator developed for this purpose is on the extreme left of the photograph which also shows the television photocell and reflector with its associated amplifier. The latter has a characteristic substantially flat form 10 cycles to 150 kilocycles.

Voltage Amplification with High Selectivity by Means of the Dynatron Circuit*

By F. M. Colebrook, B.Sc., D.I.C., A.C.G.I.

(Wireless Division, National Physical Laboratory).

SUMMARY.—In an ordinary tuned circuit triode or tetrode amplifying stage without retroaction, the selectivity is less than that of the tuned circuit alone. If, however, a tetrode valve is used in a dynatron or negative resistance condition, the selectivity of the amplifying stage is considerably greater than that of the tuned circuit alone, and the voltage amplification comparable with that given by the valve used in the normal manner. With a given tuned circuit at a given frequency the normal and the dynatron tetrode amplifying circuits can only be made comparable in selectivity by using a high degree of retroaction with the former. In this condition the voltage amplification given by the normal circuit will exceed that of the dynatron circuit, but the dynatron circuit has the advantage of simplicity, since no additional winding or other auxiliary apparatus is required.

The above distinction between the two types of circuit is deduced analytically and confirmed by experiments with a tuned audio-frequency amplifier.

1. Introduction

IN his original paper on the dynatron,† A. W. Hull pointed out the utility of a negative slope resistance characteristic for certain purposes of current and voltage amplification. He does not explicitly refer to selective alternating current or voltage amplification by means of a tuned circuit in series with a valve giving a negative slope resistance, but any such application is an obvious extension of his suggestions.

Such an arrangement differs from normal triode valve, tuned anode circuit amplification in one fundamental respect, and it has been thought worth while to point this out in order that the practical advantages of it may not be overlooked.

Stated briefly, the difference is as follows. The selectivity of a normal tuned single circuit or tuned transformer amplifying stage using a triode or tetrode (screen-grid) valve is, in the absence of retroaction, necessarily less than that of the tuned circuit. Under conditions of maximum sensitivity the selectivity of the stage will be half that of the tuned circuit alone, and an improved selectivity can only be obtained at the expense of sensitivity. If the circuit of the amplifying stage can be so arranged as to make use of retroaction, the selectivity of the stage can be made higher than that of the tuned circuit alone, with a corresponding increase in sensitivity. This, however, requires additional windings or other auxiliary apparatus for producing and adjusting the required degree of retroaction.

Suppose now that the valve of the amplifying stage is operated under such conditions that the slope resistance is made negative. Then it can be shown that the selectivity of the amplifying stage is always and necessarily greater than that of the tuned circuit alone and, by control of the magnitude of the negative, slope resistance can be made comparable with that given under conditions of maximum retroaction with the valve used normally. The actual voltage amplification so obtained will be comparable with that given by the valve used normally but without retroaction. It will, therefore, be less than that which can be obtained from the valve used normally but with retroaction.

Thus the negative resistance or " dynatron " tuned amplifying stage gives, without a retroactive winding or any other auxiliary apparatus, a selectivity comparable with that of a normal stage under conditions of maximum stable retroaction, though with a somewhat smaller amplification per stage. A brief presentation of the analytical side of the subject will now be given in order to explain this difference in behaviour.

2. Elementary Analysis of a Tuned Transformer Amplifying Stage

The circuit considered is that shown in Fig. 1. For analysis this will be transformed to the equivalent circuit shown in Fig. 2, where μ and R_a are the voltage factor and

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

† *P.I.R.E.*, 1918, Vol. 6, pp. 5–35.

slope internal resistance of the valve. In order to avoid complication it will be assumed that the interelectrode capacities of the valve play no significant part in the operation. With a screen-grid valve this assumption will be valid even at radio-frequencies.

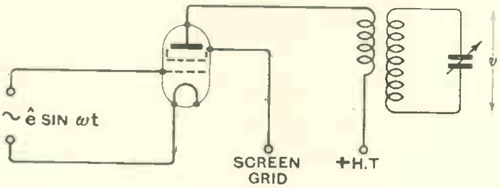


Fig. 1.

It is shown in Appendix 1 that, assuming X_a^2 (*i.e.*, $\omega^2 L_a^2$) is small compared with R_a^2, the amplification (v/e) is given by

$$\frac{v}{e} = \frac{L}{M} \frac{\omega^2 M^2/R}{R_a + \omega^2 M^2/R} \cdot \mu$$

$$= \frac{L}{M} \cdot u \cdot \frac{x}{1 + x}$$

where $$x = \frac{\omega^2 M^2/R}{R_a}$$

It is also shown in Appendix 2 that the selectivity of the stage is

$$\text{selectivity} = \frac{\omega L}{R + \dfrac{M^2\omega^2}{R_a}}$$

$$= \frac{\omega L}{R} \frac{1}{1 + x}$$

Therefore, since the selectivity of the coil is $\omega L/R$

$$\frac{\text{Selectivity of amplifying stage}}{\text{Selectivity of coil alone}} = \frac{1}{1 + x}$$

The same formulae, but with L written in place of M, apply to the case of a single tuned circuit in place of the tuned transformer. For the transformer it is well known that the optimum ratio is such that

$$\frac{M^2\omega^2}{R} = R_a$$

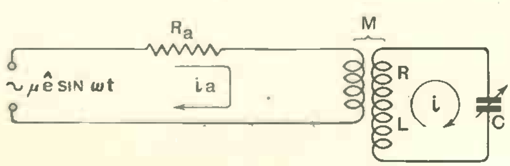


Fig. 2.

This makes $x = 1$, so that the selectivity in the optimum case (*i.e.*, highest amplification) is half that of the coil alone.

Where a single circuit is used in place of the transformer, x is required to be large for efficient amplification, but the larger x is made the greater is the loss of selectivity in the stage as compared with the coil alone.

Assume now that the screen-grid and anode voltages are interchanged, so that the anode is at a lower potential than the screen-grid. The type of characteristic obtained is shown in Fig. 3, where it is seen that the internal slope resistance R_a is now negative, and of magnitude determined by the control grid bias. It also appears that no constant value can be assigned to μ, which depends to a great extent on the other electrode potentials. It will be useful, however, to

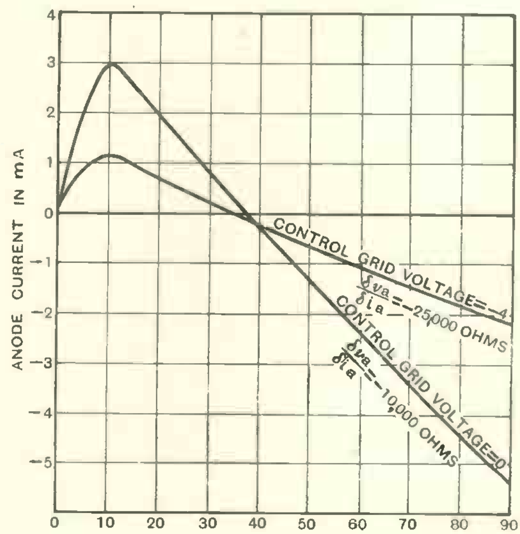


Fig. 3.—*Negative resistance characteristic of a screen-grid valve. Screen-grid voltage 120.*

retain the symbol on the understanding that it implies a mean value over the range of the voltage changes involved. The same amplification and selectivity formulae will then apply to an amplifying stage with the valve in this condition, but R_a, and consequently x, will now represent negative quantities.

For a given value of M (*i.e.*, a given transformer ratio) the value of x can be controlled by means of the control grid bias. Provided $\omega^2 M^2/R$ is not smaller than the lowest attainable value of R_a, x can be made nearly equal to minus one, in which case both the amplification and selectivity rise to large values. Up to the limit of stability the magnitude of x is always less than 1, so that the selectivity of the stage is always greater than that of the coil alone.

The value of μ in the dynatron condition will be much less than the value corresponding to the normal use of the valve. With a fine control of grid bias, however, the denominator of the expression for v/e can be made so small that the resulting amplification is as large or even larger than that given by the normal circuit without retroaction.

In the dynatron case there is no optimum transformer ratio with respect to amplification, but if the coil is such that ω^2L^2 is considerably larger than the lowest practicable value of R_a, a step-up ratio can usefully be employed.

It should be noted that a similar transformation of the formulae for the normal circuit becomes possible, if, by means of retroaction, ω^2M^2/R, or ω^2L^2/R as the case may be, can be made negative. It is found experimentally that such conditions can, in fact, be set up and the selectivity of the stage made higher than that of the coil, with a corresponding increase in amplification. The selectivity so obtained can be made comparable with that of the dynatron stage, and the amplification considerably higher. This, however, requires additional windings or other auxiliary apparatus for producing and controlling the retroaction. The dynatron circuit is a simpler means of producing the same high selectivity with a plain two terminal coil.

3. Experimental

The subject does not lend itself readily to exact measurement owing to the critical nature of the controls, but a number of resonance curves were taken with the circuit shown in Fig. 4, and the results obtained afforded a qualitative confirmation of the analysis of the preceding sections.

The input voltage was maintained constant (as indicated by the valve-voltmeter) for any given set of frequency variations. The second valve (an ordinary triode of the output or power type) with its associated transformer and thermojunction was simply used as a means of measuring the potential differences developed across the tuned coil. The frequency of the source was varied over the comparatively small ranges of frequency involved by means of a variable condenser, the scale of which was later calibrated in cycles per second by reference to a sonometer. Relative amplifications were measured in terms of the input voltages (determined from the input voltmeter and the input potentiometer) required to give similar output voltages as indicated by the thermo-junction and galvanometer.

The amplifying valve was an S.G.215 (screen-grid). For the normal circuit the anode and screen-grid voltages were made 120 and 60 respectively. For dynatron operation it was only necessary to interchange these voltages. The coil used was a plain solenoid of about 1,300 turns of No. 20 single cotton covered wire, inductance 0.135 henry, direct current resistance about 11 ohms.

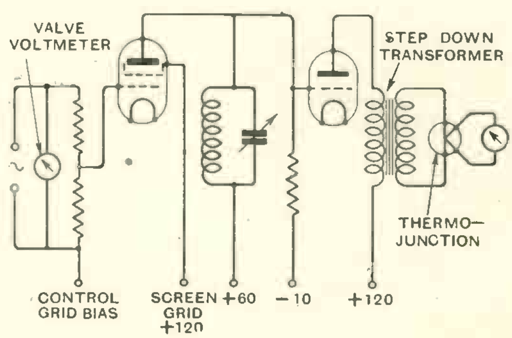


Fig. 4.

According to the formulae of section 2, the greatest differences between the selectivities given by the normal and the dynatron circuits would appear at frequencies corresponding to a relatively small tuning capacity. The curves of Figs. 5 and 6 confirm this. The ordinates of the curves are proportional to the square of the output voltage, and have been reduced to give the same maximum value for the sake of comparison.

The approximate selectivities can be calculated from the curves as follows. Writing V_r^2 and V^2 for the maximum ordinate and for some other ordinate at which the width of the resonance curve is δf cycles, then if

$$\frac{V_r^2}{V^2} = n$$

it can be shown (see Appendix 3) that

$$\text{selectivity} = \frac{\omega L}{R + \dfrac{\omega^2 L^2}{R_a}} = \sqrt{n - 1}\,\frac{f}{\delta f}$$

where f is the resonant frequency.

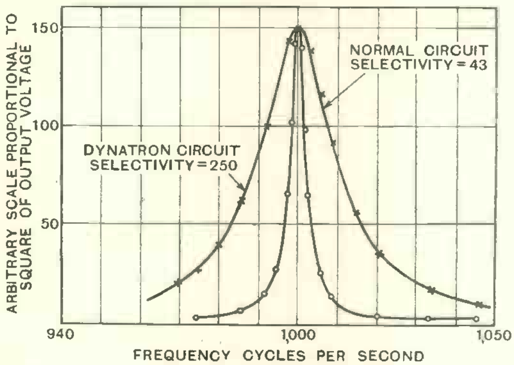


Fig. 5.—*Resonance curves of amplifying stage at 1,000 cycles per sec.*

For the curves taken at a mean frequency of 1,000 cycles per second, the selectivity with the dynatron connection was 250, and with the normal connection 43. The amplification in this case was about 20 per cent. higher with the dynatron connection. The calculated selectivity of the coil alone at 1,000 cycles was 74. (This gives about 90,000 ohms as the combined effective shunt resistance of the amplifying and output valve). With retroaction (obtained by means of a coil in the anode circuit of the output valve) a very much higher amplification was obtained with the normal circuit—about 20 times greater than the same circuit without retroaction. Even at this sensitivity, however, the selectivity was only raised to 90 as compared with the 250 given by the dynatron circuit. In a later measurement the selectivities in the two cases were determined at the extreme limits of stability and values of 620 and 2,800 were found for the normal and dynatron circuits respectively, but these were hardly practical working conditions, and the figures of 90 and 250 are more representative of perfectly stable operation.

As a check on the formulae and the method simultaneous measurements were made of the amplification and of the " band width " δf at a quarter deflection, at 1,000 cycles, using the normal connection with retroaction, the retroaction being gradually increased up to the limit of stability. An inspection of the formulae will show that the product of δf and the amplification for a given coil at a given frequency should be approximately constant. The results tabulated below can be regarded as a satisfactory confirmation of this :

Band width (δf) in cycles/sec. in $\frac{1}{4}$ output deflection.	Amplification, in arbitrary units.	Product.
37.0	4.65	172
35.6	5.10	182
30.0	5.71	171
25.6	7.17	184
19.2	9.50	183
12.0	13.5	162
5.0	35.4	177
2.8	65.7	184

Considering now the results at 4,000 cycles (using the same coil with a correspondingly smaller tuning capacity), the damping effect of the normal amplifying connection is particularly striking. The calculated selectivity for the coil alone at this frequency is 300, and the reduction to 33 in the amplifying stage indicates an effective shunt load due to the amplifying and output

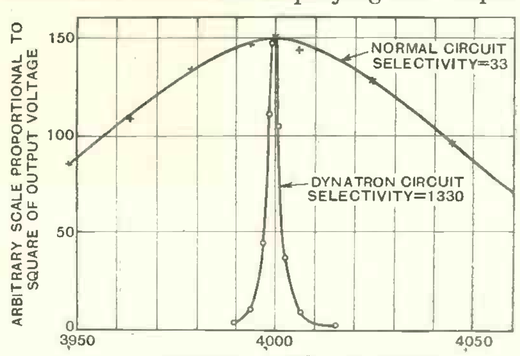


Fig. 6.—*Resonance curves of amplifying stage at 4,000 cycles per sec.*

valves of about 125,000 ohms. (It is not quite clear why this should be higher than in the 1,000 cycle case, but a variation of the input impedance of the output valve may account for it). The dynatron connection gave a selectivity of 1,330 with an amplification about seven times as great as that given by the normal connection without retroaction. The improvement in the normal connection obtained by retroaction was more marked in this case, a fairly stable selectivity of 2,000 being reached, with an amplification about 60 times that obtained without retroaction. This condition was, however, somewhat less stable than the dynatron circuit.

The measurements described, therefore, support the main conclusions arrived at by the analysis, and show that a tuned dynatron amplifying stage can be expected to give, without any retroactive winding, a selectivity comparable with that given by a normal amplifying stage under conditions of maximum stable retroaction, but that the resulting voltage amplification, though equal to or greater than given by the normal amplifying stage without retroaction, will be less than that of a normal stage with retroaction.

The author wishes to acknowledge the assistance of Mr. A. C. Gordon-Smith in making the measurements and calculations. The work was carried out in connection with the programme of the Radio Research Board, and is published by permission of the Department of Scientific and Industrial Research.

Appendix 1

The circuit equations for Fig. 2 give as the equation for v (the potential difference across the condenser C) in terms of e

$$j\omega C\left\{(R_a + jX_a)\frac{(R + jX)}{M\omega j} - M\omega j\right\}v = -\mu e$$

where $X_a = \omega L_a$ and $X = \omega L - 1/\omega C$

Assuming that

$$X_a^2 << R_a^2$$

a condition always fulfilled in practice to an accuracy of one or two per cent., the above equation can be written

$$\frac{CR_a}{M}\left\{R + \frac{M^2\omega^2}{R_a} + jX\right\}v = -\mu e$$

The resonance condition is $X = \omega L - 1/\omega C = 0$, and at resonance

$$\frac{v}{e} = \frac{\mu}{\frac{CR_a}{M}\left(R + \frac{M^2\omega^2}{R_a}\right)}$$

$$= \frac{\mu}{\frac{\omega^2 ML}{R_a}\left(R_a + \frac{M^2\omega^2}{R_a}\right)}$$

$$= \frac{L}{M}\frac{R_a + \omega^2 M^2/R}{\omega^2 M^2/R}\mu$$

Therefore voltage amplification

$$= \frac{L}{M}\frac{x}{1 + x}\mu$$

where $$x = \frac{\omega^2 M^2/R}{R_a}$$

Appendix 2

The generally accepted measure of the selectivity of the secondary of the tuned transformer of Fig. 2 is $\omega L/R$.

For the amplifying stage, put

$$\frac{v}{e} = \frac{1}{Z}\mu$$

v and e being vectors and Z a vector operator. Then the generalised formula for the selectivity of the resonance of Z is

$$\text{Selectivity} = \tfrac{1}{2}\omega\sqrt{\frac{1}{|Z|}\frac{\partial^2|Z|}{\partial\omega^2}}$$

the value of ω being that for which $\partial Z/\partial\omega = 0$.

From Appendix 1

$$|Z|^2 = \frac{C^2R_a^2}{M^2}\left\{\left(R + \frac{M^2\omega^2}{R_a}\right)^2 + \left(\omega L - \frac{1}{\omega C}\right)^2\right\}$$

Neglecting the small effect of the variation of

$$\omega \text{ on } R + \frac{M^2\omega^2}{R}$$

the double differentiation is quite straightforward, and gives the result, at resonance

$$|Z|\frac{\partial^2|Z|}{\partial\omega^2} = \frac{C^2R_a^2}{M^2}\cdot 4L^2 = \frac{4R_a^2}{\omega^4 M^2}$$

whence,

$$\text{selectivity} = \frac{\omega L}{R + \frac{M^2\omega^2}{R_a}} = \frac{\omega L}{R}\frac{1}{1 + x}$$

Appendix 3

Putting V_r for the value of V at resonance, and V for the value at some other frequency $\omega/2\pi$, then from Appendix 1

$$\frac{V_r^2}{V^2} = n = \frac{R_e^2 + (\omega L - 1/\omega C)^2}{R_e^2}$$

where R_e has been written for $R + M^2\omega^2/R_a$. Then

$$(\omega L - 1/\omega C)^2 = (n - 1)R_e^2$$

If ω_1 and ω_2 are the two solutions for ω

$$(\omega_1^2 LC - 1) = \sqrt{n - 1}\,\omega_1 CR_e$$

$$-(\omega_2^2 LC - 1) = \sqrt{n - 1}\,\omega_2 CR_e$$

Therefore $(\omega_1 - \omega_2)L = \sqrt{n - 1}\,R_e$

and if $\omega/2\pi = f$ be the resonant frequency

$$\sqrt{n - 1}\,\frac{\omega}{\omega_1 - \omega_2} = \sqrt{n - 1}\,\frac{f}{\delta f} = \frac{\omega L}{R_e} = \frac{\omega L}{R + \frac{M^2\omega^2}{R_e}}$$

i.e., $$\text{Selectivity} = \frac{\omega L}{R + \frac{M^2\omega^2}{R_a}} = \sqrt{n - 1}\,\frac{f}{\delta f}$$

The Physical Society's Exhibition
Matters of Wireless and Allied Interest

THE Twenty-Third Annual Exhibition of Scientific Instruments and Apparatus organised by the Physical Society, was held at the Imperial College, S. Kensington, on 3rd, 4th and 5th January 1933. As for many years past, the Exhibition amply fulfilled its now well-accepted function of providing a review of the continued progress in the development of measuring apparatus, and the observer was once again impressed by the degree to which electrical methods are being utilised in general physical and allied technique.

Sullivan-Griffiths universal wavemeter with interchangeable valve voltmeter and dynatron oscillator units.

Electrical Measuring Instruments

As regards general electrical instruments (*e.g.*, of the voltmeter ammeter class), there was little of very definite novelty, except that—as stated above—more examples than ever were still forthcoming of electrical instruments being used for the measuring or recording of other phenomena that could be transformed quantitatively into electrical effects.

A typical full range of instruments was naturally on view at the stand of the WESTON ELECTRICAL INSTRUMENT Co., including the standard and portable sub-standard instruments for which this Company is well known. A useful instrument was Model 301, Universal meter for A.C. or D.C.

FERRANTI, LTD., displayed a very complete range of instruments, an interesting new feature being electrostatic voltmeters, available down to the $2\frac{1}{2}$in. size, with scales reading as low as 50 volts.

NALDER BROS. & THOMPSON, LTD. showed, amongst other instruments, new "Bijou L. Type" meters with long circular scale, available as ammeters, voltmeters and wattmeters.

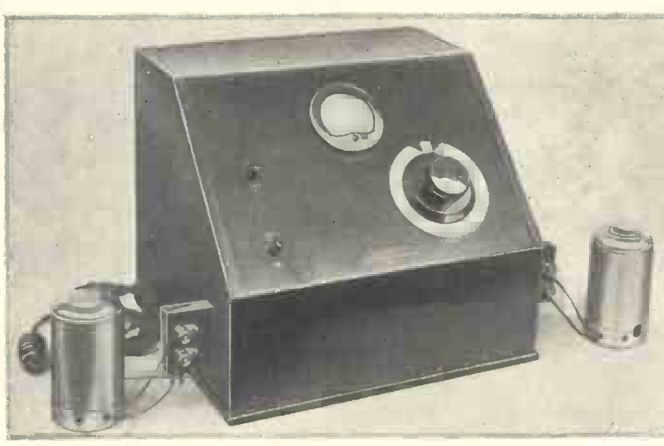
CROMPTON PARKINSON's display was mostly of the "power" class of instrument, new types being moving-iron instruments using mu-metal.

EVERETT, EDGCUMBE's display was also chiefly of "power" interest, being devoted largely to frequency control of mains supply. An interesting new instrument was a "milliampère-second" meter, while this stand also contained several typical cases utilising electrical methods, for example, magneto speed indicators for road or railway use. Instruments of this type were also shown by ELLIOTT BROS.

Instruments of the direct-reading ohmmeter type—a d.c. instrument in series with a source of voltage—are now made by most makers, a new feature of this class being a continuity tester by the RECORD ELECTRICAL Co. (with Cirscale instrument), permitting readings as low as 0.002 ohm. At the other end of the scale a new instrument of this class was shown by SALFORD ELECTRICAL INSTRUMENTS for operation from a.c. mains and developing 500 or 1,000 v. d.c. as the working source. This same firm had also a display of general instruments, including moving-iron instruments with their Gecalloy dust-core material. This Company also exhibited a mains-operated valve voltmeter of wide range (0.5 to 150 v.).

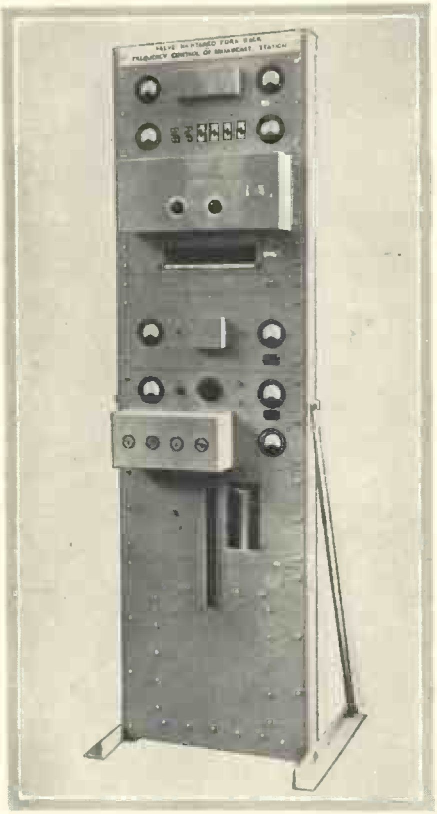
Rectifier-type instruments are now available from practically all makers and the WESTINGHOUSE Co.'s stand had samples by Ernest Turner, Everett, Edgcumbe, Cambridge Inst. Co. and a new combined A.C./D.C. Avometer. Three-range millivoltmeters were also on view at the stand of the CAMBRIDGE INST. Co.

Instruments of the magneto-generator class were shown in several new very small sizes, the RECORD



Sullivan inductance matching set for comparing screened or open coils.

Co. showing such a new type, while EVERSHED VIGNOLES had a new "Wee Megger." A similar instrument was also available for either insulation



Valve-maintained tuning fork for frequency control (Muirhead & Co., Ltd.)

or continuity testing, the scale for the latter purpose being up to 100 ohms with good openness of scale below 1 ohm.

Laboratory and Measuring Apparatus

The continued need for and progress of measuring technique makes it increasingly difficult to draw a rigorous line between apparatus of the purely "laboratory" class and measuring gear of a more "engineering" character. Apparatus of this kind was in good supply, even more so than in recent years.

The display of H. W. SULLIVAN LTD. was very extensive and devoted entirely to electrical and particularly to communication apparatus, covering standards of radio-frequency measurement, apparatus for telephonic frequencies, etc. Dynatron oscillating wavemeters were available in several types, one ranging from 30 to 10,000 m. with accuracy of 0.01% and stability of 0.001%. A new inexpensive wavemeter of similar type covering 20 to 10,000 m. was also shown. Other wavemeters were on display, one interesting new model being a short-wave instrument for 5 to 100 m. for which high stability was claimed. Other features in the radio-frequency class were thermally-compensated inductance standards and multi-range variable air-condenser standards.

The display of the CAMBRIDGE INST. Co. covered a large variety of physical measurements, including many of the bridges, etc., for which this Company is well known. An interesting new instrument was an illuminated moving-scale indicator, giving an extremely wide scale, very easily read. Another new instrument was the Cambridge "Pot" Galvanometer, primarily a reflecting instrument but also capable of pointer reading for null indications.

MUIRHEAD & Co.'s stand showed an increased range of measuring and precision apparatus, including gear for frequency control. One exhibit was the valve-maintained fork apparatus developed by the N.P.L. and B.B.C. Other frequency-control apparatus included a 1,000 ∼ phonic motor clock, and a low-frequency fork for less exacting conditions. This firm's make of Beat-Tone Oscillator of N.P.L. design was also on display, with a logarithmic volume-indicator of G.P.O. design. A new feature of this Company was condensers, variable and fixed, the latter available in paper and mica dielectric.

STANDARD TELEPHONES & CABLES, LTD., were newcomers to the Exhibition, with a large range of apparatus for telephonic and allied measurements. These included a capacity and inductance bridge, a heterodyne oscillator, a fixed frequency (1,000 ∼) oscillator and transmission measuring set, attenuation boxes, etc. An interesting display was the Company's cathode-ray oscillograph equipment, this including the tube in a viewing box, with accessories in the form of power supply unit, time

Quartz insulated precision air variable condenser (Muirhead & Co., Ltd.).

base circuit, etc., the whole being demonstrated in operation.

The display of CLAUDE LYONS, LTD., was chiefly devoted to apparatus of the American General Radio Company, this including that Company's new Standard Signal Generator, Direct Reading Wavemeter, Beat Frequency Oscillator, Decade Resistance Boxes, etc. The latest model 603-A Standard Signal Generator is admirably adapted for precise overall characteristic measurements on broadcast receivers. It has a frequency range from 100 kilocycles to 25 megacycles and a continuous output range from 0.5 microvolt to 1 volt. Internal modulation at 400 cycles is provided, but an external heterodyne oscillator may be connected for the purpose of "fidelity" tests. The new type 613-A Beat Frequency Oscillator fulfils this requirement, and has a frequency range of 5 to 10,000 cycles, with a harmonic content of less than 2 per cent. To complete the new range of receiver measuring apparatus the model 583-A Output Power Meter has been introduced. This instrument is calibrated both in milliwatts and decibels, and has a range from 5 to 5,000 milliwatts with an input impedance variable from 20 to 20,000 ohms.

GAMBRELL BROS., LTD., showed a large variety of electrical measuring apparatus, including bridges for a variety of purposes, standard variable condensers, galvanometers, and a wavemeter, 20 to 6,000 m., of sub-standard precision.

H. TINSLEY & Co. also had an extensive display of electrical gear including bridges, capacity testers, galvanometers and a.c. potentiometers for which this company is well known.

In addition to the instruments already mention, CROMPTON PARKINSON also included several items of laboratory interest.

Wireless Apparatus and Accessories

In this category the most extensive display was that of the MARCONI Co. and its allied concerns the M.O. VALVE Co. and the MARCONIPHONE Co. The last-named Company had a display of broadcast receivers, speakers, pick-ups, etc. The M.O. VALVE

Switch type audio-frequency oscillator (Standard Telephones & Cables, Ltd.).

Capacity-matching bridge for works adjustment of gang condensers (E. K. Cole, Ltd.).

Co. showed a very complete selection of valves of all classes from large transmitting tubes down to 2 v. battery receiving valves. New valves included variable-mu types in the 2-volt and d.c. mains class, while other new products were found in the mercury vapour rectifier class (G.U.3), etc.

The MARCONI Co. had an interesting display of wireless apparatus, including portable picture apparatus, and aircraft apparatus for visual course-indication on a beacon station, using two reeds as visual indicators. An interesting item was amplifying equipment with a flat response from 10 c/s to 150 kc/s, this including a photo cell and first amplifier, followed by a second amplifier giving a power-level suitable for modulation of a radio transmitter for television or picture transmissions. An item of allied interest was valve diathermy apparatus, using valves for the generation of h.f. currents for medical and surgical purposes. This apparatus gains interest from recent reports regarding the difficulty of eliminating interference from medical apparatus using "spark" methods of h.f. generation.

E. K. COLE, LTD., newcomers to this Exhibition, showed a variety of factory test-apparatus of considerable wireless interest. The gear shown included this firm's standard signal generator for the test of broadcast receivers in the course of construction, this being demonstrated in operation on several normal receivers, with dummy antenna, alternators, etc. Other factory apparatus included a condenser-ganging bridge for production matching and a bridge for acceptance tests of resistances within pre-determinable limits. Another interesting instrument was a self-contained and self-modulating oscillator unit for servicing work, having a 3-step attenuator and separate dummy antenna. This Company also had an output meter for use with the signal generators named above.

In addition to the instruments already mentioned, the WESTON Co. had several useful wireless accessories for servicing and similar purposes. These included a portable oscillator covering the range of 3,000 to 100 kc/s, an output meter, and a power level meter, a modification of the former reading directly in decibels.

The DUBILIER CONDENSER Co. showed a typically wide range of condensers for all varieties of wireless purposes, including their latest forms of electrolytic condenser. A working demonstration showed a method of reducing ignition interference from an internal-combustion engine, while a useful new device was a small attachment for easy introduction into the leads of any domestic power-consuming apparatus (small motors, etc.) for smoothing and elimination of radio interference.

The display of the EDISON SWAN CO., LTD., was devoted chiefly to vacuum devices. These included cathode ray oscillographs, mercury vapour tubes, (diode and triode) valves of all sizes, mercury switches, barretters, etc., and a large number of lamps for projection and other purposes.

The stand of PHILIPS INDUSTRIAL, LTD., had a number of their well-known X-ray tubes, while items of more definite wireless interest were found in this firm's barretters, rectifiers, hot-cathode relay tubes, gas protective devices (aerial arresters), mercury switches, etc.

Other matters of wireless interest were to be seen in the resistances, rheostats and transformers of the ZENITH ELECTRICAL Co. Resistances, mercury switches, etc., of ISENTHAL & Co., and resistances, rheostats, potentiometers of the BRITISH ELECTRIC RESISTANCE Co. This Company also showed a typewriter-keyboard morse transmitter and ship receiver for wireless working, for example on small ships where no operator is available.

Research and Experimental Section

A considerable number of wireless items were to be found in this section. The larger display of communications interest was that of the G.P.O. ENGINEERING RESEARCH STATION. This was chiefly telephonic, including a demonstration of the "number-engaged" talking apparatus to replace signalling tones by spoken words from a sound film. A very interesting exhibit was a precision beat-tone oscillator up to 12 kc/s, with output flat to 0.1 d.b. and with a frequency error of less than 0.2 per cent. The harmonic content is particularly low, a new type of correction circuit involving a shunted metal oxide rectifier having been incorporated to correct the effects of valve curvature in the amplifier.

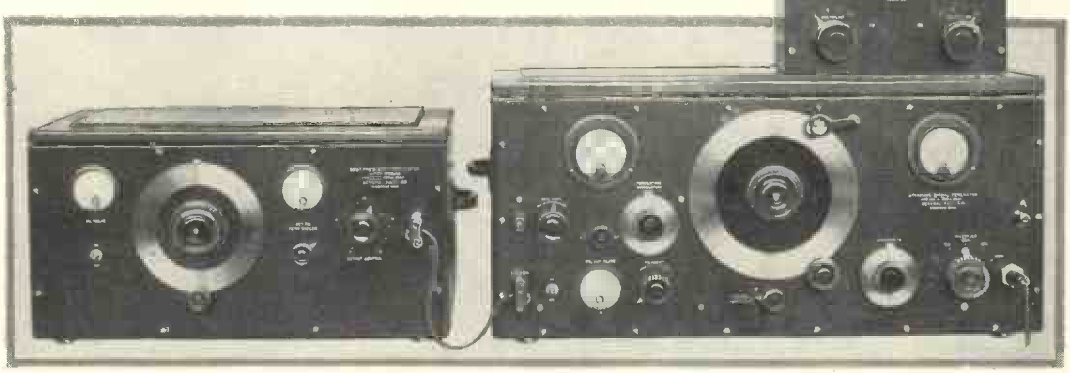
The main exhibit of the B.T.H. ENGINEERING LABORATORIES was the Wynn-Williams (Thyratron) counting circuit, together with examples of thyratrons and rectifiers.

An exhibit of high-frequency interest was the high-voltage cathode ray tube shown by PROF. G. I. FINCH and the CAMBRIDGE INST. Co., with a writing speed showing traces of one micro-second duration.

The G.E.C. RESEARCH LABORATORIES demonstrated an experimental form of photoelectric musical instrument, in which a photo cell was illuminated by slits of varying wave-form producing a pure-tone or one with any desired degree of harmonic component in simulation of various instrumental tones.

MR. L. G. VEDY (Reading University) had a demonstration of the propagation of waves near a focus, linking the cases of waves of different kinds including wireless radiation, while PROF. L. S. PALMER and MR. R. WITTY (University College, Hull) showed a photographic and graphical demonstration of the pick-up effects at long and short waves from a frame aerial revolving about a horizontal axis.

Lectures were given each evening during the Exhibition, one of particular wireless interest being a discourse by MR. R. A. WATSON WATT, Superintendent of the Radio Research Station, Slough, on the general problems of oscillography and dealing with the particular advantages of the cathode ray tube.

General Radio apparatus for measuring overall receiver characteristics. (Left) type 613-A beat-frequency oscillator; (right) type 603-A standard signal generator, and (above) type 583-A output power meter.

Output Stages*

The Choice of Valves for Use in Low-frequency Amplifiers

By C. C. Whitehead

IN an article published in this journal a few months ago† the late Mr. B. C. Brain, of the B.T.H. Co.'s research staff, demonstrated that all the data required to fix the operating conditions of a valve for maximum undistorted output can be obtained by the aid of a slide rule and five minutes' work from a knowledge of two valve constants. These constants are embodied in the information which usually accompanies commercially made valves.

During the practical use of the method, the writer had occasion to carry out a slight extension to it, with a special application in view. It is thought that the work in question is of sufficient interest to warrant description.

It is proposed, for the benefit of those readers who have not had the privilege of access to Mr. Brain's original work, to commence with a brief and abridged resumé of this.

It was shown in the above-mentioned article that the practical form of the valve anode-current equation over the "linear" portion of the characteristic was:

$$‡I_a = k\left(\frac{V_0}{m} - E_g - z\right)^{3/2} \quad .. \quad (1)$$

and, differentiating the above with respect to V_0, and inverting, we obtain the A.C. resistance (R_a) under any specified conditions:—

$$R_a = \frac{dV_0}{dI_a} = \frac{2}{3}\cdot\frac{m}{k}\left(\frac{V_0}{m} - E_g - z\right)^{-\frac{1}{2}} \quad (2)$$

It was further shown that the optimum value of the ratio—

$$n = \frac{\text{Load Resistance}}{\text{Valve A.C. Resistance}} = \frac{R_e}{R_a} = 1.6:1 \quad (3)$$

for maximum undistorted power.§

* MS. received by the Editor, July, 1931.

† See Bibliography (3).

‡ The usual negative grid bias is regarded as positive throughout this article.

§ The question of harmonic content is not dealt with herein, but for all practical purposes the maximum power output from these calculations may be regarded as "undistorted."

To fulfil condition (3) under all working conditions would necessitate that the permissible power dissipation at the anode of the valve be practically unlimited.

As, however, a definite limitation is always

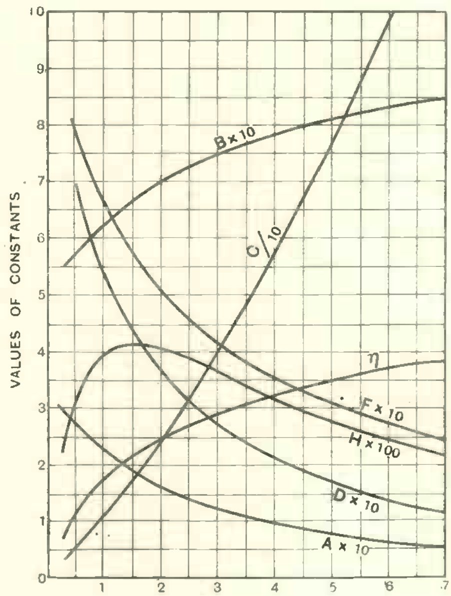


Fig. 1.

imposed in practice (the purpose of which is well known), a set of constants was given, allowing all the working conditions to be readily determined when this limitation was imposed.

It was shown that they could be most conveniently expressed as functions of the ratio "n." These constants are plotted in Fig. 1, and an abridged table given (Table 1). An extra column, η, denoting the efficiency, has been added, the use and derivation of which is explained later.

The uses of the above constants are shown in Table 2.

The following information only is required to be obtained from the particulars supplied

TABLE 1.

n.	B.	A.	C.	D.	2B.	F.	H.	η.
0.5	0.572	0.274	0.508	0.697	1.14	0.786	0.0308	0.1123
1.0	0.620	0.230	1.09	0.538	1.25	0.662	0.0394	0.171
1.5	0.667	0.192	1.73	0.439	1.33	0.578	0.0415	0.216
2.0	0.700	0.164	2.43	0.368	1.40	0.511	0.0406	0.248
2.5	0.727	0.143	3.19	0.314	1.45	0.462	0.0393	0.275
3.0	0.750	0.125	4.00	0.269	1.50	0.418	0.0365	0.292
4.0	0.786	0.099	5.76	0.209	1.57	0.353	0.0317	0.321
5.0	0.813	0.081	7.70	0.171	1.63	0.308	0.0282	0.348
7.0	0.850	0.058	12.04	0.120	1.70	0.244	0.0218	0.376
10.0	0.885	0.039	19.60	0.080	1.77	0.185	0.0155	0.398

by the manufacturers :—

Maximum permissible anode dissipation.

Maximum permissible anode voltage.

m = Voltage amplification factor of valve.

k = Valve constant.

z = Correction term, to allow for fall of potential along the cathode (not necessary if the cathode is indirectly heated, or unless the greatest accuracy is required, and/or the value of $\frac{V_0}{m}$ is small).

z' = *Additional* grid bias to be applied when the filament is *directly* heated by A.C. (in the equations this must be used in place of z).

$$z = \frac{E_f}{2}\left(1 + \frac{1}{m}\right) \quad \ldots \quad (4)$$

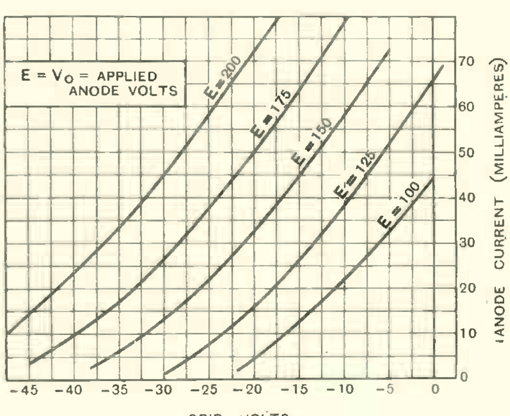


Fig. 2.

$$z' = \sqrt{2}\left(\frac{E_f}{2}\right) \quad \ldots \quad (5)$$

Where E_f = Filament voltage applied to valve.

The practical use of the method is as follows :—

It is required to find the correct operating conditions for the maximum undistorted

TABLE 2.

Symbol of Constant.	Required to Find.	Formula.
n		$n = \frac{R_e}{R_a}$
B	Grid Bias	$E_g = B\left(\frac{V_0}{m}\right)$
A	Anode Feed Current	$I_a = Ak\left(\frac{V_0}{m}\right)^{3/2}$
C	Load Resistance ..	$R_e = C\frac{m}{k}\left(\frac{V_0}{m}\right)^{-\frac{1}{2}}$
D	Maximum (Peak) Anode Current ..	$I_{max.} = Dk\left(\frac{V_0}{m}\right)^{3/2}$
$2B$	Maximum (Peak) Anode Voltage ..	$V_{max.} = 2BV_0$
F	Minimum Anode Voltage	$V_{min.} = FV_0$
H	Output	$W = Hkm\left(\frac{V_0}{m}\right)^{5/2}$
η	Efficiency	$\eta = 100\frac{H}{A}\ \%$

output of the valve, the particulars of which, supplied by the makers, are given in Fig. 2—

Here, Max. anode dissipation = 5 watts.

Max. anode voltage = 200 V.

m = 3.50

Assuming that the filament is heated by D.C. (from 4, above)

$$z = \frac{6}{2}\left(1 + \frac{1}{3.5}\right) = 3.86$$

To evaluate "k" most accurately, it is advisable to take a point upon the V_0/E_g curve where the values of V_0, I_a, and E_g, are relatively high.

Turning to Fig. 2, we find :—

$$V_0 = 200, \quad I_a = 42.5, \quad E_g = 31.25$$

Then (from 1, above),

$$I_a = k\left(\frac{200}{3.5} - 31.25 - 3.85\right)^{3/2} = 103.9\,k$$

Whence $$k = \frac{42.5}{103.9} = 0.409$$

We have now obtained all the information we require about the valve, viz. :—

$m = 3.5$, $k = 0.409$, $z = 3.85$,
mz (see below) $= 12.25$

In fixing the operating conditions of the valve by the aid of the tables or curves, if we desire the greatest accuracy, we can use in the place of V_0/m, given therein :—

$$\frac{V_0}{m} - z, \text{ or } \frac{V'}{m}, \text{ where } V' = V_0 - mz$$

The latter is probably more convenient.

Since the permissible anode dissipation is limited to 5 watts, at $V_0 = 200$ we must so arrange things that the steady anode current (I_a) is limited to $5/200 = 0.025$ A. = 25 mA.

Now in Col. 3, Table 2, we find that the value of steady anode current

$$I_a = Ak\left(\frac{V'}{m}\right)^{3/2} = A\,.\,409\left(\frac{188}{3.5}\right)^{3/2} = 161\,A$$

Whence $$A = \frac{25}{161} = 0.155$$

Turning now to Fig. 1, we find—

$A = 0.155$, $B = 0.710$, $C = 2.72$, $D = 0.345$, $\eta = 0.2505$, $F = 0.492$, $H = 0.0402$.

Evaluating, by aid of Table 2, we find,

Anode D.C. voltage (V_0) = 200 v.

Anode D.C. current (I_a) = 25 mA.

Anode voltage peak ($V_{max.}$) = 284 v.

Anode voltage " trough " ($V_{min.}$) = 92.5 v.

Anode current peak ($I_{max.}$) = 57 mA.

Grid bias (E_g) = 38 v.

Load resistance (R_e) = 3,180 ohms.

Output (W) = 1,250 milliwatts
(= 1.25 watts)

Efficiency (η) = 25%.

This completes the resumé of Mr. Brain's work, as far as it concerns our present purpose.

The particular object the writer had in mind was to find a rapid test, based upon the above, to be applied to an alleged " power " valve to determine its suitability or otherwise for employment in the output stage of any given amplifier, the anode voltage of which was limited to a definite figure.

Incidentally, it also led to the solution of the following problems :—

(1) The minimum anode voltage required to obtain a given output and efficiency.

(2) Whether a *reasonable* efficiency is obtainable without exceeding the maximum anode voltage recommended by the makers. Upon this latter depends the suitability of the valve under test as an output valve.

It is surprising how many alleged " power " valves, sold as such by reputable makers, fail to pass this test.

It is very well known that the efficiency increases progressively as we increase the values of $V_0 - E_g$ and the load resistance. The first thing to be done, therefore, was to determine the efficiency under the various operating conditions, and arrange the values so obtained to fit in conveniently with the information so far known, *i.e.*, obtain the values shown in Col. 9, Table 1, and Curve η, Fig. 1.

The expression for the efficiency is very simply derived as follows :—

$$\text{Input to valve} = V_0 Ak\left(\frac{V_0}{m}\right)^{3/2}$$

$$\text{Output} = Hkm\left(\frac{V_0}{m}\right)^{5/2}$$

$$\text{Therefore efficiency } (\eta) = \frac{\text{Input}}{\text{Output}}$$

$$= \frac{Hkm\left(\frac{V_0}{m}\right)^{5/2}}{V_0 Ak\left(\frac{V_0}{m}\right)^{3/2}} = \frac{H}{A}$$

and this is the value shown in the tables and curves.

It has long ago been demonstrated that as the values of $V_0 - E_g$ and R_e are increased, without limit, η approaches the value 0.5 asymptotically.*

The question is, "How far can we go in the direction of securing efficiency without encountering 'snags'?"

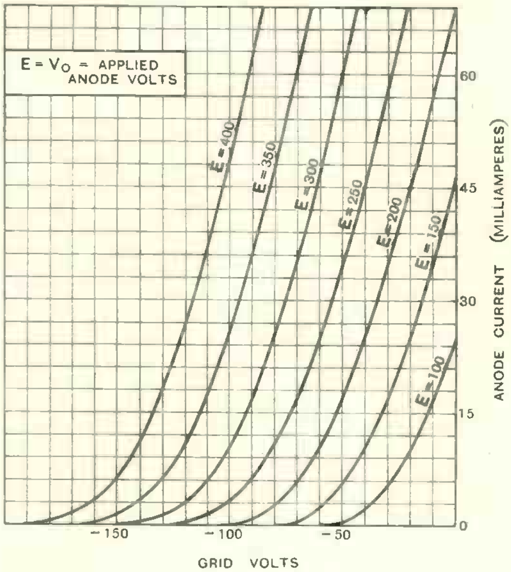


Fig. 3.

For reasons to be discussed a little later, it was decided that an efficiency of 25 per cent. ought reasonably to be expected of a valve at the maximum anode voltage recommended by the makers, otherwise it can hardly be regarded as suitable for use in the output stage.

We must now derive expressions, by means of which, having fixed the desired output and/or efficiency, we can at once determine the correct operating conditions.

Taking the expression for the output (which we will call W) in Col. 8, Table 2,

$$W = Hkm\left(\frac{V_0}{m}\right)^{5/2}$$

Therefore

$$V' = m\left(\frac{W}{Hkm}\right)^{2/5} = \left(\frac{W}{Hk} \cdot m^{3/2}\right)^{2/5}$$

so that $$V_0 = \left(\frac{W}{Hk} \cdot m^{3/2}\right)^{2/5} + mz \quad \ldots \quad (6)$$

and calling the input power "P,"

$$V_0 = \left(\frac{P\eta}{Hk} \cdot m^{3/2}\right)^{2/5} + mz = \left(\frac{P}{Ak} \cdot m^{3/2}\right)^{2/5} + mz \quad \ldots \quad \ldots \quad (7)$$

* See Bibliography (No. 2).

The following is a practical example of the use of the above expression :—

We wish to determine the suitability of either of the valves, the particulars of which are shown in Figs. 3 and 4, for use as output valves, at the maximum anode voltages recommended by the makers.

Call Fig. 3—"Valve A."

Call Fig. 4—"Valve B."

Referring to Fig. 1, at the efficiency required, *i.e.*, 25 per cent., the following constants apply :

$A = 0.160$, $B = 0.703$, $C = 2.53$, $D = 0.360$, $\eta = 0.25$, $F = 0.500$, $H = 0.0405$, $n = 2.10$.

Taking Valve A (Fig. 3), we have,

Maximum anode voltage (makers') $= 400$ V.

Maximum anode dissipation (makers') $= 13.5$ watts

$m = 2.5$

$k = 0.110$

$z = 3.5$ (at $E_f = 5$ V.)

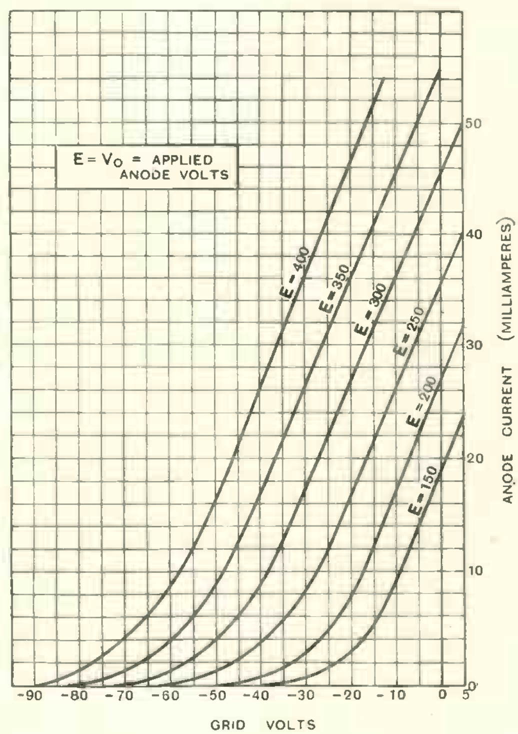


Fig. 4.

From (7) above (remembering that all constants are in mA/V units),

$$V_0 = \left(\frac{13.5 \cdot 10^3}{0.160 \cdot 0.110} \cdot 2.5^{3/2}\right)^{2/5} + 8.75 = 398 \text{ v.}$$

Since 398 < 400 v., this valve is suitable for use as an output valve. Dealing now with Valve B, (Fig. 4),

Maximum anode voltage (makers') = 400 v.
Maximum anode dissipation (makers') = 10 watts
m = 5.0
k = 0.112
z = 3.0 (at E_f = 5v.)

Here

$$V_0 = \left(\frac{10 \cdot 10^3}{0.160 \cdot 0.112} \cdot 5^{3/2}\right)^{2/5} + 15 = 535 \text{ v.}$$

Since 535 > 400 v., this valve is *not* very suitable for use as an output valve, an anode voltage considerably in excess of that recommended by the makers being required in order to obtain a reasonable efficiency.

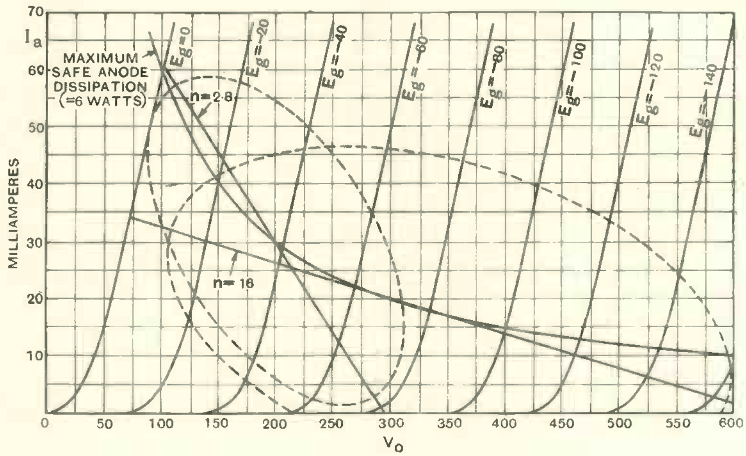


Fig. 5.

In conclusion, let us return again to the question of the maximum efficiency obtainable in *practice*.

Fig. 5 depicts the anode voltage—anode current characteristics of a valve having the following constants :—

$$m = 3.5 \quad k = 0.410$$

(the correction term "z" is neglected, as this is only used when the greatest accuracy is required).

The behaviour of the valve is shown under two operating conditions, $n \approx 2.8$ and $n \approx 16$, the anode dissipation being the same in both cases. The purpose of the figure is to show that, apart from the possible danger due to excessive peak anode voltage ($V_{max.} = 2BV_0$), there is another "snag" to be avoided.

Apart from the question of the peak anode voltage, we could increase the efficiency to perhaps 40–45 per cent., *provided that the load behaved as a pure resistance and remained constant over the whole of the frequency range over which the output is required.*

But this is seldom if ever the case in practice, both the value of the load and its power-factor varying very considerably over the frequency range required.

When the power-factor is less than unity, the locus of the working point, instead of being represented by a straight line (R_e) becomes an ellipse, the width of which becomes greater as the power-factor decreases. The dotted ellipses in Fig. 5 represent loads of the same power-factor in each case.

It will be seen that under conditions of varying load and power-factor the operating conditions $n = 2.8$ allows rather more latitude, *i.e.*, less danger of rectification and consequent distortion, but at a sacrifice of efficiency.

It seems most reasonable to aim at efficiencies of the order of between 20 and 30 per cent., hence the reason for taking 25 per cent. as the standard in the above argument.

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(2) E. Green, "Use of Plate Current—Plate Voltage Characteristics in Studying the Action of Valve Circuits." (*E.W. & W.E.*, July, 1926, p. 402)

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Non-linear Valve Characteristics*

A Brief Discussion on their Use

By C. S. Bull, M.Sc.

(Electric and Musical Industries Ltd., Hayes, Middlesex)

SUMMARY.—In this article a method is given for showing how the frequencies in an input signal are added and subtracted by a curved valve characteristic. The resultant frequencies are not all able to give an output voltage across the anode load, since the load is generally reactive or resistive to a limited range of frequencies only. Simple rules are given for determining the effective combination of frequencies, and modulation rise, cross modulation, detection, modulation, and high frequency mixing are considered in detail.

THE use of a valve as an amplifier is treated most simply by supposing that the characteristics are parallel straight lines. Valves are frequently used, however, over non-linear parts of their characteristics, either on account of the nature of the performance required, or on account of the large signal voltages that they are required to handle. A discussion of the properties of non-linear characteristics is frequently of small practical value, for the resulting equations are very complicated, and their physical significance may be lost. This paper is an attempt to give a less complete account of the effects in a manner that has been found practically helpful. It is realised that much more detailed discussions can be found in papers by Carson and other writers.

In considering the use of a valve working over a curved characteristic, it is necessary to apply a composite E.M.F. to the grid, and derive the working of the valve from the expression required to represent its characteristic. At this point we must simplify by making the assumption that the load impedance is small compared with the anode impedance of the valve, and that it is a pure resistance. The anode current is then given by

$$i_a = f(V_g)$$

and the output voltage on applying a signal δv_g is proportional to δi_a

$$\delta i_a = \frac{di_a}{dv_g}(\delta v_g) + \frac{1}{2!}\frac{d^2 i_a}{dv_g^2}(\delta v_g)^2 + \frac{1}{3!}\frac{d^3 i_a}{dv_g^3}(\delta v_g)^3 + \text{etc.}$$

The signal δv_g is usually, in most amplifiers or detectors, a composite voltage, of the form

$$(A_1 \cos a_1 t + A_2 \cos a_2 t + \ldots\ldots)$$

Raising an expression of this form to higher power than the second is tedious, but by using the relation

$$\cos\theta = \frac{e^{j\theta} + e^{-j\theta}}{2}$$

the angular speeds $a_1\ a_2\ \ldots$ etc., may be treated as pairs of positive and negative indexes of e. If the term of the n^{th} order is required, we require to find $(\delta v_g)^n$. This is a polynomial raised to the power n, and the terms are of the form

$$P\left(\frac{A_1}{2}\cdot\frac{A_2}{2}\ldots n \text{ terms}\right) \times e^{j(a_1 + a_2 + a_3 \ldots n \text{ terms})t}$$

where P is a number depending on the form of the term. $A_1 A_2$, etc., will be referred to as coefficients.

The number of terms that will be obtained on full expansion of $(\delta v_g)^n$ is equal to the number of ways the indexes $+a_1$, $-a_1$, $+a_2$, $-a_2$, etc., can be added n at a time, each index being taken up to n times. It is to be noted that for each resulting index there must be an equal negative index with the same coefficient, so that reconversion to the cosine form is possible, giving half the number of terms of the form.

$$P\frac{A_1 A_2 A_3 \ldots n \text{ terms}}{2^{n-1}} \times \cos(\pm a_1 \pm a_2 \pm a_3 \ldots n \text{ terms } t)$$

The number of these terms may be very large, and it may be tedious to work them all out systematically. Only certain terms, however, are required, since the anode circuit load will offer appreciable impedance to a limited band of frequencies only, and no output voltage will be developed outside

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

this band. One is able to lay down simple *ad hoc* rules for obtaining the combinations giving currents inside the band of frequencies to which the anode circuit is resistive in each case.

We will now consider various cases in turn, taking the longest first, so that the method of obtaining rules for the selection of the effective output components will be illustrated and then give a briefer account of simpler cases. These will not require explanation, and the results may be compared with well-known formulae.

Modulation Rise

When a modulated carrier is applied to an H.F. amplifier it has frequently been stated that curvature in the amplifier does not distort the modulation, but merely produces harmonics of the carrier frequency, which are filtered out by the succeeding tuned circuits. It is now generally recognised that distortion of the modulation occurs, and that it is accompanied by an increase in the modulation percentage. The rise in modulation is used as a measure of the distortion and is generally limited to 20 per cent. This procedure is only a rough precaution, and we will now proceed to determine the rise in modulation and the kind of distortion accompanying it. (We will use the term modulation ratio for the modulation percentage expressed as a fraction.)

The applied signal voltage is :—

$$\delta v_g = E \cos \omega t + B \cos (\omega + p)t + B \cos (\omega - p)t$$

which represents a carrier and two side bands. The modulation ratio is

$$\frac{2B}{E} = M \text{ say}$$

The anode circuit is resistive to frequencies in the neighbourhood of ω, that is, it is a circuit tuned to the carrier. The coefficients and indexes may be tabulated as follows :—

Coefficient	Index.
E	$\omega = a$
E	$-\omega = b$
B	$\omega + p = c$
B	$-\omega + p = d$
B	$\omega - p = e$
B	$-\omega - p = f$

It will be seen that the indexes have been allocated symbols a, b, etc., to avoid confusion.

The first order term gives straightforward amplification of the input voltage. The second order term contributes no output, since the addition of any two indexes gives either a low frequency, zero frequency (D.C. change in anode current) or frequencies approximately double that of the carrier. The third order term is obtained by the following considerations.

Terms in the neighbourhood of ω are required. These can only be produced by the combination of two like and one unlike terms. Combinations of three positive or three negative terms give resultant terms in the neighbourhood of 3ω. Now two positive terms of the group a, c, e may be added to one negative term of the group b, d, f. There are three ways of selecting two terms from the group a, c, e and three ways of adding a term from the group b, d, f, giving nine terms having $P = 6$. Again, taking the terms a, c, e twice each there are three ways of selecting a term from the group b, d, f. These combinations give nine more terms having $P = 3$. The resulting combinations are tabulated below :

Combination.	Resultant Angular Velocity.	Coefficient.
$2a + b$	ω	$3\,E^3$
$2a + d$	$\omega - p$	$3\,E^2B$
$2a + f$	$\omega + p$	$3\,E^2B$
$2c + b$	$\omega + 2p$	$3\,EB^2$
$2c + d$	$\omega + p$	$3\,B^3$
$2c + f$	$\omega + 3p$	$3\,B^3$
$2e + b$	$\omega - 2p$	$3\,EB^2$
$2e + d$	$\omega - 3p$	$3\,B^3$
$2e + f$	$\omega - p$	$3\,B^3$
$a + c + b$	$\omega + p$	$6\,E^2B$
$a + c + d$	ω	$6\,EB^2$
$a + c + f$	$\omega + 2p$	$6\,EB^2$
$a + e + b$	$\omega - p$	$6\,E^2B$
$a + e + d$	$\omega - 2p$	$6\,EB^2$
$a + e + f$	ω	$6\,EB^2$
$c + e + b$	ω	$6\,EB^2$
$c + e + d$	$\omega - p$	$6\,B^3$
$c + e + f$	$\omega + p$	$6\,B^3$

In order to simplify the appearance of the subsequent equations, the following abbreviations will be used :

$$\frac{di_a}{dv_g} = g \qquad \frac{d^2 i_a}{dv_g{}^2} = g' \qquad \frac{d^3 i_a}{dv_g{}^3} = g''$$

The complete expression for the output is :

$$\delta i_a = gE\cos\omega t + \frac{1}{3!}g''(\tfrac{3}{4}E^3 + \tfrac{9}{2}EB^2)\cos\omega t$$

$$+ gB\cos(\omega \pm p)t + \frac{1}{3!}g''(\tfrac{9}{4}B^3 + \tfrac{9}{4}E^2B)\cos(\omega \pm p)t$$

$$+ \frac{1}{3!}g''\tfrac{9}{4}EB^2\cos(\omega \pm 2p)t$$

$$+ \frac{1}{3!}g''\tfrac{3}{4}B^3\cos(\omega \pm 3p)t$$

1st order terms, 3rd order terms.

$$\therefore \quad \delta i_a = \left[gE + g''\left(\frac{E^3}{8} + \tfrac{3}{4}EB^2\right)\right]\cos\omega t \quad \text{(carrier)}$$

$$+ [gB + g''(\tfrac{3}{8}B^3 + \tfrac{3}{8}E^2B)]\cos(\omega \pm p)t \quad \text{(fundamental sideband)}$$

$$+ \tfrac{3}{8}g''EB^2\cos(\omega \pm 2p)t + \tfrac{1}{8}g''B^3\cos(\omega \pm 3p)t)$$

(distortion sidebands, 2nd and 3rd harmonics)

(Note that the sign $\pm$ is used to represent the sum of the two terms indicated, *i.e.*, $\cos(\omega \pm p)t = \cos(\omega + p)t + \cos(\omega - p)t$).

The modulation increases from

$$M = \frac{2B}{E} \text{ to } M_D \text{ given by}$$

$$M_D = \frac{2[gB + g''(\tfrac{3}{8}B^3 + \tfrac{3}{8}E^2B)]}{[gE + g''(\tfrac{1}{8}E^3 + \tfrac{3}{4}EB^2)]}$$

$$= \frac{2B}{E}\,\frac{g + g''(\tfrac{3}{8}B^2 + \tfrac{3}{8}E^2)}{g + g''(\tfrac{1}{8}E^2 + \tfrac{3}{4}B^2)}$$

$$= M\left[1 + \frac{g''}{g}(\tfrac{1}{4}E^2 - \tfrac{3}{8}B^2)\right] \text{(approx.)}$$

$$= M\left[1 + \tfrac{1}{4}\frac{g''}{g}E^2\right] \text{neglecting } B^2$$

$$= M[1 + R]$$

Where $R = \frac{1}{4}\frac{g''}{g} \cdot E^2$

R is the fraction by which the modulation ratio M increases when the amplifier is non-linear. This rise in modulation is accompanied by distortion. The ratio of second harmonic to fundamental is given by

$$D = \frac{\tfrac{3}{8}g''EB^2}{Bg} \text{ (approx.)}$$

$$= \tfrac{3}{8} \cdot \frac{g''}{g} \cdot EB$$

$$= \tfrac{3}{4}RM$$

This expression shows that the distortion is proportional to the initial modulation ratio, as well as to the modulation rise. Thus if $M = 0.5$, and $R = 0.2$, values frequently met with in practice,

$$D = \tfrac{3}{4} \times 0.5 \times 0.2 = 0.075 = 7.5\%$$

This amount of distortion is considerably more than that permitted in calculating the power output from triode power valves.

Cross Modulation

If two signals of neighbouring frequency are applied to a non-linear H.F. amplifier tuned to one of the signals, the modulation of the untuned signal is heard after detection, even though the overall selectivity of the circuits is sufficient to separate the signals completely. This effect is known as cross-modulation. It may be overcome by the provision of better selectivity before the first H.F. valve or by the use of valves with a sufficiently long linear characteristic to deal with the applied signal voltage. The improved selectivity is generally obtained by means of band-pass tuning, while "variable-mu" valves and "H.F. Pentodes" have been constructed to provide long substantially linear characteristics.

We will consider the reception of an unmodulated carrier in the neighbourhood of an unwanted modulated signal.

The input to the first grid is :—

$$\delta v_g = E_1\cos\omega_1 t + E_2\cos\omega_2 t + B_2\cos(\omega_2 \pm p_2)t$$

E_1 being the desired unmodulated signal, and E_2 the undesired modulated signal.

The coefficients and indexes of e are as follows :—

E_1	$\omega_1 = a$	B_2	$\omega_2 + p_2 = e$
E_1	$-\omega_1 = b$	B_2	$-\omega_2 + p_2 = f$
E_2	$\omega_2 = c$	B_2	$\omega_2 - p_2 = g$
E_2	$-\omega_2 = d$	B_2	$-\omega_2 - p_2 = h$

The first order term gives straightforward H.F. amplification. The second order term gives no frequencies in the neighbourhood of ω_1. The third order term will be considered in more detail. The overall response of the amplifier is sufficiently good to cut off the frequency $\omega_2/2\pi$ and its sidebands while it will pass the frequency $\omega_1/2\pi$ and any sidebands produced. Consequently, the only output terms required are those representing a frequency $\omega_1/2\pi$ and side bands introduced.

To obtain the positive group of indexes, we can start each combination with the term $a = +\omega_1$, and add pairs of positive and negative indexes obtained from one carrier to it, so that the resultant index is :—

$$\omega_1 + 0$$
$$\omega_1 \pm p_2$$
or
$$\omega_1 \pm 2p_2$$

There is only one combination from the desired signal, viz., $a + (a + b)$ that gives an index ω_1. No other arrangement of terms from the wanted signal will give this index. The six terms from the unwanted signal can be taken in positive and negative pairs in nine ways (each positive one can be paired with one negative one). Hence there are altogether ten terms. Only the first term has the same index occurring twice, so that $P = 3$, while $P = 6$ for the remaining nine.

The following table shows the result of this process.

Combination.	Resultant Angular Velocity.	Coefficient.
$a + a + b$	ω_1	$3\ E_1^3$
$a + c + d$	ω_1	$6\ E_1E_2^2$
$a + e + f$	ω_1	$6\ E_1B_2^2$
$a + g + h$	ω_1	$6\ E_1B_2^2$
$a + c + f$	$\omega_1 - p_2$	$6\ E_1E_2^2$
$a + c + h$	$\omega_1 + p_2$	$6\ E_1E_2B_2$
$a + d + e$	$\omega_1 + p_2$	$6\ E_1E_2B_2$
$a + d + g$	$\omega_1 - p_2$	$6\ E_1E_2B_2$
$a + e + h$	$\omega_1 + 2p_2$	$6\ E_1B_2^2$
$a + f + g$	$\omega_1 - 2p_2$	$6\ E_1B_2^2$

The complete expression for δi_a is therefore

$$\delta i_a = gE_1 \cos \omega_1 t + \frac{1}{3!} g''(\tfrac{3}{4}E_1^3 + \tfrac{3}{2}E_1E_2^2 + 3E_1B_2^2) \cos \omega_1 t \quad \text{wanted carrier}$$
$$+ \frac{1}{3!} g'' \cdot 3E_1E_2B_2 \cos(\omega_1 \pm p_2)t + \frac{1}{3!} g'' \cdot \tfrac{3}{4}E_1B_2^2 \cos(\omega_1 \pm 2p_2)t \quad \text{output of unwanted modulation}$$

1st order 3rd order

This consists of the wanted carrier modulated at the fundamental and the 2nd harmonic frequencies of the modulation of the unwanted carrier. The expression has two limiting cases, (1) when the wanted carrier is large compared with the unwanted carrier, and (2) when the wanted carrier is small.

In case (1), the modulation ratio introduced to the carrier E_1 by the carrier E_2, considering the fundamental only, is ${}_1M_c$ given by

$${}_1M_c = \frac{\tfrac{1}{2}g''E_1E_2B_2}{gE_1}$$
$$= \tfrac{1}{2} \cdot \frac{1}{g} \cdot g''E_2B_2$$
$$= \frac{g''}{g} \cdot E_2^2M_2 \text{ where } M_2 = \frac{2B_2}{E_2}$$

The depth of modulation is therefore proportional to the square of the strength of the interfering station and to its modulation depth. The factor $\frac{g''}{g}$ has been called the cross talk factor. (Ballantine & Snow, *Pro. Inst. Radio. Eng.*, Dec., 1930).

In case (2), the modulation percentage is given by ${}_2M_c$, where

$${}_2M_c = \frac{\tfrac{1}{2}g''E_1E_2B_2}{\frac{1}{3!}g''(\tfrac{3}{2}E_1E_2^2 + 3E_1B_2^2)}$$
$$= \frac{\tfrac{1}{2}E_2B_2}{[\tfrac{1}{4}E_2^2 + \tfrac{1}{2}B_2^2]}$$
$$= \frac{E_2B_2}{\tfrac{1}{2}E_2^2 + B_2^2} = \frac{E_2^2\frac{M_2}{2}}{\tfrac{1}{2}E_2^2 + \frac{E_2^2M_2^2}{4}}$$
$$= \frac{M_2}{1 + \frac{M_2^2}{2}}$$

If M_2 is small, ${}_2M_c \simeq M_2$.

If M_2 is 1.0, ${}_2M_c = 0.66$, and there is no maximum value of ${}_2M_c$ between $M_2 = 0$ and $M_2 = 1$.

The amplitude of the desired carrier is :—

$$\frac{1}{3!} g''(\tfrac{3}{2}E_1E_2^2 + \tfrac{3}{4}E_1E_2^2M_2^2)$$

and is seen to be proportional to the square of the input of unwanted carrier. Case (2) is the more usual case in practical problems in radio receivers.

Detection

In detecting a carrier and two side bands the applied signal voltage is

$$\delta v_g = E \cos \omega t + B \cos (\omega + p)t + B \cos (\omega - p)t$$

the anode circuit being resistive to low frequencies.

The coefficients and indexes of e are as follows :—

$E \quad \omega = a \qquad B \quad -\omega + p = d$

$E \quad -\omega = b \qquad B \quad \omega - p = e$

$B \quad \omega + p = c \qquad B \quad -\omega - p = f$

Only the even order terms are able to give low frequency currents, for it will not be possible by taking any odd number of high frequency terms to produce a low frequency.

Consider the second order term. The coefficients and indexes are as follows :—

Combination.	Resultant Angular Velocity.	Coefficient.
$a + d$	$-p$	$2\,E\,B$
$a + f$	p	$2\,E\,B$
$c + f$	$2p$	$2\,B^2$

No other combinations will give a low frequency term.

The output is therefore :—

$$\frac{1}{2!} g' (2EB \cos pt + B^2 \cos 2pt)$$

This is a distorted reproduction of the modulation. The percentage of second harmonic is :—

$$\frac{B^2}{2EB} = \frac{B}{2E} = \tfrac{1}{4}M,$$

$$\text{where } M = \frac{2B}{E} = \text{modulation ratio.}$$

This result is well known.

The fourth order term introduces third and fourth harmonics.

Considering modulation at mixed frequencies,

$$\delta v_g = E_1 \cos \omega t + B_1 \cos (\omega \pm p)t + E_2 \cos \omega t + B_2 \cos (\omega \pm p)t + \text{etc.}$$

These terms taken two at a time, give terms of the form :—

$$\frac{1}{2!} g^1 [B_1 B_2 \cos (P_2 \pm p_1)t]$$

These terms are proportional to the square of the modulation percentage. They are objectionable since they have no simple multiple relation in frequency to the input. The presence of 2nd harmonic is tolerated very easily however.

If now, two modulated carriers be applied to the grid,

$$\delta v_g = E_1 \cos \omega_1 t + B_1 \cos (\omega_1 \pm p_1)t + E_2 \cos \omega_2 t + B_2 \cos (\omega_2 \pm p_2)t$$

the signal E_1 being desired.

The indexes are as follows :—

$$\pm \omega_1 ;\ \pm (\omega_1 + p_1) ;\ \pm (\omega_1 - p_1) ;\ \pm \omega_2 ;\ \pm (\omega_2 + p_2) ;\ \pm \omega_2 - p_2$$

Normal rectification of both signals, and the production of combination tones of form

$$\cos (\omega_2 - \omega_1 + p_2 \pm p_1)t$$

takes place.

These last terms are generally supersonic.

We see then that no "wipe out" or demodulating effect can be obtained by use of continuous curvature detectors. This method of analysis is not applicable to detection by discontinuous characteristic.

Modulation

The simplest method of producing a modulated H.F. signal is to apply an H.F. voltage and an L.F. voltage simultaneously to the grid of a valve, so that it is operated over a curved characteristic.

The input voltage is

$$\delta v_g = E_1 \cos \omega t + E_2 \cos pt$$

where ω and p are the high and low angular velocities. The anode circuit is resistive to frequencies around ω.

The coefficients and indexes of e are :—

$E_1 \qquad \pm \omega$

$E_2 \qquad \pm p$

If the indexes $\pm \omega$, $\pm p$ are given values

a, b, c and d

the following combinations occur for the second and third order terms :—

Order.	Combination.	Resultant Angular Velocity.	Coefficient.
2nd	$a + c$	$\omega + p$	$2\,E_1E_2$
,,	$a + d$	$\omega - p$	$2\,E_1E_2$
3rd	$a + a + b$	ω	$3\,E_1^3$
,,	$a + c + c$	$\omega + 2p$	$3\,E_1E_2^2$
,,	$a + d + d$	$\omega - 2p$	$3\,E_1E_2^2$
,,	$a + c + d$	ω	$6\,E_1E_2^2$

The complete expression up to the third order is then :—

$$\delta i_a = gE_1 \cos \omega t + \frac{1}{2!} g'(E_1E_2 \cos (\omega + p)t + E_1E_2 \cos (\omega - p)t) + \frac{1}{3!} g''[(\tfrac{3}{4}E_1^3 + \tfrac{3}{2}E_1E_2^2) \cos \omega t + \tfrac{3}{4}E_1E_2^2 \cos (\omega + 2p)t + \tfrac{3}{4}E_1E_2^2 \cos (\omega - 2p)t]$$

This expression contains a carrier

$$[gE_1 + \frac{1}{3!} g''(\tfrac{3}{4}E_1^3 + \tfrac{3}{2}E_1E_2^2)] \cos \omega t$$

and four side bands representing the modulation frequency and its 2nd harmonic.

It will be seen that attempts to increase the modulation ratio, increases the relative strength of the distortion by an amount proportional to the L.F. voltage E_2. Also that the third order term introduces an extra carrier term which tends to reduce the modulation efficiency.

The method of modulating a carrier described above is not in general use. It is more common practice to apply the L.F. voltage through the tuned output circuit to the anode, while the H.F. voltage is applied to the grid. The anode current is not now a function of the grid voltage only, but of the anode voltage as well. The anode voltage will contain terms due to the L.F. frequency, the carrier frequency, and the side-band frequencies, and of the distortion side-band frequencies if these are present. The effects can be examined by successive approximations, using the present method of finding the effective terms, by expanding the equation

$$i_a = f(v_a, v_g)$$

This would take us beyond the scope of the simplification made at the beginning of this paper.

High Frequency Mixing

In a super het. the signal and oscillator frequencies are applied in various ways to a detector working into a tuned circuit resonant at the beat frequency. This case is different from that of the L.F. detector, where the output is an L.F. resistance. The applied signal is :—

$$\delta v_g = E \cos \omega t + B \cos (\omega \pm p)t + E_2 \cos \omega_2 t$$

which represents a modulated carrier and the E.M.F. due to the local oscillator. The output load is resistive to frequencies in the neighbourhood of $(\omega - \omega_2)/2\pi$.

The coefficients and indexes are as follows :

E	$\omega = a$		B	$\omega - p = e$
E	$-\omega = b$		B	$-\omega - p = f$
B	$\omega + p = c$		E_2	$\omega_2 = g$
B	$-\omega + p = d$		E_2	$-\omega_2 = h$

The second and even order terms give output of the required frequencies. Only the combinations $a + h$; $c + h$; $e + h$; will give output terms in the neighbourhood $+ (\omega - \omega_2)$.

The output is therefore given, up to the second order, by

$$\delta i_a = \tfrac{1}{2} \cdot g'(EE_2 \cos (\omega - \omega_2)t + BE_2 \cos (\omega - \omega_2 \pm p)t)$$

The output is seen to be proportional to the oscillator voltage and the modulation ratio is unchanged, while no second harmonic distortion is produced, as in L.F. detectors. The fourth and higher even terms introduce distortion.

I wish to thank the Electric and Musical Industries, Ltd., Hayes, Middlesex, for permission to publish this article.

Books Received

Small Transformers. Their Design and Construction

By A. H. Avery

In addition to practical instructions in building small mains transformers of the type used in wireless receivers, this booklet gives diagrams for the usual tests, and devotes two chapters to various types of rectifier. Pp. 56 with 46 illustrations and diagrams. Published by Percival Marshall and Co., Ltd., London. Price 9d.

Photo Cells and Their Application. (2nd Edition)

By V. K. Zworykin, E.E., Ph.D. and E. D. Wilson, Ph.D.

The history, theory and construction of photo-electric cells, methods of amplification and their use in photometry, colour matching, sound recording and reproduction, phototelegraphy, television, etc. Greatly enlarged from previous edition with five entirely new chapters. Pp. 331+xv. with 180 illustrations and diagrams. Published by John Wiley and Sons, Inc., New York, and Chapman and Hall, Ltd., London. Price 18s. 6d.

Some Characteristics of Short-wave Propagation

Paper by Prof. J. Hollingworth, M.A., D.Sc., M.I.E.E., before the Wireless Section, I.E.E., on 7th December, 1932

Abstract

THE first part of the paper describes the phenomena observed when using a cathode-ray direction-finder on closed coils for examining short wave signals of the order of 30 m. (10,000 kc./s). A schematic diagram of the apparatus is shown in Fig. 1.* The set is worked on closed coils in order to include the horizontal polarised component which is essential from the theoretical standpoint. Their orientation is unimportant, but it is convenient in practice to have them *N-S* and *E-W*. The receiver uses a frequency change from the signal frequency to 2.5 kc./s, and at 30 m. wavelength a field of about 10μV/m. gives a deflection of about 2 cm. on the oscillograph.

In general, the pattern on the oscillograph is in the nature of an ellipse, frequently appearing to be in a state of violent irregular oscillation, but closer study permits the picking out of certain definite characteristics, viz.: (1) *Straight Line*, sometimes oscillating about a mean position or rotating continuously, both effects being very frequent; (2) *Rotating Ellipse;* (3) *Oscillating Ellipse;* (4) *Circle*, sometimes persisting up to 30 seconds; (5) *Pulsating Ellipse*, most pronounced on distant stations; (6) *Inverting Ellipse;* (7) *General Feeding.*

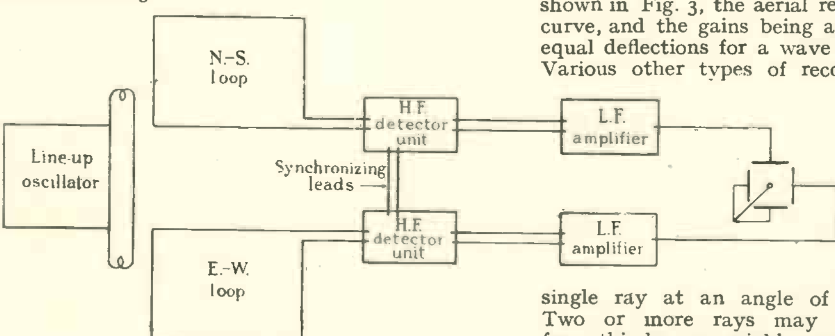

Fig. 1.

The author's primary effort is then directed to an attempt to fit in the observed ellipse-characteristics with the magneto-ionic theory, which takes cognisance both of the ionised layer and of the effect of the earth's magnetic field on the returned signal. According to this theory the upgoing ray on striking the ionised region is split by double refraction into two components; whose return paths are determined by the relation between the density N and the refractive index μ. This relation is given by a complex vector equation which allows for the effect of the earth's magnetic field.

From the evidence of the author's experiments it is concluded that in general this theory provides a reasonable explanation of the majority of the phenomena observed. In the more complicated cases, especially when dealing with long-distance transmissions, the proof is less rigorous. This is, however, probably due to the limitations of visual analysis of transient phenomena rather than to breakdown in theory.

The second part of the paper describes experiments which have for their purpose the determination of the angle of incidence of the downcoming ray. The apparatus uses a vertical aerial and a coil, each with its associated receiver, which can be worked on the same station at the same time without mutual interference. This apparatus can also be worked simultaneously with and close to the cathode-ray receiver already described. The aerial and coil receivers are joined to amplifiers whose output is rectified and passed to mirror oscillographs recording on a common band of travelling photographic paper. The coil is first turned into the plane of propagation ("Direct" position), and then abruptly turned through right angles ("Crossed" position). A typical record is shown in Fig. 3, the aerial reading being the lower curve, and the gains being adjusted so as to give equal deflections for a wave arriving horizontally. Various other types of record are illustrated in the paper.

The most striking fact that arises from these observations is that it appears definitely possible to have a signal from a station at a distance of 2,500 km. consisting of a single ray at an angle of incidence of 30 deg. Two or more rays may be present separated from this by appreciable angles. The persistence of this high angle over considerable periods suggests that there are a certain finite number of possible paths for the ray which have a considerable degree of permanence and that the apparent variations of angle of incidence of the incoming signal are primarily due to variations in the energy distribution between these fixed paths. It is extremely difficult to reconcile these results with the idea of multiple reflections, since a 30 deg. ray would roughly correspond to a tenth reflection (assuming a layer height of 250 km.) and it would be necessary to provide a mechanism by which all other rays, including, for example, the ninth and eleventh reflections, were totally absorbed or caused to vanish by electron limitation.

* The Author's original figure numbers are used throughout this abstract.

The general experimental results are not nearly as complete as the author would have liked, and it is hoped to carry them much further in the future. The work described was done at the Radio Research Stn., Slough, of the Department of Scientific and Industrial Research.

Two theoretical and mathematical appendices deal with (i) Study of the Ellipse produced in a Cathode-ray Direction Finder ; (ii) Form of trace obtained when more than one downcoming ray is present.

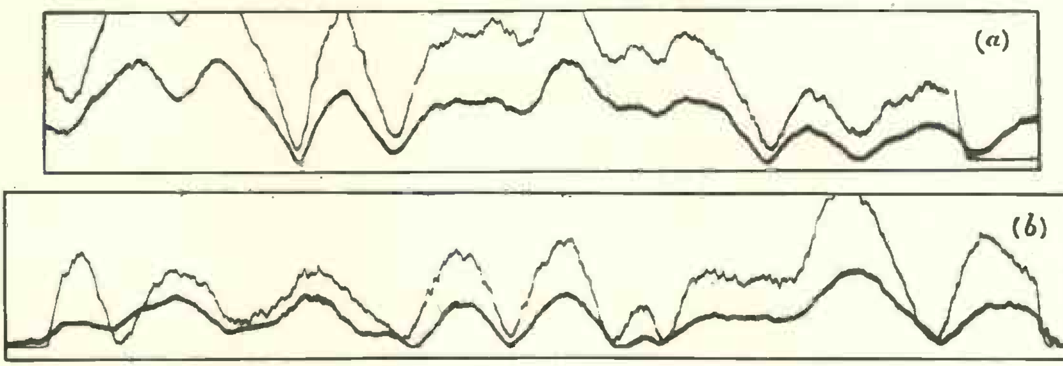

Fig. 3.—(a) *Coil in "direct" position. This shows close agreement in shape and ratio between coil and aerial curves.* (b) *Coil in "cross" position. This shows the slight departures from correspondence at low intensities. It succeeds Fig.* 3 (a) *immediately in time. Each exposure* 20 *sec.*

In presenting the paper at the meeting, the author elaborated on the definitions and meanings of polarisation, angle of incidence, etc., and also developed a new theoretical explanation of the angles of incidence observed on long-distance transmissions. This was concerned with the bending effect, first of the E region while the ray was on its way up to the F region actually concerned with its return, and further bending at the E region in the process of its return to earth.

Discussion

Dr. R. L. Smith Rose referred to the difficulties that arose due to the fact that the phenomena were in three dimensions. In previous work on this subject it had been necessary to take separate and simultaneous measurements of the direction of V and H, and also of the intensity of U. These were now done in one operation in the cathode-ray technique. He did not consider the coil-aerial combination accurate for the determination of large angles of incidence.

Prof. L. S. Palmer liked the explanations developed by the author in the presentation of the paper and hopes it was the correct one. He queried the size of coil used, *e.g.*, were they above 2.5 m. in size ? It was possible to get phase effects such as those described by the author due to a single downcoming ray and a single reflection from the ground. He queried also the effects of the polarisation of the indirect ray where it was first incident on the layer.

Mr. J. A. Ratcliffe said that he had encountered a number of similar points in medium-wave propagation. The chief importance as to the state of the downcoming ray lay in the differential absorption of the two magneto-ionic components. He criticised certain of the assumptions made in the author's theoretical development of Appendix I, also the behaviour of a "suppressed ray" receiver in the presence of more than one downcoming ray.

Mr. Smith referred to pulse-transmission experiments in which either of the two magneto-ionic components could be selected for examination of its state of polarisation.

After the author had briefly replied to some of the points raised in the discussion a vote of thanks was carried on the motion of the Section Chairman, Mr. L. B. Turner, M.A.

The late Mr. G. S. Kemp

The death of Mr. G. S. Kemp, one of Marchese Marconi's first assistants in this country, has removed a well-known figure in wireless engineering circles. The late Mr. Kemp, who was seventy-six years of age, was still in the service of the Marconi Company at the time of his death and had completed over thirty-five years with the Company. It was in December, 1901, that he, together with Mr. P. W. Paget, accompanied the young Marconi to St. John's, Newfoundland, where the historic first radio signals were picked up on a kite aerial from Poldhu in Cornwall.

Abstracts and References

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PROPAGATION OF WAVES

ULTRA-SHORT WAVES: MARCHESE MARCONI'S LECTURE AT THE ROYAL INSTITUTION.—Marconi. (*Electrician*, 9th Dec., 1932, Vol. 109, p. 758.)

Short summary of the lecture of 2nd December, sections of which dealt with the recent Rocca di Papa–Cape Figari results on a 57-cm wave, the distance being 275 km (1932 Abstracts, p. 632), and the Vatican–Castel Gandolfo service (20 km over land, screened by intervening trees).

SOME CHARACTERISTICS OF SHORT WAVE PROPAGATION [especially Long-Distance Reception of a Single, Very High-Angle Ray].—J. Hollingworth. (Short summary in *Electrician*, 23rd Dec., 1932, Vol. 109, p. 810.)

The I.E.E. paper read on 7th December, 1932, dealing in a preliminary way with phenomena observed when using a cathode-ray direction finder for examining received signals on frequencies of the order of 10 mc/s. The systematic appearance of certain cyclic forms is examined in the light of the magneto-ionic theory, and the majority of them are found to be capable of explanation on this basis. The most striking fact arising from the tests is that it appears definitely possible to have a signal, from a station 2 000 km away, consisting of a single ray with an angle of incidence of 30°. Two or more other rays may be present, separated from this by considerable angles. The persistence of this high-angle ray (which can hardly be accounted for by multiple reflection) over considerable periods leads to the tentative suggestion that there are a certain finite number of possible paths which have a considerable degree of permanence, and that the apparent variations of angle of incidence of the incoming signal are primarily due to variations in the energy distribution between these fixed paths.

ANGLE OF ELEVATION OF SHORT-WAVE RAYS.—T. Walmsley. (*Nature*, 26th Nov., 1932, Vol. 130, p. 814.)

This preliminary letter gives the results of measurements of the angle of elevation at the transmitting end of the path of waves [of length of the order of 20 m] for transmissions between Rugby and New York. It was found that, during the past year, the best angle of projection of waves traversing an all-light path varied only ± 2° or 3° from 10° to the horizontal. "The average field as measured at the receiving end has corresponded approximately to that portion of the energy radiated along a direction having an angle of elevation of 10°."

THE EFFECT OF THE SUN'S ECLIPSE ON RADIO WAVES [Facsimile Observations on about 35 Metres and Aural on 30 Metres: Effect of Electronic Shadow Found].—E. F. W. Alexanderson. (*Rad. Engineering*, Oct., 1932, Vol. 12, pp. 19–20.)

"The outstanding result of the observations was that this normally strong signal [from Schenectady, 200 miles away, on about 35 m] almost totally disappeared during the two hours preceding the optical eclipse of the sun, which . . . would be the time during which the corpuscular or electronic eclipse would take place." This signal came back, first in a scattered way and then strongly and continuously, shortly before the optical eclipse began.

Simultaneous aural observations on a 30-metre signal from Germany showed a maximum strength (with a very substantial increase) during the very period when the Schenectady signal was at its minimum. This increase in the German signal is attributed to the effect of night produced by the electronic shadow over the Atlantic: "a 30-metre signal is known to be stronger over such a distance at night." The difficulty in explaining why the presence or absence of electronic bombardment to the east of the point of observation (for the electronic shadow fell entirely to the east of the path of total eclipse, where the observations were made) should have such an effect on a signal from the west (Schenectady) is surmounted by assuming that this signal arrived not by direct travel but by "Hoyt Taylor" reflection from a point some 1 000 miles east. The nature of the graphic record is said to indicate the occurrence of two such reflections, yielding two rays of which the one had travelled several hundred miles more than the other. "This theory of reflection may also explain the recent findings of Marconi that even ultra-short waves may at times reach points far beyond the horizon" [*see* top of left hand col.]. It is suggested that the reflecting medium involved may be the Appleton layer. Finally, "the important fact established is that a signal of a particular wave-length and a particular distance is almost completely suppressed by the electronic eclipse if this eclipse area lies immediately beyond the point of observation as seen from the transmitting station."

AN EFFECT OF THE RECENT SOLAR ECLIPSE ON THE IONISED LAYERS OF THE UPPER ATMOSPHERE [supporting Ultra-Violet Light as Ionising Agency for Lower Layer].—J. P. Schafer and W. M. Goodall. (*Science*, 11th Nov., 1932, Vol. 76, No. 1976, pp. 444–446.)

Results of investigations carried out at the Bell Telephone Laboratories. Three transmitters and receivers adjusted to the frequencies 2 398, 3 492.5, and 4 797.5 kc/s were used. A magnetic disturbance introduced difficulties in interpreting results, but certain phenomena were outstanding. Lower layer reflections were being received for the 2 398 kc/s signal when the light eclipse began. These disappeared during the eclipse, and upper layer reflections, weak at first but soon becoming strong, were received. Upper layer reflections on all three frequencies were much stronger during the central portion of the eclipse. "Everything taken together, the phenomena observed during the eclipse were suggestive of the changes which occur in the lower layer during the late afternoon from about 2 hours before sunset until sunset, followed by the changes which occur during the corresponding period after sunrise.

" If the ionisation in the lower layer were due to ultra-violet light, the minimum in the ionic density and hence the most pronounced effect on the lower layer reflections should have occurred a few minutes after the maximum of the light eclipse." If the layer is due, however, to neutral particles emitted from the sun, the minimum in ionic density should occur near the end of the corpuscular eclipse. Actually, the ionisation minimum occurred at 3.45 p.m. and the light eclipse maximum at 3.34 p.m. For the corpuscular eclipse to cause an ionisation minimum at that time, it is shown that the speed of the neutral particles would have to be of the order of 10 000 km/sec. As there is little or no evidence to justify this high speed, the authors conclude that the ultra-violet theory is the correct interpretation of their results.

THE ECLIPSE OF THE SUN OF 31ST AUGUST, 1932, AND THE "SOUNDING" BY ATMOSPHERIC PARASITES.—J. Lugeon. (*Comptes Rendus*, 7th Nov., 1932, Vol. 195, pp. 817–819.)

Records, on 11 000 m wavelength, taken near Warsaw, at Tromsö, and at Bjornoya, are shown and discussed in relation to the photoelectric action of the ultra-violet solar radiation on the ionisation of the upper atmosphere, and in particular to the writer's theories (1931 Abstracts, pp. 29—two—and 318).

METEORS CAUSE REFLECTION OF SHORT WAVE RADIO SIGNALS.—A. M. Skellett: Schafer and Goodall. (*Sci. News Letter*, 26th Nov., 1932, p. 335.)

Radio pulse measurements made by Schafer and Goodall during the Leonid meteor shower of November 15th-16th confirm Skellett's theory (1932 Abstracts, p. 156) that meteors cause sufficient ionisation in the upper atmosphere to reflect short waves. Coincidently with the occurrence of meteors overhead, the ionic density of the lower layer often increased, this increase lasting from 20 seconds to 2 minutes and sometimes longer.

RADIO TRANSMISSION FROM THE STRATOSPHERE, DURING PICCARD'S ASCENT.—(*E.T.Z.*, 3rd Nov., 1932, Vol. 53, No. 44, p. 1062.)

Note of a French article on the communication maintained with the Zurich Station.

KURZER ÜBERBLICK ÜBER DIE PHYSIK DER HOHEN ATMOSPHÄRE (A Short Survey of the Physics of the Upper Atmosphere).—J. Bartels. (*Zeitschr. f. tech. Phys.*, No. 12, 1932, Vol. 13, pp. 611–616.)

This short survey (taken from a longer survey shortly to appear in *E.N.T.*) neglects all work connected with the propagation of electromagnetic waves and with polar aurorae and confines itself to information derived from observations of high clouds, twilight, shooting stars, the light of the night sky, absorption by ozone, the propagation of sound waves, and the variations of terrestrial magnetism. The writer concludes that the most valuable information of all comes from the last-named domain: he wishes that the newly developed and valuable tool of radio propagation should be used in close conjunction with the magnetic results. As an example of lack of co-ordination he mentions the hypothesis of the high conducting layer, deduced from magnetic observations by Balfour Stewart in 1878 and quickly developed by Schuster: this had to be re-deduced, from data of radio propagation, more than 20 years later!

ESTIMATING THE THICKNESS OF THE OZONE LAYER BY VISUAL PHOTOMETRY.—J. Gauzit. (*Comptes Rendus*, 14th Nov., 1932, Vol. 195, pp. 892–894.)

NOTE ON THE FIELD INTENSITY OF THE MARCONI BROADCASTING STATION ERECTED AT WARSAW.—Eckersley. (*See* under "Stations, Design and Operation.")

DIE MAGNETISCHE DREHUNG DER POLARISATIONSEBENE VON ELEKTROMAGNETISCHEN WELLEN IN IONISIERTEN GASEN (The Magnetic Rotation of the Plane of Polarisation of Electromagnetic Waves in Ionised Gases [Experimental Confirmation of Theory]).—P. Keck and J. Zenneck. (*Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, pp. 153–158.)

Description of laboratory researches on 4 cm waves, with paraffin lenses (*cf.* Dänzer, 1929 Abstracts, p. 500). The effectiveness of these lenses was confirmed by preliminary tests. Ionisation (up to about $5 \times 10^{11}/cm^3$) was produced by the electrodeless discharge. A comparison of the measured rotations, in neon, argon and nitrogen at various pressures, with the theoretical values calculated from the equation $\phi = \frac{\pi l}{\lambda}(n_1 - n_2)$, is given in the final table. The maximum disagreement does not exceed 10%: this is as good as could be expected in view of the probable errors in measuring the angle of rotation, the absorption coefficient, and the refraction coefficient. These last two quantities have to be found in order to obtain values for n_1 and n_2, the phase velocities of the two circularly-polarised components.

LES GAZ IONISÉS DANS LE CHAMP MAGNÉTIQUE; PRESSIONS PLUS PETITES QUE 10^{-3} MM HG (Ionised Gases in the Magnetic Field; Pressures less than 10^{-3} mm Hg [and the Effect of Water Vapour]).—Th. V. Jonescu and C. Mihul. (*Comptes Rendus*, 7th Nov., 1932, Vol. 195, pp. 765–767.)

Continuation of the work dealt with in 1932 Abstracts, pp. 335 and 399–400. The paper concludes: "The study of the propagation in the upper atmosphere of waves longer than 10 m has shown that the reflecting layers are to be found at great altitudes. The calculations made from our results have shown that these waves are strongly reflected for pressures below 10^{-4} mm HG; that is to say, at heights greater than 150 km. Even at these heights oxygen should be found." *See* also next abstract.

LES GAZ IONISÉS DANS LE CHAMP MAGNÉTIQUE ; PRESSIONS PLUS GRANDES QUE 10^{-3} MM Hg (Ionised Gases in a Magnetic Field ; Pressures greater than 10^{-3} mm Hg).—Th. V. Jonescu and C. Mihul. (*Comptes Rendus*, 28th Nov., 1932, Vol. 195, pp. 1008–1010.)

Pressures below 10^{-3} mm Hg were dealt with in a previous paper (*see* above). In the present tests the conductivity and dielectric constant were measured in air, hydrogen and nitrogen. In the two latter gases measurement was easy and the same values were always obtained for the same pressures, but in air the shapes of the curves were reproducible, but not the identical values. The curves given are those for hydrogen and nitrogen.

For pressures of the order of 10^{-2} mm, the effect only of the free electrons is seen, both on the conductivity and on the dielectric constant. For higher pressures the appearance of the curves changes, and "everything happens as if there were other vibrations than those due to the free electrons." But for high values of the magnetic field these other vibrations vanish, only those due to the free electrons remaining. The field values for which the conductivity passes through a maximum vary with the pressure. The dielectric constant also undergoes changes characteristic of resonance phenomena (Fig. h). The researches were extended to deal with widely varying wavelengths and fields exceeding 100 gauss : under these conditions "other changes were found."

The paper ends with the statement : "Since these changes are found in nitrogen and in air for pressures between 2×10^{-2} and 1.5×10^{-1} mm Hg, they must also occur in the atmosphere at heights between 50 and 80 km. These changes have a high value during the day, when they favour the propagation of waves of 5 to 6 m ; they may carry with them the absorption of long wavelengths."

ÜBER DIE ABSORPTION KURZER ELEKTRISCHER WELLEN IN IONISIERTEN GASEN, EIN VERSUCH ZUM NACHWEIS DER LANGWELLIGEN STRAHLUNG DES WASSERSTOFFATOMS (On the Absorption of Short Electric Waves in Ionised Gases, an Attempt to Establish the Existence of the Long Wave Radiation of the Hydrogen Atom).—O. Betz. (*Ann. der Physik*, 1932, Series 5, Vol. 15, No. 3, pp. 321–344.)

A full account of work of which a short description was recently given by Klumb (1932 Abstracts, p. 517).

METINGEN VAN DIELECTRISCHE VERLIEZEN AAN RICINUSOLIE (Measurements of Dielectric Losses in Castor Oil [Confirmation of Debye's Formulae for Anomalous Dispersion and Absorption, for Wavelengths 200–2 000 Metres]).—J. L. Snoek. (*Physica*, No. 7, Vol. 12, 1932, pp. 234–238.)

THE THEORY OF CRITICAL OPALESCENCE IN THE DIFFUSION OF LIGHT [Discrepancies between Observed Facts and the Calculations of Einstein and of Ornstein and Zernicke : a New Theory].—Y. Rocard. (*Comptes Rendus*, 7th Nov., 1932, Vol. 195, pp. 771–773.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

LOW ALTITUDE AURORAE.—S. Chapman. (*Nature*, 19th Nov., 1932, Vol. 130, pp. 764–765.)

This note describes an unusually low aurora witnessed at Tromsö on 8th March, 1932, and already described by Harang and Bauer. The note also discusses the occurrence and significance of exceptionally low aurorae. *See* also Bauer, 1932 Abstracts, p. 578.

ON THE FORMATION OF NEGATIVE IONS ACCORDING TO QUANTUM MECHANICS [and the Light of the Night Sky].—Y. Rocard. (*Comptes Rendus*, 21st Nov., 1932, Vol. 195, pp. 945–947.)

At the end of his paper the writer applies his results to show the possibility (under certain assumptions, one being that the Heaviside layer is 30 km thick) that a great part of the continuous spectrum of the light from the night sky is due to the formation of negative ions of helium or hydrogen in the layer.

STUDY OF THE ELECTRICAL CONDUCTIVITY AND CONDENSATION NUCLEI ON A VOYAGE TO GREENLAND.—Ch. Maurain and J. Devaux. (*Comptes Rendus*, 14th Nov., 1932, Vol. 195, pp. 837–840.)

THE VALUE OF THE TOWNSEND COEFFICIENT FOR IONISATION BY COLLISION AT LARGE PLATE DISTANCES AND NEAR ATMOSPHERIC PRESSURE.—F. H. Sanders. (*Phys. Review*, 1st Sept., 1932, Series 2, Vol. 41, No. 5, pp. 667–677.)

A METHOD OF PROTECTION AGAINST DIRECT LIGHTNING STROKES [for Points on an Overhead Line particularly liable to such Strokes].—W. Holzer. (*Bull. Assoc. Suisse d. Élec.*, 11th Nov., 1932, Vol. 23, No. 23, pp. 636–637.)

Prompted by the work of Dauzère and of Lehmann, dealt with in past Abstracts and below, the writer has patented a process by which lightning is to be diverted to spots where it can do no harm by the use of special rockets forming an ionised path from the cloud. Some such result is already obtained in high Alpine plateaus by the use of large fires.

THE CAUSES OF THE PREVALENCE OF LIGHTNING STROKES AT CERTAIN POINTS ON A HIGH-TENSION LINE [Effect of Subterranean Water : Hazel-Twig Divining].—G. Lehmann. (*E.T.Z.*, 13th Oct., 1932, Vol. 53, No. 41, pp. 980–983.) *See* also Abstracts, January, p. 32 ("Lightning Research") and 1932, p. 577.

LIGHTNING AND ITS BEHAVIOUR TO OVERHEAD LINES.—V. Aigner. (*Ibid.*, pp. 985–986.)

OVERHEAD LINES AND LIGHTNING DISTURBANCES ACCORDING TO RECENT FOREIGN PUBLICATIONS.—D. Müller-Hillebrand. (*E.T.Z.*, 24th Nov., 1932, Vol. 53, No. 47, pp. 1121–1125.)

On the "Return" Shock.—E. Mathias. (*Comptes Rendus*, 14th Nov., 1932, Vol. 195, pp. 844–846.)

Bead-Corona on Radio Antenna.—B. van der Pol.—(*Nature*, 29th Oct., 1932, Vol. 130, p. 662.)

This letter describes a curious high frequency-high tension phenomenon observed on several days in February and March, 1932, under exceptionally dry atmospheric conditions. A bead corona on the aerial of the Hilversum broadcasting station "caused an acoustical effect such that the modulation of the emission could clearly be heard up to a distance of approximately 800 m. A reduction of the antenna power from 20 kw to 12 kw caused the phenomenon to disappear."

The Eclipse of the Sun of 31st August, 1932, and the "Sounding" by Atmospheric Parasites.—Lugeon. (*See* under "Propagation of Waves.")

Papers on Atmospheric Electricity and Terrestrial Magnetism, at the International Electricity Congress, Paris.—(Summaries in *Elektrot. u. Masch:bau*, 27th Nov., 1932, Vol. 50, No. 48, pp. 666–668.)

Intensity of Cosmic-Ray Ionisation in Western North America.—R. D. Bennett, J. L. Dunham, E. H. Bramhall and P. K. Allen. (*Phys. Review*, 1st Nov., 1932, Series 2, Vol. 42, No. 3, pp. 446–447.)

This preliminary report gives curves showing the variation of ionisation with barometric pressure at lat. 40° N. and the variation of ionisation with latitude. "The results indicate no significant variation of intensity of ionisation due to penetrating radiation . . . in the region covered" [Alaska, California, Colorado].

Ionosphere Rays Possible as New Name for Cosmic Rays.—Compton. (*Sci. News Letter*, 19th Nov., 1932, p. 321.)

Compton says "cosmic rays may be satisfactorily explained if we suppose that the cosmic rays consist of electrons originating some hundreds of miles above the surface of the earth in the upper atmosphere." Three lines of evidence support this theory :—(1) Variation of intensity with latitude, indicating a variation with the magnetic field of the earth. (2) Variation with altitude. The intensity approaches a constant value at high altitudes [*cf.* next abstracts]. Also, Piccard's results show that at a height of about 10 miles as many rays are passing horizontally as vertically. (3) Variation between day and night, supporting Compton's magnetic theory.

He states, however, that there is still the possibility of a portion of the rays coming from outer space.

Progress of Cosmic-Ray Survey.—A. H. Compton. (*Phys. Review*, 1st Sept., 1932, Series 2, Vol. 41, No. 5, pp. 681–682.)

Extension of measurements previously reported (1932 Abstracts, p. 578) confirm the conclusion that the intensity of the cosmic rays at sea-level increases with distance from the equator. Measurements to date of the cosmic rays at sea-level can be expressed satisfactorily as a function only of the dip of the earth's magnetic field. "The intensity of the cosmic rays seems to increase continuously to as high altitudes as the measurements have as yet been made."

Altitude Increases Quantity of Cosmic Rays.—L. M. Mott-Smith. (*Sci. News Letter*, 12th Nov., 1932, p. 308.)

". . . the intensity of cosmic rays at 25 000 feet is about 21 times that at sea level and is still increasing rapidly." At that height, "1 inch of lead reduces the intensity by 40 %, a surprisingly large amount."

Airplane Cosmic-Ray Intensity Measurements [Preliminary Report].—L. M. Mott-Smith and L. G. Howell. (*Phys. Review*, 15th Oct., 1932, Series 2, Vol. 42, No. 2, pp. 314–316.)

Diurnal Variation of Cosmic Rays and Terrestrial Magnetism.—R. Gunn. (*Phys. Review*, 1st Sept., 1932, Series 2, Vol. 41, No. 5, p. 683.)

This note points out "that the diurnal variation of the cosmic ray intensity is a necessary consequence of the newly demonstrated deflectibility of the ionising particles by the earth's magnetic field."

An Interpretation of Cosmic-Ray Phenomena.—T. H. Johnson. (*Phys. Review*, 1st Sept., 1932, Series 2, Vol. 41, No. 5, pp. 545–552.)

The writer interprets Schindler's data on the transition effects of the cosmic rays (1932 Abstracts, p. 219, left hand column) "on the assumption that the equilibrium between the primary radiation and its secondary corpuscular rays is different in different media." The absorption coefficients of the primary radiation and the production and absorption coefficients of the secondary rays are deduced for lead and iron, and the following estimates are made. "(*a*) The lower limit of the average energy of the secondary radiation is about 3×10^7 volts. (*b*) The average number of secondaries per primary is about 100 in iron and 230 in lead. (*c*) The energy of a primary cosmic ray, equal to the sum of the energies of its secondaries, is about 2×10^{10} volts."

The Variation of the Cosmic-Ray Intensity with Azimuth.—T. H. Johnson and J. C. Street. (*Phys. Review*, 1st Sept., 1932, Series 2, Vol. 41, No. 5, p. 690.)

A preliminary note on the investigation referred to in January Abstracts, p. 34—two.

Magnetisches Spektrum der Höhenstrahlen (Magnetic Spectrum of Cosmic Rays).—P. Kunze. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 3/4, pp. 203–205.)

Curved cosmic ray tracks are obtained with a Wilson expansion chamber in a strong homogeneous magnetic field. From these, with certain assumptions, the energy of the corpuscles may be deduced. Positively charged particles occur more frequently than negatively charged ones. An energy spectrum showing the frequency distribution is given.

SPECTRUM OF COSMIC RADIATION.—A. W. Conway. (*Nature*, 15th Oct., 1932, Vol. 130, p. 581.)

The writer notes that a formula such as that suggested by Skapski (Jan. Abstracts, p. 33) " can be deduced from the classical equations of Maxwell without reference to wave mechanics."

SOLAR COMPONENT OF COSMIC RAYS.—J. C. Stearns, W. P. Overbeck and R. D. Bennett. (*Phys. Review*, 15th Oct., 1932, Series 2, Vol. 42, No. 2, pp. 317–318.)

The writers' experiments lead to the deduction that " the sun does not contribute any appreciable amount of the total cosmic radiation."

THUNDERSTORMS AND PENETRATING RADIATION.—G. B. Rizzo. (*Nature*, 15th Oct., 1932, Vol. 130, p. 584.)

This note reports an observation of the screening effect of thunderstorms on ordinary fine-weather penetrating radiation, similar to that observed by Schonland (January Abstracts, p. 33).

THE IONISATION DUE TO GAMMA AND COSMIC RAYS IN OXYGEN AND XENON [Preliminary Communication].—V. Masuch. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 3/4, pp. 264–265.)

" SUPER-RADIUM " SUPPLIED ENERGY FOR RAPID COSMIC EVOLUTION [Cosmic Rays are Traces of the Radiation emitted Then].—G. Lemaitre. (*Sci. News Letter*, 3rd Dec., 1932, Vol. 22, No. 608, p. 351.)

COSMIC-RAY IONISATION AS A FUNCTION OF PRESSURE, TEMPERATURE, AND DIMENSIONS OF THE IONISATION CHAMBER.—F. W. Broxon. (*Phys. Review*, 1st Nov., 1932, Series 2, Vol 42, No. 3, pp. 321–335.)

" The experiments herein described constitute further evidence in favour of the contention that the explanation of the characteristics of cosmic-ray ionisation at high pressures, entirely in terms of secondary radiations from the vessel walls, is quite inadequate."

SECONDARY RADIATION PRODUCED BY COSMIC RAYS.—J. M. Benade. (*Nature*, 5th Nov., 1932, Vol. 130, p. 699.)

The writer has made measurements of cosmic rays on a mountain-top in the Himalayas at an altitude of about 19 500 ft using a Lindemann electrometer with screens of different materials. " The results of these measurements indicate clearly that the ionisation of gas in an ionisation chamber is due at least in part, if not entirely, to a secondary radiation produced in the walls of the chamber and other surrounding media, by cosmic radiation . . . it is obvious that the density and thickness of the ionisation chamber walls must have a considerable effect on the shape of the curves obtained by different instruments."

A SELF-RECORDING COSMIC-RAY ELECTROMETER AND DEPTH-IONISATION CURVE.—J. M. Benade. (*Phys. Review*, 15th Oct., 1932, Series 2, Vol. 42, No. 2, pp. 290–297.)

This paper describes a self-contained automatic recording electrometer which has been used to measure intensity of cosmic rays at various depths in a lake in Kashmir. " The curve obtained corresponds to those of Millikan and Cameron to a depth of 50 metres, but at greater depths it more closely parallels that of Regener."

SECONDARY EFFECTS OF PENETRATING CORPUSCULAR RADIATION: ANOMALIES OF ABSORPTION OF PENETRATING RADIATION.—B. Rossi: Rossi and Crino. (Summaries in *Sci. Abstracts, Sec. A*, Oct., 1932, Vol. 35, No. 418, pp. 964–965 and 965.)

ON THE LIMITS OF APPLICATION OF THE MATHEMATICAL THEORIES OF THE VERTICAL COUNTER EFFECT IN COSMIC RADIATION AND OF THE COSMIC RAY COINCIDENCES.—L. Tuwim. (*Zeitschr. f. Physik*, 1932, Vol. 77, No. 11/12, pp. 815–817.)

EFFICIENCY OF GEIGER COUNTER AND ABSORPTION OF COSMIC RAYS.—J. C. Jacobsen. (*Nature*, 15th Oct., 1932, Vol. 130, p. 581.)

The efficiency was found to approach unity at the upper limit of the sensitive range of voltage; the writer thinks that it would be very difficult to account for such high efficiency if the cosmic rays were of electromagnetic nature.

EFFICIENCY OF THE GEIGER-MÜLLER COUNTER.—B. Rossi. (*Nature*, 5th November, 1932, Vol. 130, p. 699.)

Referring to the letter by Jacobsen (*see* above abstract) the writer notes that the experiments there described confirm results already obtained by himself in 1930 and adds that " the efficiency of the counter does not vary when the thickness of the wall is very markedly reduced; which proves that the discharge in the tube is actually due to the direct ionisation of the primary cosmic rays, and not to some softer secondary radiation generated by the primary rays in the walls of the tube."

THE DISCHARGE MECHANISM IN THE GEIGER-MÜLLER COUNTER AND ITS CONNECTION WITH PROPERTIES OF THE NORMAL GLOW DISCHARGE.—W. Schulze. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 1/2, pp. 92–110.)

PROPERTIES OF CIRCUITS

UNTERSUCHUNGEN ÜBER DEN GITTERSTROMEINSATZPUNKT BEI VERSTÄRKERRÖHREN (Investigations on the Setting-In Point of Grid Current in Amplifier Valves).—H. Rothe. (*Telefunken-Zeit.*, July, 1932 [publication delayed], Vol. 13, No. 61, pp. 45–51.)

In amplifier valves with indirectly heated oxide cathodes, grid current begins to flow at a negative grid potential of about one volt; in valves with directly heated oxide cathodes, particularly those made by the barium vapour process, it sets in only for positive grid voltages. The writer investigates this difference in behaviour, taking throughout his paper the setting-in point as the grid potential at which the grid current amounts to 10^{-7} A. He first discusses from a theoretical standpoint the various factors controlling this point (initial current characteristic, contact potential, voltage drop along the cathode, and anode potential), and then gives the results of numerous tests on various types of valve in both classes.

The following conclusions are reached :—The different behaviour of the two classes of cathode is at once comprehensible when the potential distribution between anode and cathode is considered. In valves with indirectly heated cathodes the system anode/cathode can be considered as a plane system, so that the potential has a linear course, whereas in valves with thin cathodes it runs according to a logarithmic law. With directly heated cathodes, therefore, the potential produced at the grid by the anode potential, and consequently the anode potential displacement also, are considerably larger than with indirectly heated cathodes. " To sum up, it may be said that in valves with directly heated cathodes the grid current setting-in point always lies in the positive grid potential region, because the low emissivity makes the emission displacement comparatively small, so that it is completely compensated by the additive effects of contact potential, heating voltage displacement and anode voltage displacement. The small variations occurring in both classes are chiefly due to differences in contact potential, *i.e.* to differences of grid work function."

La Détection des Oscillations modulées (The Detection of Modulated Oscillations [and the Deficiencies of the Usual Valves for Both Methods of Detection]).—G. Varret. (*L'Onde Élec.*, Sept., 1932, Vol. 11, No. 129, pp. 315–328.)

An investigation of experimentally obtained " detection characteristics " for anode-bend and grid detection, paying special attention to the action of the output impedance (whether the output is to a succeeding stage of amplification or to the telephone or loud speaker itself) and to the occurrence of distortion. In spite of the fact that the valve employed was specially recommended for detection, the following conclusions are arrived at :—

Neither method of detection gives a perfect solution. In the case of anode detection, the r.f. amplitudes must be kept comparatively low. The apparent internal valve resistance under the best conditions is about three times as great as that of the same valve working as an amplifier; since, therefore, the output impedance must be carefully matched with the valve resistance, it is wrong to employ the same type of transformer after the detector as after an amplifier stage. Such a transformer would cause a loss of the low notes.

In grid detection, a considerable continuous current must pass through the primary of the transformer—a current several times as great as the corresponding current in anode detection. Grid detection requires an even more severe limitation of r.f. amplitude than anode detection : provided this is done, an absolutely undistorted output can be obtained even with 100% modulation.

The writer remarks that the only way of improving the detector action, particularly for anode detection, would seem to be to modify the design of detector valves to yield sharper bends and nominal internal resistances two or three times smaller than those of the present valves. In a foot-note he mentions that since this paper was written a certain step forward in the direction of distortionless detection has been made by the production of a special valve with a small additional anode immediately surrounding the filament, forming a little diode to which the process of detection is entrusted (*cf.* 1932 Abstracts, p. 409). Besides allowing the plate voltage and grid bias to be adjusted to give the best distortionless amplification, this separation of the two functions avoids the occurrence of simultaneous anode-bend rectification with its effect, opposed to that of the desired grid detection, of bending the detection curve again upwards. " The extent of the distortionless region is increased, and the inconvenience of a strict limitation of r.f. amplitude is very notably diminished."

The writer ends by pointing out that the " detection-characteristic " method of investigation described can be applied to numerous other " electric relays," such as photo-cell circuits, microphones, etc.

The Efficiency of Valve Detection.—G. Kahan and S. Dierewianko. (*Wiadomości i Prace Inst. Radjotech.*, *Warsaw*, No. 6, Vol. 3, 1931, pp. 80–87.)

Authors' summary :—Amplification can be calculated from the valve characteristics as well as from the valve constants. The introduction of " characteristics for detection " and " constants for detection " allows an analogous method to be applied to the determination of the efficiency of the detector stage and the influence on it of anode voltage, load, and applied a.c. voltage. The effect of these factors on the distortion introduced by detection is demonstrated. The method of determining the best conditions of operation, and the best value for the applied a.c. voltage, is shown by an example.

" Demodulation " [and in particular the " Detector Choking Effect "].—W. B. Lewis : Colebrook. (*Wireless Engineer*, Nov., 1932, Vol. 9, No. 110, pp. 629–630.)

Explanation (with additional information) of the writer's letter dealt with in 1932 Abstracts, p. 33 : instead of being merely a step towards the " Callendar-Appleton theory," the writer's arguments go a step beyond this and are based on a consideration of the dependence of the detector response on the rate of change of carrier amplitude.

Eine frequenzunabhängige Rückkopplung beim Röhrensender und Schwingaudion (A Retroaction Coupling Independent of Frequency, for Valve Oscillators and Oscillating Audions [derived from the Loftin-White Circuit]).—F. Below. (*Hochf:tech. u. Elek: akus.*, Nov., 1932, Vol. 40, No. 5, pp. 167–169.)

According to the theory of the Loftin-White circuit (Fig. 1), the coupling through the mutual inductance increases with the frequency, while that through the common condenser decreases, so that in the region where $1/\omega C_{12} = \omega L_{12}$ the total coupling remains practically constant. Actually it is found that though a region of constant coupling can be obtained, the equality mentioned above only occurs a long way outside that region. The present writer investigates this discrepancy, and shows that the practical result conforms with the true theory. The conditions for the setting-in of oscillation at a coupling adjustment independent of frequency, within the chosen region, are given in equations 8. Under certain conditions one of the inductances can be omitted, the circuit then resolving itself into the 3-point circuit shown in Fig. 5. Under others, the common capacity becomes infinite and can therefore be replaced by a short-circuit. In practice, if the coils are changed to obtain a new constant-coupling region, the common capacity must also be altered. A numerical example of the calculation of the components is given.

NUOVI TIPI DI AMPLIFICATORI TERMOIONICI (New Types of Thermionic Amplifier [particularly the Use of Virtual Negative Resistance in " Compensated " Resistance-Coupled Amplifiers]).—E. Denina. (*L'Elettrotec.*, 15th Oct., 1932, Vol. 19, No. 29, pp. 727–729.)

Some new amplifier circuits successfully used in the Electrochemical Institute, Turin.

FREQUENCY DIVISION BY MEANS OF A DYNATRON OSCILLATOR.—G. Kahan. (*Wiadomości i Prace Inst. Radjotech., Warsaw*, No. 6, Vol. 3, 1931, pp. 78–79.)

POTENTIALS, RESISTANCES AND TUNING IN DAMPED AND UNDAMPED CIRCUITS: ERRATA.—Osnos. (*Hochf:tech. u. Elek:akus.*, Oct., 1932, Vol. 40, No. 4, p. 152.)

Corrections to the paper dealt with in 1932 Abstracts, pp. 635–636.

INITIAL PHASE ANGLES OF LOW-PASS NETWORKS, AND THE PHASE COMPENSATING NETWORKS OF THE " BRIDGED-T " TYPE.—K. Nagai. (Short summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. pp. 10–11.)

SOME EXPERIMENTS ON THE RETARDATION NETWORKS [the Adjustment of the Delay Time, and the Action of Transients].—K. Nagai. (*Ibid.*, p. 11.)

Including a description of the writer's very compact arrangement (in which all the coils have a common magnetic path) enabling the delay time to be made constant for all frequencies from zero to an assigned value by the choice of suitable distances between adjacent coils.

CAN MAGNETISATION FORMULAE BE APPLIED TO THE QUANTITATIVE TREATMENT OF BUILDING-UP PROCESSES IN CIRCUITS CONTAINING IRON ?—J. Hak. (*Elektrot. u. Masch:bau*, 30th Oct., 1932, Vol. 50, No. 44, pp. 597–602.)

ÜBER DAS VERHALTEN VON WELLENFILTERN BEI BELASTUNG DURCH GESÄTTIGTE EISENDROSSELN (The Behaviour of Wave-Filters when Loaded with Saturated Iron Chokes).—H. Wassmann. (*Archiv f. Elektrot.*, 4th Nov., 1932, Vol. 26, No. 11, pp. 745–754.)

ÉTUDE DES RÉGIMES TRANSITOIRES ET DES CONSTANTES DE TEMPS POUR LES PRINCIPAUX CIRCUITS UTILISÉS EN T.S.F. (A Study of Transitory Régimes and Time Constants for the Principal Circuits used in Wireless Engineering).—Y. Rocard. (*L'Onde Élec.*, Sept. and Oct., 1932, Vol. 11, Nos. 129 and 130, pp. 273–295 and 339–363.)

After referring to the Heaviside operator method and the Carson formula, the writer remarks that many engineers are not able to study the action of transients in complex circuits and the protection offered by those circuits to parasitic disturbances. " In this paper we propose to show, with the support of numerous examples, that the study of the transitory régimes of a circuit can be carried out with the same simplicity as the calculation of its resultant impedance. This study is accomplished, for sudden disturbances, by Heaviside's original method ; but when dealing with an arrangement of identical circuits, coupled (without reaction) by screen-grid valves, it is necessary to generalise somewhat the Heaviside process by an obvious mechanism." For a disturbance which is not sudden but is some function of time, the use of Carson's solution can generally be avoided by the writer's method (p. 282 onwards) of finding an imaginary circuit in which a simple disturbance will produce the same effects as those caused by the more complex disturbance in question in the circuit under consideration.

The writer deals in turn with the following problems : (1) The establishment of current in a series of tuned circuits ; (2) the same, in a double circuit coupled by capacity or by mutual inductance ; (3) the true significance of the time constant (pp. 345–349) : circuits with the same apparent selectivity, *i.e.*, with the same amplification curve in their pass-band zone, may behave quite differently to parasitic disturbances ; (4) the time constants of certain important circuits : the series-parallel resonant circuit, the reaction detector (s.g. and triode), the amplifier coupled by transformer with tuned secondary or with tuned primary and secondary ; (5) Motion of a relay actuated by a parasitic disturbance arriving at various types of receiver. This leads to a comparison between a capacity-coupled double circuit and a double circuit inductively coupled, with the resulting conclusion that *circuits with an equal number of stages and the same apparent curve of selectivity may present entirely different protection against sudden disturbances* : in order to work the relay, a parasite would have to be at least twice as strong for inductive coupling as for capacitive coupling.

ON THE THEORY OF ELECTRICAL FILTERS.—V. Bubenik. (*Comptes Rendus*, 28th Nov., 1932, Vol. 195, pp. 1002–1004.)

The writer first considers a " simple " filter composed of resistances in series alternating with resistances in parallel, forming a series of identical " cells." Assuming each cell to be of the " V " type, equivalent to R (the series resistance) and G (the conductance of the combination of the halves of the parallel resistances) he finds the ratio between the voltages at the two ends of a filter section comprising m cells. If now a resistance ρ is connected across the output terminals of the last cell, the filter becomes a "loaded" filter (filtre chargé), and the ratio of the input voltage to the output voltage is given by a continuous fraction S in function of $(k - a)$, where $k = RG + 2$ and $1/a =$ the constant $1 + R/\rho + RG/2$. Thus $V_0 = V_{n+1}S$; S may have any value between 0 and ∞. Similarly if I_{n+1} is the output current intensity, $V_0 = I_{n+1}U$, where U is the resultant resistance of the "loaded" filter, in general a complex resistance depending on the frequency: there are in general several frequencies for which U passes through a minimum (so that the filter has very little effect in decreasing the current) and several for which it is a maximum.

Two-Element Band-Pass Filters [and the Use of Charts].—R. T. Beatty. (*Wireless Engineer*, Oct., 1932, Vol. 9, No. 109, pp. 546–557.)

"The purpose of this paper is to show how the design of band-pass filters can be greatly simplified by the use of charts from which the type of filter best suited to any particular problem can be immediately chosen; the numerical values can then be easily calculated. A method is also given by which resonance curves may be drawn with a minimum of labour. The present treatment is limited to symmetrical filters, but it is hoped to consider in a future paper the effects of asymmetry and reaction."

The Theory of Band-Pass Filters for Radio Receivers.—C. W. Oatley. (*Wireless Engineer*, Nov., 1932, Vol. 9, No. 110, pp. 608–614.)

"The present article may be divided into three parts. In the first of these the theory of the symmetrical two-stage filter is developed and various formulae which may be applied to practical design are derived. In the second part consideration is given to the effects which may arise in actual filters due to lack of symmetry in the two halves of a filter. In particular the effects of faulty ganging are dealt with. Finally, the third part is devoted to an experimental confirmation of the preceding theory."

The Experimental Demonstration of the Effects of Coupling of Harmonic Motions, as illustrating Phenomena in Quantum Mechanics [Study of Coupled Electrical Circuits.]—A. C. Burton. (*Phil. Mag.*, Nov., 1932, Vol. 14, No. 93, pp. 777–788.)

The Direct Solution of Coupled Tuned Circuits.—L. A. Kelley. (*Elec. Engineering*, Nov., 1932, Vol. 51, pp. 789–794.)

A method of computing easily and accurately the transmission characteristics of a coupled tuned circuit under practical operating conditions.

Invariant Properties of the Extreme Fringes of Inducing and Induced [Magnetic] Fields.—Th. Lehmann. (*Rev. Gén. de l'Élec.*, 3rd Sept., 1932, Vol. 32, No. 9, pp. 271–277.)

Pulse Factor and Pulse Damping.—R. Führer. (*T.F.T.*, Oct., 1932, Vol. 21, pp. 263–267.)

TRANSMISSION

Sur l'Amorçage des Oscillations de très haute Fréquence (The Setting-In of Ultra-High-Frequency Oscillations).—A. Witt. (*Comptes Rendus*, 28th Nov., 1932, Vol. 195, pp. 1005–1007.)

The writer takes the case of a diode, but the B.-K. or G.-M. oscillations with a triode can be dealt with similarly; he remarks that among the numerous publications on the subject he knows of none giving the conditions for the setting-in of oscillation. The treatment is entirely mathematical, and the writer shows that at a first approximation the setting-in condition is given by $\frac{\sin \omega T}{\omega T} - \cos \omega T + \rho < O$, where T is the path time at constant potential and ρ is a quantity involving frequency, oscillatory circuit constants, emission current (saturated) and applied potential. The cases where ρ is, and is not, negligible are discussed.

The Generation of Standing Waves [Ultra-Short Waves down to 3 Metres, using Concentric Feeders in the Oscillating Circuit].—I. F. Mouromtseff and H. V. Noble. (Summary in *Elektrot. u. Masch:bau*, 20th Nov., 1932, Vol. 50, No. 47, p. 652.)

See 1932 Abstracts, p. 636, and below and opposite. By the use of two valves in push-pull, one at each end of the concentric feeder, the outputs mentioned can be doubled.

Magnetostatic Oscillator for [Ultra-Short] Waves below 50 Centimetres.—I. F. Mouromtseff and G. R. Kilgore. (Summary in *Elektrot. u. Masch:bau*, 20th Nov., 1932, Vol. 50, No. 47, p. 652.)

"Inside a cylindrical magnet coil traversed by d.c. lies a two-electrode valve with an axial hot filament and a concentric anode consisting of two cylindrical segments. These two segments are carried by two parallel tungsten rods brought through the wall of the valve and prolonged by two conductors, of adjustable length, short circuited at the ends by a cross piece. The d.c. anode supply is led in at the middle point of this cross piece. The field coil can be rotated through some 15° with regard to the valve axis. The mode of action is similar to that of a magnetron, but the oscillations take place between the two halves of the anode by self-excitation, each half acting in turn as a grid for the other half. The frequency depends not on the dimensions of the external circuit but only on the electrical and magnetic relations in the valve. It is desirable, however, to make the anode plus its extension equal to half a wavelength. At 42 cm an output power of 10 watts is obtained."

New Forms of [Ultra-] Short-Wave Tubes [including the "Standing Wave" and "Magnetostatic" Oscillators].—I. E. Mouromtseff, G. R. Kilgore and H. V. Noble. (*Electronics*, Sept., 1932, pp. 278–280.)

See two preceding abstracts. Both arrangements are described and illustrated. By reducing the anode dimensions in the magnetostatic generator, still shorter waves (12–10 cm) can be produced, with reduced output. The main difficulty lies in supplying a sufficiently strong magnetic field.

ULTRA-SHORT-WAVE TECHNIQUE IN RADIO COMMUNICATION.—R. L. Smith-Rose. (*Nature*, 3rd Dec., 1932, Vol. 130, p. 856.)

A note on the papers on the generation of ultra-short waves read by Mouromtseff and Noble and by Mouromtseff and Kilgore at the International Congress of Electricity, Paris, July, 1932 (*see* three preceding abstracts).

NEW TRANSMITTER AND RECEIVER FOR ULTRA-SHORT WAVES [Grid and Anode led out through Both Sides of Bulb, for use with Two Lecher Wire Systems].—Hollmann. (*Electronics*, Oct., 1932, p. 322.)

ON THE GENERATION OF ULTRA-SHORT ELECTROMAGNETIC WAVES USING THE SCHEME OF H. BARKHAUSEN AND K. KURZ.—G. Potapenko. (*Phil. Mag.*, Dec., 1932, Series 7, Vol. 14, No. 95, pp. 1126–1142.)

This paper gives a critical account of the present explanation of the phenomena of generation of ultra-short waves and covers essentially the same ground as papers already dealt with in 1932 Abstracts, pp. 281, 520, 581 and 582.

SELF-MODULATION OF BARKHAUSEN-KURZ ULTRA-SHORT-WAVE TRANSMITTERS.—(Circuit of French Patent in *Electronics*, Nov., 1932, p. 349.)

THE DYNATRON OSCILLATOR [and the Suitability of the Mazda AC/S2 Valve for Frequencies up to at least 60 Megacycles/Sec with Normal Dynatron System].—M. G. Scroggie: Colebrook. (*Wireless Engineer*, Oct., 1932, Vol. 9, No. 109, p. 574.)

A letter prompted by Colebrook's paper on a modified system for very high frequencies (1932 Abstracts, pp. 34, 164, 222, 342, 404 and 582).

[Ultra-?] SHORT WAVE GENERATING CIRCUIT USING VALVE WITH TWO COLD ELECTRODES, POINT AND PLATE.—(Summary of German Patent in *Electronics*, Nov., 1932, p. 348.)

" A very high vacuum is used and some 100 000 volts applied. The E/I curve of such a tube is very steep, and under suitable conditions shows negative resistance . . ."

NEUERUNGEN IM BAU VON RUNDFUNKSENDERN (New Developments in the Design of Broadcasting Transmitters [Chireix De-phasing Modulation, at " Radio-Paris " and " Poste Parisien "]).—H. Singer. (*Elektrot. u. Masch:bau*, 9th Oct., 1932, Vol. 50, No. 41, pp. 560–562.) *See* also 1932 Abstracts, p. 520.

AIRPORT RADIO TRANSMITTER [Western Electric Type 10A].—W. M. Knott. (*Rad. Engineering*, Nov., 1932, Vol. 12, pp. 13–14.)

MODULATED LIGHT-RAY FROM AIRSHIP AS A LINK IN BROADCAST TRANSMISSION.—(*E.T.Z.*, 27th Oct., 1932, Vol. 53, p. 1041; *Electrician*, Vol. 59, p. 296.)

BAND WIDTHS IN FREQUENCY- AND AMPLITUDE-MODULATION.—Lüschen. (*See* abstract under " Miscellaneous.")

MODULATION AND DISTORTION MEASUREMENTS BY MEANS OF THE CATHODE-RAY OSCILLOSCOPE.—S. Bagno and S. S. Egert. (*Rad. Engineering*, Nov., 1932, Vol. 12, pp. 7–9.)

SPECIAL KINDS OF NEON TUBE OSCILLATIONS [using Cylinder and Co-axial Wire Electrodes and a Magnetic Field].—K. Okabe. (Summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. p. 8.)

ELECTRONIC 'PHONE BREAK-IN: ANOTHER 'PHONE BREAK-IN SYSTEM.—J. O. Mesa: H. D. Ashlock. (*QST*, Nov., 1932, Vol. 16, pp. 39–40.)

Prompted by the articles (Chapin, Ewing) referred to in 1932 Abstracts, p. 583.

EFFICIENCY IN THE OUTPUT AMPLIFIER [and Aerial]: SOME SUGGESTED METHODS OF INCREASING ANTENNA POWER.—F. H. Schnell. (*QST*, Nov., 1932, Vol. 16, pp. 17–21.)

RECEPTION

THE SCREEN-GRID VALVE AS A FREQUENCY-CHANGER IN THE SUPER-HET [Theoretical Treatment and Practical Conclusions].—E. L. C. White. (*Wireless Engineer*, Nov., 1932, Vol. 9, No. 110, pp. 618–621.)

One result of the theory is that " the best value of grid bias is zero or just sufficiently negative to avoid grid current, and not, as previously supposed, such as to bring the operating point to the bottom bend of the grid volts / anode current characteristic." This is confirmed by experimental curves.

ON SUPER-REGENERATION.—Egerland. (Summary in *Electronics*, Nov., 1932, p. 349.)

THE TWO-CIRCUIT TUNER [in Broadcast Receivers: Usual Adjustment of Coupling loses Brilliancy of High Notes: Desirability of Small Amount of Adjustable Tone Correction].—Editorial. (*Wireless Engineer*, Oct., 1932, Vol. 9, No. 109, p. 545.)

HIGH SELECTIVITY TONE-CORRECTED CIRCUITS.—G. W. O. H. (*Wireless Engineer*, Nov., 1932, Vol. 9, No. 110, pp. 605–607.)

Editorial on Radio Research Special Report No. 12, recently issued by the Department of Scientific and Industrial Research.

RETAINING HIGHER FREQUENCIES: PART II. FREQUENCY CORRECTION.—E. G. Bowen. (*Television*, Oct., 1932, Vol. 5, No. 56, pp. 296–298.)

A REGENERATIVE RESISTANCE AMPLIFIER FOR A WIDE FREQUENCY BAND.—H. Wada. (Short summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. p. 10.)

" By adjusting the circuit, the voltage amplification may be controlled and the frequency/amplitude and frequency/phase distortions may be decreased, thus enabling a good frequency characteristic to be obtained. It is experimentally shown that a uniform amplification for a frequency band of from 10 to 3×10^5 c/s is possible even with triodes."

A Practical Criterion of Selectivity [Unsatisfactory Nature of I.R.E. Practice and of Thomas' Method: Need of Arbitrary Limit defining "Just Appreciable" Interference: Suggestion of 10% Relative Audio-Volts Output].—M. V. Callendar. (*Wireless Engineer*, Nov., 1932, Vol. 9, No. 110, p. 631.)

Improving the Grid-Leak Detector: a Simple Method of Obtaining Greater Linearity in a Superheterodyne Receiver [Addition of Second R.F. Choke between Anode and Junction of By-Pass Condenser and R.F. First Choke].—C. H. Smith. (*World Radio*, 9th Dec., 1932, Vol. 15, No. 385, pp. 1264–1265.]

Double-Grid Valve in Circuit to prevent Overloading [Anode-Bend Rectification] in Grid Detection. (Summary of French Patent in *Electronics*, Oct., 1932, p. 323.)

Grid Bias from Anode Current: Some Necessary Precautions.—J. C. van Reysschoot: F. J. A. Pound. (*Wireless Engineer*, Nov., 1932, Vol. 9, No. 110, pp. 630–631.)

Correspondence on Pound's article referred to in 1932 Abstracts, p. 639.

A New Development in Tuning [" Permeability " Tuning].—R. W. Hallows. (*World Radio*, 18th Nov., 1932, Vol. 15, No. 382, pp. 1152 and 1156.)

Ferrocart, a New Material [and a Two-Valve Receiver using Ferrocart Coils].—H. Olvenstedt. (*Die Sendung*, 18th Nov., 1932, Vol. 9, No. 47, p. 1020.)

Some Causes of Interference with Radio Reception on Aeroplanes, and Methods of Overcoming Their Effects.—L. Zanini. (*L'Elettrotec.*, 15th Oct., 1932, Vol. 19, No. 29, pp. 724–725.)

Anti-Fading Circuit using Variable-Mu Valve.—Chrétien. (Short summary in *Electronics*, Sept., 1932, p. 298.)

Preferably with anode-bend detection. No independent battery is needed, total anode current remains constant (important for mains-fed sets), and margin of regulation is said to be very great.

Balancing Radio Receiving Circuits [Discussion of Methods of Stabilising against Oscillation].—D. M. Tennil. (*Rad. Engineering*, Sept., 1932, Vol. 12, pp. 17–18.)

Automatic Disconnection of Mains Aerial on plugging in the Outside Aerial, in a Telefunken Receiver. (*Die Sendung*, 16th Sept., 1932, Vol. 9, No. 38, p. 820.)

Der gegenwärtige Stand im Rundfunkempfängerbau (The Present Position in Broadcast Receiver Design [Berlin Exhibition and Vienna Autumn Fair, 1932]).—E. Klein: E. Mittelmann. (*Elektrot. u. Masch:bau*, 23rd Oct., 1932, Vol. 50, No. 43, pp. 586–589.)

New Ideas in American Sets.—(*Wireless World*, 9th December, 1932, Vol. 31, pp. 518–520.)

Automatic volume control, a visual tuning indicator, acoustic compensation, a push-pull diode detector, and a resistance-coupled push-pull output stage are among the features to be found in this season's models.

Ingenious Circuits in New Radio Receivers.—(*Electronics*, Nov., 1932, pp. 330–331.)

Acoustically compensated volume control (increasing bass and high notes at low volume level): proper phase- and amplitude-relations for push-pull stage resistance-coupled to preceding valve: saturated transformer control of incandescent lamp as visual tuning-indicator: etc., etc.

Monodial D.C. Super.—W. T. Cocking. (*Wireless World*, 2nd and 9th December, 1932, Vol. 31, pp. 490–494 and 510–513.)

A seven-valve d.c. mains-operated superheterodyne receiver for the amateur constructor. The principal features are:—a preliminary stage of r.f. amplification at signal frequency, special band pass filters with a total of eight tuned circuits, one stage of tone correction, an output stage consisting of two power pentodes in parallel, and volume control by variation of the grid bias of the signal-frequency and intermediate-frequency amplifiers, in which positions variable-mu valves are employed.

New Auto Radio Receiver [Nine-Valve Superheterodyne with Class B Amplification].—RCA Victor Company. (*Rad. Engineering*, Oct., 1932, Vol. 12, p. 20.)

The " Die Sendung " 5-Valve Superheterodyne Receiver [with only one I.F. stage: Automatic Volume Control]. (*Die Sendung*, 11th Nov., 1932, Vol. 9, No. 46, pp. 997–998.)

The Wireless World Straight Three [Battery Operated].—H. F. Smith. (*Wireless World*, 16th December, 1932, Vol. 31, pp. 528–531.)

An Improved Version of the Loftin-White Circuit [using only Indirectly-Heated Valves, including a Pentode in the Output Stage].—H. Prinzler. (*Die Sendung*, 9th and 16th Sept., 1932, Vol. 9, Nos. 37 and 38, pp. 800 and 822–823.) *See* also *ibid.*, 30th September, p. 867. For a paper on the Loftin-White circuit *see* under " Properties of Circuits " (Below).

An All-Wave [Two-Valve] Midget Receiver: a Semi-Portable covering from 12 to 4 500 Metres.—R. B. Parmenter. (*QST*, Nov., 1932, Vol. 16, pp. 14–16 and 86–87.)

THE SINGLE-SIGNAL RECEIVER AT WORK: THE SINGLE-SIGNAL SUPER IN ANOTHER DRESS.—R. B. Parmenter : D. L. Lusk : Lamb. (*QST*, Nov., 1932, Vol. 16, pp. 29–31 : 31–32 and 90.)

More on the receiver referred to in Jan. Abstracts, p. 39.

AERIALS AND AERIAL SYSTEMS

DIE VERTEILUNG DER STRAHLUNGSLEISTUNG LÄNGS EINER DIPOLANTENNE (The Distribution of Radiated Power along a Dipole [Half-Wave] Aerial).—R. Bechmann. (*Telefunken-Zeit.*, July, 1932 [publication delayed], Vol. 13, No. 61, pp. 51–54.)

Of the two methods of treatment described by the writer in a previous paper (1931 Abstracts, pp. 96–97 and 155), the first, using the Poynting vector, is unsuitable for the present purpose, as it gives only the total radiation flow; the second, here applied, replaces the excited linear aerial by a corresponding convection current, employs the Hertzian vector, and deals with the processes in the aerial itself. A distribution law for the radiated energy is obtained, represented by

$$S_z = \frac{240\, I^2}{\lambda} \cdot \frac{\cos^2 kz}{1 - (4z/\lambda)^2}.$$

Here S_z is the energy radiated in unit time from unit length at a position z along the aerial, and I the current value at the antinode. By integration over the whole aerial this yields the established formula for the dipole radiation output, $S = 73.13\, I^2$. An expression is also found for the local radiation resistance, for unit length in the position z.

REPLY TO MR. HALLÉN'S REMARKS ON MY PAPER "THE FREE ELECTRICAL VIBRATIONS OF ROD-SHAPED CONDUCTORS."—K. F. Lindman. (*Ann. der Physik*, Oct., 1932, Series 5, Vol. 15, No. 1, pp. 127–128.)

For reference to Hallén's paper *see* 1932 Abstracts, p. 640.

A STUDY OF [Ultra-] SHORT WAVE DIRECTIVE ANTENNAE.—S. Chiba, S. Taki and S. Ito. (Summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. p. 8.)

As types of untuned beam aerials, the Beverage wave antenna and the Yagi-Uda wave director were tested on 84 cm waves. As types of tuned arrays, a zig-zag system for vertically polarised 84 cm waves, and a vertical plane horizontal-doublet system for horizontally polarised 50 cm waves, were tested, with particular attention to their behaviour when used simultaneously on the same site. "The vertical and the horizontal waves are projected with no appreciable mutual interference with each other."

A NEW TYPE OF DIRECTIVE AERIAL [with Radiating Elements of Progressively Increasing Length: Especially Suitable for Ship-Shore Working].—T. Walmsley. (*Wireless Engineer*, Nov., 1932, Vol. 9, No. 110, pp. 622–625.)

There is no separate reflector curtain, reflector action being obtained without recourse to the usual inductive excitation of reflector wires or to the coil and condenser phasing devices introduced to produce the necessary phase difference between the two curtains. The usual non-radiating feeder termination for matching the surge impedance of the array is replaced by a radiating element, thus increasing the radiation efficiency.

DIRECTIONAL BROADCASTING AT WFLA–WSUN [Two Insulated Towers tuned to a Quarter Wavelength and spaced a Quarter Wavelength].—Wilmotte. (*Rad. Engineering*, Sept., 1932, Vol. 12, p. 16.)

To eliminate interference caused by this station (in Florida) to another station (in Milwaukee) on the same 620 kc channel. The plan is to operate the towers in phase during the day, when no interference trouble arises, and out of phase at night. Preliminary tests indicate that a distinct dark sector covering about 90° is given. The boundaries of this sector are remarkably sharp. "Everyone is anxious to learn whether the system is suppressing the sky wave in the direction of Milwaukee as well as it has eliminated the direct or ground wave in that direction."

RESULTS OF THE BRESLAU "ANTI-SPACE-WAVE" ONE-WIRE BROADCASTING AERIAL.—Böhm. (Short summary in *Electronics*, Nov., 1932, p. 350.)

The aerial dealt with in 1932 Abstracts, p. 526, "is giving excellent results. At 80 km the fading was in the ratio of 1 : 2 maximum (and rarely over 1 : 1.2) as compared with 1 : 30 with the normal antenna; at 160 km, 1 : 12 maximum (average 1 : 2) as against 1 : 50. Good reports of distant reception have been received, *e.g.* from Greece and Finland." *See* also under "Stations, Design and Operation."

ANGLE OF ELEVATION OF SHORT-WAVE RAYS.—Walmsley. (*See* under "Propagation of Waves.")

A THREE-SIDED RADIO TOWER [Self-Supporting 200-Foot Tower, Steel Tube Construction].—S. Couzin. (*Rad. Engineering*, Oct., 1932, Vol. 12, pp. 17–18.)

EARTH RESISTANCES [Potential Gradient in the Surrounding Soil depends only on Dimensions of the Earth Plate].—G. F. Tagg. (*Elec. Review*, 30th Sept., 1932, Vol. 111, p. 460.)

VALVES AND THERMIONICS

TELEFUNKEN TRANSMITTING VALVES [including Short- and Ultra-Short-Wave Types, and Special Valves for Decimetre Waves].—W. E. Kühle. (*Telefunken-Zeit.*, July, 1932 [publication delayed], Vol. 13, No. 61, pp. 5–19.)

With photographs and table of data.

RADIATION-COOLED POWER TUBES FOR RADIO TRANSMITTERS.—H. E. Mendenhall. (*Electronics*, Oct., 1932, pp. 316–317.) *See* January Abstracts, pp. 40–41.

VALVE WITH GLOW DISCHARGE AS ELECTRON SOURCE.—(German Pat. 381 432, Telefunken, accepted 6th Oct., 1932.)

A cathode unit consists of two flat strip electrodes, the cathode and the auxiliary electrode for producing the glow discharge, separated by a strip of insulating material, preferably mica. Several of these units are arranged round the control grid, which encloses, and is concentric with, the anode. The electrons passing from cathode to anode are forced to take a circuitous path owing to the auxiliary electrodes being larger than the cathodes, thus completely screening them from the anode.

NEW FORMS OF [Ultra-] SHORT-WAVE TUBES [including the "Standing Wave" and "Magnetostatic" Oscillators].—Mouromtseff, Kilgore and Noble. (*See* under "Transmission.")

A POWER AMPLIFIER PENTODE TUBE [Radiotron 48, Cunningham C-48]. (*Rad. Engineering*, Nov., 1932, Vol. 12, p. 15.)

"Advance information . . . discloses that the rib structure fastened to the inner surface of the plate serves to suppress the effects of secondary emission which limit the power output of four-electrode, screen-grid types." Applications and tentative rating and characteristics are given.

NOTES ON THE 59-TYPE POWER OUTPUT TUBE [Three Grids, Seven-Prong Base; for Alternative Use as Triode, Class A or Class B, or Pentode, Class A].—K. W. Jarvis. (*Electronics*, Oct., 1932, pp. 310–311.)

Also, "new functions of using the extra grids for tone controlling and harmonic suppression are already in evidence." *See* also Chicago Trade Show, 1932 Abstracts, pp. 459–460.

RADIO TUBE PROGRESS [Arcturus 58: Radiotron 55—Two Diode and Triode Unit: Radiotron 82—Full Wave Rectifier]. (*Rad. Engineering*, Sept., 1932, Vol. 12, p. 26.)

CHARACTERISTICS OF AMERICAN ELECTRONIC TUBES: WITH CHART.—K. Henney. (*Electronics*, Oct., 1932, p. 308: chart inset.)

THE SCREEN-GRID VALVE AS A FREQUENCY-CHANGER IN THE SUPER-HET.—White. (*See* under "Reception.")

DYNAMIC TUBE MEASUREMENTS OVER WIDE RANGES OF VALUES [by Valve Bridge].—W. N. Tuttle: General Radio Company. (*Electronics*, Nov., 1932, pp. 344–345.)

INVESTIGATIONS ON THE SETTING-IN POINT OF GRID CURRENT IN AMPLIFIER VALVES [Comparison between Directly and Indirectly Heated Cathodes].—Rothe. (*See* under "Properties of Circuits.")

NEW MATERIAL FOR RADIO TUBES ["Svea" Plate and Wire for Electrodes, Plates, Getter Cups, Screens, Lead-In and Support Wires, etc.].—H. C. Todd. (*Rad. Engineering*, Sept., 1932, Vol 12, pp. 18–20.)

"A special type of exceptionally pure Swedish iron made by a secret process to approach a chemically pure iron." Contains about one-half the occluded gas found in nickel, has a greater heat resistance, a coefficient of expansion nearer to that of glass, very low hysteresis loss, and other valuable properties.

GRIDS FOR TUBES [Comparison between Molybdenum and Nickel].—F. L. Hunter. (*Rad. Engineering*, Aug., 1932, Vol. 12, pp. 12–13.)

CIRCUIT FOR DETERMINING HEATING TIME OF VACUUM TUBES [using Telecron Clock].—W. P. Koechel. (*Electronics*, Sept., 1932, p. 293.)

THE THERMIONIC EFFECT TREATED ACCORDING TO THE FERMI STATISTICS AND WAVE MECHANICS.—B. Rossi. (*L'Elettrotec.*, 15th Nov., 1932, Vol. 19, No. 32, pp. 797–798.)

PAPERS ON THE INVESTIGATION OF OXIDE CATHODES BY MEANS OF THE ELECTRON MICROSCOPE.—Brüche and Johannson. (*See* abstracts under "Subsidiary Apparatus and Materials.")

DIRECTIONAL WIRELESS

AN IMPROVED GONIOMETER-TYPE DIRECTION FINDER FOR HIGH-FREQUENCY WAVES [using Adcock Aerials and a Divided Search Coil].—T. Tsukada. (Summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. p. 8.)

The rotating search coil is divided into two parts (on a common shaft) electrically connected in series and set at right angles to each other. There are two aerial coils, each within its shielded chamber and each coupled to one part of the search coil. Two sets of Adcock-type aerials are used. Stray couplings between the two aerial coils are thus entirely eliminated, and successful direction finding on high frequencies can be carried out.

THE CATHODE-RAY DIRECTION FINDER USED FOR EXAMINING LONG-DISTANCE SHORT-WAVE SIGNALS.—Hollingworth. (*See* abstract under "Propagation of Waves.")

SUR DES ENREGISTREURS ULTRA-SENSIBLES POUR AVION DE VARIATION D'ALTITUDE ET DE TEMPÉRATURE (Supersensitive Recorders of Altitude- and Temperature-Variations, for Aircraft).—P. Idrac. (*Comptes Rendus*, 7th Nov., 1932, Vol. 195, pp. 761–762.)

ACOUSTICS AND AUDIO-FREQUENCIES

VERTEILUNG DER SCHALLSTRAHLUNG VON KREISSCHEIBEN MIT KNOTENLINIEN (Distribution of Sound Radiation from Circular Discs with Nodal Lines [Mathematical Investigation]).—N. W. McLachlan. (*Ann. der Physik*, 1932, Series 5, Vol. 15, No. 4, pp. 422–439.)

This paper discusses mathematically the radiation from flexible plates, using approximations for the dynamical deformation curves which permit rapid calculation of the radiation characteristic. The strict solution is also given.

DIE AUSGESTRAHLTE SCHALLLEISTUNG VON KREISSCHEIBEN MIT KNOTENLINIEN (The Acoustic Power Radiated from Circular Discs with Nodal Lines [Mathematical Investigation]).—N. W. McLachlan. (*Ibid.*, pp. 440–454.)

Continuing the paper referred to in the previous abstract, the power radiated by the discs when vibrating as there described is investigated and its ratio to that radiated from a rigid disc of the same oscillatory amplitude is found.

LOUD SPEAKERS: DISCUSSION AT INFORMAL MEETING OF I.E.E.—McLachlan and others. (*Electrician*, 2nd Dec., 1932, Vol. 109, p. 713.)

McLachlan, in his opening talk, said that a single loud speaker would only cover adequately a range up to 4 or 5 thousand c/s: extension to 7 000 c/s by a second instrument made reproduction much more natural, and the masking effect of low tones was offset to a greater extent. Large low-frequency amplitudes cause alien tones owing to inelastic centring devices and the movement of the coil to the non-uniform field outside the air gap. Improvement in efficiency and greater damping of resonances would accrue with stronger magnetic fields and improved magnet design, preferably electromagnets. To obtain high efficiency a horn could be used with good results with a 6-inch diaphragm.

MacGregor showed a slide illustrating a device of bakelite construction which had been tried successfully in French marine service: the stiffness of the centring device was altered, thus making it possible to shift the resonant points. Hughes pointed out that the original source of sound "has a size": this implies that an orchestra requires a reproducer of very large area: he suggested an arrangement of loud speakers to obviate this disability. Sowter said that the magnet criterion factor suggested by McLachlan should be used in preference to a mere statement of flux density.

DAMPING OF LOW-FREQUENCY OSCILLATIONS IN A M.C. LOUD SPEAKER.—N. W. McLachlan. (*Wireless Engineer*, Oct., 1932, Vol. 8, No. 109, pp. 559–563.)

Author's summary:—"(1) A fourth order differential equation is given which can be adapted to investigate the l.f. growth or decay transients in a m.c. loud speaker. (2) When the natural frequency of the diaphragm on its surround occurs in the l.f. audible region, *e.g.*, above 25 c/s, the transient is usually oscillatory. (3) For good reproduction the natural frequency with the coil on open circuit should be below audibility. This does not apply to the case where the surround acts as an annular membrane. Here the natural frequency of the membrane should be in the neighbourhood of 100 c/s. (4) The stronger the magnetic field and the lower the *closed* coil circuit resistance, the greater the damping.

"There is little doubt that if the magnetic field strength in commercial loud speakers were increased appreciably, the quality of reproduction would be enhanced owing to a reduction in the natural oscillations which occur over the frequency range, and to the livelier response to transients (quicker growth and decay)." *Cf.* Neumann, 1932 Abstracts, p. 170.

METHODS OF INVESTIGATING THE VIBRATIONAL FREQUENCIES OF CONICAL SHELLS AND LOUD SPEAKER DIAPHRAGMS.—N. W. McLachlan. (*Wireless Engineer*, Nov., 1932, Vol. 9, No. 110, pp. 626–628.)

Applications and limitations of (1) bridge measurement of motional resistance and inductance, (2) measurement of steady air pressure on axis, and (3) recording acoustic output when shell is electrically impulsed.

MATHIEU'S EQUATION AND THE M.C. LOUD SPEAKER [Analysis of Electro-Mechanical Rectification].—N. W. McLachlan. (*Wireless Engineer*, Oct., 1932, Vol. 9, No. 109, pp. 573–574.)

Analysis of the phenomenon referred to in 1932 Abstracts, pp. 464 and 589.

SPECIAL LOUD SPEAKER FOR REPRODUCTION OF LOW NOTES IN LARGE AUDITORIUM.—A. M. B. Charlin and P. M. G. Toulon. (Long summary of French Patent in *Rev. Gén. de l'Élec.*, 26th Nov., 1932, Vol. 32, No. 21, p. 167 D.)

LOUD SPEAKERS AT THE BERLIN SHOW.—Nesper. (Summary in *Electronics*, Oct., 1932, p. 322.)

Including notices of the Grassmann dynamic coil, allowing separation to be unusually small: light-weight permanent magnets (Dietz and Ritter): membrane stiffening devices (Müller, radial supports; Grassmann, folded membrane; Schwarzer, flat folded membrane—*see* also January Abstracts, p. 43).

LOUD SPEAKER CURVES AND THEIR INTERPRETATION.—P. G. A. H. Voigt. (*Wireless World*, 25th November and 2nd December, 1932, Vol. 31, pp. 474–476 and 500–501.)

LOUD SPEAKER REQUIRES WIDER BAND THAN TELEPHONE RECEIVER FOR EQUAL SPEECH INTELLIGIBILITY.—Lüschen: Hines. (*See* abstract under "Miscellaneous.")

NEW VELOCITY ["Ribbon"] MICROPHONE PROMISES REVOLUTIONARY BROADCAST ADVANCES [Uniform Response from Zero to 14 000 Cycles/Sec].—RCA Victor Company. (*Rad. Engineering*, Sept., 1932, Vol. 12, p. 15.)

THE RIBBON MICROPHONE AND ITS APPLICATIONS.—J. Weinberger. (*Electronics*, Nov., 1932, pp. 336–337 and 356.)

A MINIATURE CONDENSER TRANSMITTER [Microphone] FOR SOUND-FIELD MEASUREMENTS [Overall Diameter ¾ Inch].—W. M. Hall. (*Journ. Acous. Soc. Am.*, July, 1932, Vol. 4, pp. 83–93.)

THE PICK-UP AND THE FIDELITY OF REPRODUCTION.—G. Varret. (*L'Onde Élec.*, Oct., 1932, Vol. 11, No. 130, pp. 364–379.)

In an ordinary pick-up the writer calculates that the groove must exert, on the end of the needle, alternating forces rising to 100 grammes or more. With a view to reducing these forces, and their consequences of record-wear and distortion, he has constructed a special pick-up in which the moving part is the needle itself and nothing more. One pole of the permanent magnet is prolonged by a block of india-rubber in which is embedded (for about half its length) the needle. The other pole is prolonged by a laminated two-branched pole piece, each branch carrying a winding of many turns of very fine wire. The ends of this pole piece lie close to the rubber block where the needle emerges, so that the latter lies in the air gap between the two branches.

Any movement of the needle increases the flux through one branch and decreases it through the other, and the two windings are connected in opposition so that the effects add together. The output is only of the order of 1/10 volt compared with about 1 volt from the ordinary pick-up, so that an additional stage of amplification is necessary; special precautions must also be taken to avoid various parasitic inductions. But the final result is a reproduction free from background noise and of a fidelity which—short of abolishing the needle altogether—seems unsurpassable; record-wear, moreover, is notably reduced.

PICK-UP RESONANCE AND NEEDLE SCRATCH.—A. W. Stewart. (*Wireless World*, 16th December, 1932, Vol. 31, p. 533.)

The majority of pick-ups show a marked resonance between 3 000 and 5 000 cycles. In this article details are given of various experiments carried out with tuned acceptor circuits in order to overcome this undesirable characteristic.

TURNTABLE DESIGN AND OPERATION.—V. V. Gunsolley. (*Rad. Engineering*, Nov., 1932, Vol. 12, pp. 17–20.)

ZUR THEORIE DER MAGNETISCHEN TONAUFZEICHNUNG (The Theory of Magnetic [Steel Wire or Band] Sound Recording).—E. Hormann. (*E.N.T.*, Oct., 1932, Vol. 9, pp. 388–403.)

From the author's summary:—By tests on models the course of the lines of force is investigated and the various effects of leakage flux made clear. It is desirable to magnetise the carrier, before recording, up to the point of maximum remanence. High frequencies are distorted. The limit of distortionless recording depends, for one-pole recording, on the size of the "leakage zone" a (Fig. 10); for two-pole recording, on the gap breadth b_1 (Fig. 12). [An artifice arising from this latter fact consists in making one pole thicker than the other but with fewer or no turns of winding (Fig. 14)].

Reproduction involves a double differentiation. With two-pole reproduction the total e.m.f. is the geometrical resultant of the two separate e.m.fs, with the result that interference may occur. Moreover, the ratio of the pole-core breadth h [determining the gap between the conductors forming the winding—Fig. 17] to the wavelength becomes of importance. It is desirable that h should be about equal to half the minimum wavelength [for steel-band working there is a possibility that non-rectangular pole surfaces might improve matters here].

In recording, the a.c. must be superposed on a d.c. which sets the working point on the middle of the straight part of the characteristic. The preliminary magnetising current must be opposed to this biasing d.c.

It is advantageous to perform the wiping-out process with one pole [there are several disadvantages in the use of two poles, one being the danger that a leakage flux may cause a reduction of the desirable maximum remanence—p. 398]. The pole-core breadth, and in two-pole recording and wiping-out the pole-gap also, must be large compared with the diameter of the carrier.

Short wavelengths of the magnetising fluctuations weaken the remanence and reduce the effective number of turns of the reproducing winding [the winding should be brought as near as possible to the carrier—p. 400]. The frequency characteristic depends on the combined action of several factors, some of which favour the high frequencies, some the low. The resultant curve falls off both at high and at low frequencies. The *amplitude* of the process is limited upwards by the complete modulation of the hysteresis curve, and downwards by the reversibility which appears at small amplitudes.

Various types of distortion are discussed [section IX: section VII deals with the influence of carrier speed]. The method of transverse magnetisation [section X] is inferior to the longitudinal magnetisation method. *See* also Meyer and Schüller, below.

MAGNETISCHE SCHALLAUFZEICHNUNG AUF STAHLBÄNDER (The Magnetic Recording of Sound on Steel Bands).—E. Meyer and E. Schüller. (*Zeitschr. f. tech. Phys.*, No. 12, 1932, Vol. 13, pp. 593–599.)

Authors' summary:—"The work deals with magnetic sound recording on steel bands of varying origin. Single- and double-pole [open- and closed-circuit] sound-boxes were employed for recording and reproducing; air-cored coils were also used. The static and dynamic remanence curves of the different recording sound-boxes were plotted: on them depends the linearity and the modulation zone. The reproducing sound-boxes chiefly govern the dependence on frequency of the whole equipment: this dependence varies according to whether the magnetic potential difference or the magnetic flux issuing from the band is picked up; it also depends very much on the wavelength and the gap width. In addition to the frequency curves, the non-linear distortion factor and the background-noise level and spectrum were measured." *See* also Hormann, above.

DISTORTION DANS L'ENREGISTREMENT ET LA REPRODUCTION DU SON (Distortion in Recording and Reproduction of Sound [I. "Kinematic" Distortion, in Sound-on-Film and Magnetic Systems: Application to Secret Telephony]).—I. Podliasky. (*L'Onde Élec.*, Oct., 1932, Vol. 11, No. 130, pp. 380–394.)

Later papers will deal with geometrical, optical, photographic, electrical and acoustical distortion, and the parts they play in the complete electro-acoustical chain from recording to reproduction. The present paper considers only the theory of the distortion produced by variations in the recording and reproducing speeds. This distortion, as the writer establishes on p. 386, is analogous to frequency distortion in a wireless transmitter. The very small fluctuations causing it may be studied by the use of an induction accelerometer. From p. 390 onwards the paper deals with the use of such kinematic distortion for secret telephony systems.

OFFICE DICTATING MACHINES NEED BETTER FIDELITY.—(*Electronics*, Oct., 1932, p. 315.)

" AUTOMATIC SECRETARY " FOR RECORDING TELEPHONE CONVERSATIONS WITHOUT ELECTRICAL CONNECTIONS TO TELEPHONE CIRCUIT.—Loftin-White Laboratories. (Illustrated in *Electronics*, Sept., 1932, p. 281.)

The pick-up coil of the disc recorder, placed near the telephone bell box, utilises the leakage flux from the open-core repeating coil contained in the latter, giving both sides of the conversation.

METHOD OF RECORDING SOUND BY MEANS OF A CATHODE RAY.—H. von Hartel. (Summary of French Patent in *Rev. Gén. de l'Élec.*, 26th Nov., 1932, Vol. 32, No. 21, pp. 167–168 D.)

A NEW SYSTEM OF REPRODUCING SOUND PHOTO-ELECTRICALLY.—Selgas and Laffon. (*Electrician*, 9th Dec., 1932, Vol. 109, p. 758.)

Paragraph on a system just demonstrated in Madrid, claimed to render easy (and therefore less costly) and more perfect " the photographic development of the photo-sound ribbon," and to register sounds of higher frequency. No particulars are given.

SOUND FILM RECORDING [especially the Photophone System].—M. E. Federici. (*L'Elettrotec.*, 5th Oct., 1932, Vol. 19, No. 28, pp. 705–713.)

DER TON WIRD SYNCHRONISIERT (Sound is Synchronised [the Use of the " Rhythmograph " in Transposing Sound Films into Other Languages]).—N. Feinberg : Blum. (*Die Sendung*, 28th Oct., 1932, Vol. 9, No. 44, pp. 948–949.) *See* also 1932 Abstracts, p. 646.

RECORDING A FOREIGN LANGUAGE ON TO AN EXISTING FILM : THE " DUBBING " BOOTHS OF THE JOFA STUDIOS.—(Illustrated in *Electronics*, Sept., 1932, p. 281.)

THE DESIGN OF PORTABLE SPEECH INPUT EQUIPMENT FOR REMOTE CONTROL BROADCASTING.—R. S. Lyon. (*Rad. Engineering*, Aug., 1932, Vol. 12, pp. 17–24 and 28.)

A NEW BEAT-FREQUENCY OSCILLATOR.—S. M. Bagno. (*Rad. Engineering*, Sept., 1932, Vol. 12, pp. 14–15.)

One of the special points in this instrument is the use of a transformer " which by reflecting the variable capacity from primary to secondary as the square of the turn ratio of the transformer enabled us to get an effective capacity several hundred times the maximum capacity of the variable condenser, by using such a transformer across a 0.0005 microfarad straight-line wavelength condenser in series with another, fixed, condenser," the 0.0005 microfarad variable condenser being thus converted into a 0.1 microfarad variable condenser. Special steps are taken to avoid locking into step, harmonics, and frequency fluctuations. The range is from 10 to 10 000 c/s.

DYNAMIC MICROPHONES CREATE NEW REQUIREMENTS AS TO NOISE LEVELS [Notes on the Design of Suitable Attenuators].—M. Bjorndal. (*Rad. Engineering*, Oct., 1932, Vol. 12, pp. 21–22.)

By careful attention to the various causes of noise (such as thermoelectric e.m.fs) the writer has designed attenuators which consistently have a noise level of -150 to -160 db.

ÜBER DIE GÜNSTIGSTE RAUMDÄMPFUNG (On the Most Favourable [Acoustic] Space Absorption).—H. Benecke. (*Ann. der Physik*, Nov., 1932, Series 5, Vol. 15, No. 3, pp. 259–272.)

THE " AMPLIFILTER " [applicable to Harmonic Telegraphy by Carrier Currents].—Kajii and Matsumae. (*See* abstract under " Miscellaneous.")

POINTER INSTRUMENTS FOR BEAT-NOTE METHODS OF MEASUREMENT [including Harmonic Analysis].—Laible. (*See* under " Measurements and Standards.")

JUDGING THE LOUDNESS OF MUSICAL SOUNDS.—Trautwein. (Note in *Electronics*, Oct., 1932, p. 322.)

In a paragraph on a meeting of the Heinrich-Hertz Society and the German Physical Society, it is mentioned that Trautwein presented results showing that musical sounds estimated by trained musicians to be of the same strength may show differences of 1 : 20, the ear judging apparently from the components of constant frequency rather than from the fundamental. *Cf.* 1932 Abstracts, p. 288 (Free).

PHOTOTELEGRAPHY AND TELEVISION

DIE INTENSITÄTSSTEUERUNG GASKONZENTRIERTER ELEKTRONENSTRAHLEN DURCH ELEKTRISCHE FELDER — WEHNELTZYLINDER (Intensity [Brightness] Control of Gas-Concentrated Cathode Rays by Electrical Fields—Wehnelt Cylinder).—F. Michelssen and W. Kleen. (*Telefunken-Zeit.*, July, 1932 [publication delayed], Vol. 13, No. 61, pp. 35–45.)

From the authors' summary :—" With a Wehnelt cylinder negative to the cathode, the task of controlling the intensity of a gas-concentrated ray by cylinder-potential is closely comparable with that of controlling the anode current in three-electrode high-vacuum valves by grid potential. It is thus possible to define the quantities ' penetration coefficient ' ($1/\mu$), mutual conductance, and internal resistance for gas-concentrated cathode-ray tubes. For practical purposes, continuous control is only possible with the cylinder negative with regard to the cathode. An essential condition for a practical ray control is a correct 'penetration' of the anode potential to the cathode, with a negatively biased cylinder. The geometrical condition $a \leq d/2$ must be fulfilled [a being the distance of the cathode emitting surface from the front opening of the cylinder, d the diameter of the latter: the necessity for the fulfilment of this condition is due to the fact that only thus can a suitable penetration coefficient be obtained. A similar geometrical relation has been found for a flat or curved control electrode introduced between anode and cathode and negatively biased, an arrangement patented by Michelssen, results with which are to be communicated later]. The characteristic curves of the cylinder voltages for the setting-up and the suppression of the ray and for the 'optimum spot' condition, for varying anode potentials, are all straight lines; the modulation curves [cylinder bias / anode current] show a large region of linearity."

The controlling action of the cylinder on the electron quantity in the ray is due to the fact that with a negatively biased cylinder only a small fraction of the electrons in the cloud around the cathode are taken to form the ray (in these tests the emissive power of the cathode, in high vacuum, was often more than 500 times the actual ray current), and that the value of this fraction is controlled by the cylinder potential. The correct sharpness of ray (giving a node in the plane of the screen) is determined—for a given gas pressure—by a definite electron quantity in the ray, and is thus easily obtainable by adjusting the cylinder bias. Thus the Wehnelt cylinder offers, besides its brightness-modulating powers, the additional advantage of dispensing with the inconvenient heating-current regulation necessary, in other gas-concentrated tubes, for the balancing of ions and electrons. For a paper on work allied to these researches (including a description of the special indirectly heated cathode used in some of them) *see* Dobke, 1932 Abstracts, p. 653.

Sulla Produzione di Luce modulata (The Production of Modulated Light).—G. Wataghin and R. Deaglio. (*Alta Frequenza*, Sept., 1932, Vol. 1, No. 3, pp. 326–330.)

The writers discuss two new methods of light modulation. The first is by electronic bombardment of the anode, which has the effect of decreasing the anodic dissipation. A special "tetrode" for this purpose is described. There are three straight barium-oxide "cathode" filaments spaced equally outside, and close to, a cylindrical control grid. Inside this is a cylindrical screen grid, and close to the common axis lie four straight tungsten "anode" filaments. The cathode filaments are raised to the emissive temperature by a common battery of accumulators; the anode filaments can be heated to incandescence either by a second battery or by electronic bombardment from the cathode, or by the two combined. The energy of this bombardment is modulated by the control grid. Preliminary tests show that the limit of modulation frequency with this arrangement is 17 000 c/s compared with 9 000–10 000 c/s with the ordinary Joule effect method: at 8 000 c/s the latter method required about 1 watt to produce the depth of modulation given by about 0.17 watt with the new method.

The second scheme depends on varying the heat of evaporation of the electrons from the surface of the emitting electrode. It appears (from a German abstract at the end of the journal, though this is not clear from the paper itself) that the modulation is obtained by using the grid to control the space charge. These experiments have led to the design of a special emitting electrode: a thin metallic film is deposited on the surface of a material which is a bad conductor of heat. Under such conditions the modulating thermal wave, propagating itself from the surface to the interior of the electrode, is strongly damped at a distance of some microns. Thus for a cylindrical filament of radius r, with an emitting film of thickness Δr, the thermal capacity of the stratum involved in the modulation process is reduced in the ratio $2\Delta r/r$; if the Joule effect will give good modulation at 5 000 c/s, the new type of filament should work at frequencies of the order of 50 000 c/s. Experiments on these lines are in progress.

Light Modulation. Improved Method for Use in Television—Brighter Images [Use of Kerr Cell without Nicol Prisms].—L. M. Myers: Wilson Laboratories. (*Electrician*, 25th Nov., 1932, Vol. 109, No. 2843, p. 665.)

The light losses in a television system using the Kerr effect, with Nicol prisms for polarising the light, amount to approximately 80 %. A new arrangement is described which dispenses with Nicol prisms entirely. The first (polarising) "specially designed" prism passes the whole cone of light convergent on it, both ordinary and extraordinary rays being transmitted. There are no losses due to reflection at the surface of separation. All the available light is then passed through the aperture which is focused on to the screen. Thus both rays pass through the nitrobenzene; their vibrations are brought into the same plane before the double beam passes through the analyser ("also a particular type of prism with the normal of the surface of separation parallel to the direction of the incident light") and is brought to a focus on the receiving screen. It is claimed that the resulting picture is 80 to 100 % brighter than previous Kerr cell pictures.

A New Crater Point Lamp [giving almost Pure Black and White Image].—Mervyn Sound and Vision Company. (*Television*, Dec., 1932, Vol. 5, No. 58, p. 382.)

Sodium-Vapour Lamps.—A. Wertli: Philips Company. (*Bull. Assoc. Suisse d. Élec.*, 11th Nov., 1932, Vol. 23, No. 23, pp. 630–634.)

See also Ewest, "Gas-Discharge Lamps and Their Possible Applications," *ibid.*, pp. 634–636.

Über das Pendeln von Nipkowscheiben (On the "Hunting" of Nipkow Discs [with Toothed-Wheel Synchronisation]).—R. Haefer and H. G. Möller. (*Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, pp. 170–175.)

A theoretical investigation followed by experimental checking of the results. Among these may be mentioned the following:—the mean amplitude of the hunting sinks with increasing natural frequency, which should therefore be made high. This natural frequency increases with the so-called "mains voltage" N of frequency ω (either from an alternator or from the receiving amplifier) and also with the induced voltage E (due to the rotating toothed disc, and also of frequency ω in the case of true synchronism) but sinks again when E becomes very high, and finally reaches zero; the disc then falls out of step and comes to rest. Therefore to increase the frequency and thus decrease the amplitude of the hunting, N must be made large. Moreover, the moment of inertia should be as small as possible, so that the hunting frequency may be high and the excitation by the picture impulses (the cause of the hunting) may be small. Lastly, the air friction, which is proportional to the square of the angular velocity, should be made large in comparison with the linear and constant frictional elements.

Is the Scanning Disc Obsolete?—H. J. Barton Chapple. (*Television*, Oct., 1932, Vol. 5, No. 56, pp. 290–291.)

Über Trägheitserscheinungen in gasgefüllten Photozellen (Inertia Effects in Gas-Filled Photoelectric Cells).—F. Ollendorff. (*Zeitschr. f. tech. Phys.*, No. 12, 1932, Vol. 13, pp. 606–611.)

Author's summary:—For the investigation of the inertia effects in gas-filled photoelectric cells the Townsend discharge mechanism is employed for the space/time development of the positive and negative carrier currents. It is thus assumed that the electrons ionise in space, whereas the positive carriers can set free new carriers only at the cathode, by surface ionisation. The quasi-stationary integral of the Townsend fundamental equations is given for a cathode illumination varying with complex frequency. The observed (true) current is made up of this Townsend convection current and the Maxwellian displacement current. The frequency-curves show a wave-formed course which can be interpreted as [due to] resonance between the ion migration times and the periodic time of the intermittent illumination. Preliminary experiments confirm the theoretical predictions; working backwards, the migration velocity of the ions can be deduced from these.

For the course of the electron current for sudden illumination, a series development is given which builds up the current out of elementary "avalanches." In the same way a representation is found for the true current, tending towards its final value in an exponential manner.

The Photoelectric Properties of Alkali Metal Films as a Function of Their Thickness.—J. J. Brady. (*Phys. Review*, 1st Sept., 1932, Series 2, Vol. 41, No. 5, pp. 613–626.)

Über das Zustandekommen des spektralen selektiven Photoeffektes an dünnen Alkalimetallhäuten (On the Occurrence of the Spectral Selective Photoelectric Effect at Thin Alkali Metal Films).—R. Suhrmann and A. Schallamach. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 3/4.)

Berechnung der langwelligen Grenze des lichtelektrischen Effektes aus dem Atomvolumen der Elemente (Calculation of the Long-Wave Limit of the Photoelectric Effect from the Atomic Volume of the Elements).—G. Schweikert. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 3/4, pp. 248–253.)

The Selective Photoelectric Effect [Comprehensive Survey].—G. Déjardin. (Summary in *Rev. Gén. de l'Élec.*, 19th Nov., 1932, Vol. 32, No. 20, pp. 667–669.)

Versuche über den selektiven Photoeffekt und die optische Absorption an zusammengesetzten Photokathoden (Experiments on the Selective Photoelectric Effect and the Optical Absorption at Compound Photoelectric Cathodes [Preliminary Communication]).—W. Kluge. (*Physik. Zeitschr.*, 15th Nov., 1932, Vol. 33, No. 22, pp. 873–874.)

The Internal Photoelectric Effect in Crystals.—A. H. Wilson. (*Nature*, 17th Dec., 1932, Vol. 130, pp. 913–915.)

An outline of the theoretical principles governing photo-conductivity in crystals.

Elektrisches und optisches Verhalten von Halbleitern. VII.—Lichtelektrische Eigenschaften von Halbleiter-Sperrschichten (Electrical and Optical Behaviour of Semi-Conductors. VII.—Photoelectric Properties of Semi-Conducting Barrier Layers).—W. Leo. (*Ann. der Physik*, 1932, Series 5, Vol. 15, No. 2, pp. 129–144.)

Elektrisches und optisches Verhalten von Halbleitern. VIII.—Ein Verfahren zur Messung lichtelektrischer Ströme in Halbleitern (Electrical and Optical Behaviour of Semi-Conductors. VIII.—A Method for the Measurement of Photoelectric Currents in Semi-Conductors).—B. Schönwald. (*Ann. der Physik*, 1932, Series 5, Vol. 15, No. 4, pp. 395–421.)

The Problems of Television [including mention of a New Photoelectric Cell, Cable for Frequencies up to 500 kc/s, etc.].—G. W. Walton. (*Television*, Dec., 1932, Vol. 5, No. 58, pp. 376–378.)

Extracts from a lecture. The writer's cell has a dull-emitter filament around which is a heavy spiral anode; the photo-sensitive electrode is outside this, and is kept at a lower positive potential than that of the anode, so that it is "bombarded with cathode rays. This increases the emission of the photo surface due to a light impulse, and as the space between the photo surface and the anode exhibits a negative resistance characteristic, by suitable arrangements of output circuits and devices a greatly increased response is obtained." With regard to the special cable experimented with in America, consisting of a wire in the centre of a metal tube, with a minimum of insulating material, "it is reported that frequencies up to

500 000 per second can be transmitted for a few miles by means of it, though I expect the higher frequencies would be greatly attenuated relative to the lower ones."

Big Events in 1932 : a Year of Progress.—(*Television*, Dec., 1932, Vol. 5, No. 58, pp. 369–372 and 378.)

" News " by Television : the Baird Process.—Baird Company. (*Television*, Oct., 1932, Vol. 5, No. 56, pp. 298–299.)

" Self-Centred " Television.—P. J. De Wet. (*Television*, Dec., 1932, Vol. 5, No. 58, pp. 367–368.)

" Instead of the usual sixteen pictures on a film to which we have become accustomed, the new television camera spins the image of anything before the lens at the rate of sixteen revolutions per second about its own centre by means of a prism. . . ." The camera and the projector are identical as regards the optical and mechanical parts : the entire mechanism of each is removable and can be held in the palm of one hand. Among the advantages claimed are simplicity, central analysis of image, uniform exposure and mask, any size of projection, no up-and-down sway, etc. The equipment gained the gold medal at the London Exhibition of Inventions.

Developments in Television [including Telefunken Results with Mirror Helix and Intermediate Film, using 7 Metre Wave].—Lance. (*Electrician*, 2nd Dec., 1932, Vol. 109, p. 708.)

Paragraph on a recent lecture. For a paper on the Fernseh Company's intermediate film system, *see* 1932 Abstracts, p. 530.

Television at the 1932 Berlin Radio Exhibition.—E. H. Traub. (*Journ. Television Soc.*, Sept., 1932, Series II, Vol. 1, Part 5, pp. 155–166.)

Television in Holland.—H. E. Witsenberg. (*Ibid.*, pp. 167–168.)

Television Demonstrated by Marconi's [at the British Association Meeting at York].—(*Ibid.*, p. 169.)

The Marconi Company and Television Research: Marconi Television Demonstration [British Association Meeting].—Marconi Company. (*Marconi Review*, Sept.-Oct., 1932, No. 38, pp. 1–5 : 6–7.)

Television in America To-day [including Details of the Farnsworth Cathode-Ray " Dissector " and " Oscillite " Tubes].—A. Dinsdale. (*Journ. Television Soc.*, Sept., 1932, Series II, Vol. 1, Part 5, pp. 137–149.)

[One-Wave] Sound and Vision Broadcasting.—Columbia Broadcasting Company. (*Rad. Engineering*, Oct., 1932, Vol. 12, p. 22.)

On the system referred to in January Abstracts, p. 46—Peck.

" The overall band for transmission extends from 2 750 to 2 850 kc/s, a channel 100 000 cycles wide, or ten times as wide as the usual broadcast band. The picture is composed of 4 320 picture elements, 20 complete pictures per second. This requires 86% of the 100 kc channel. Nearly all of the remaining 14% is used for the accompanying voice or music."

A New System ? [Numerous Photo-sensitive Elements each controlling Amplitude of One Particular Note : Corresponding Conversion at Receiver].—W. P. Owen. (*Television*, Oct., 1932, Vol. 5, No. 56, pp. 309–310.) *See* also *ibid.*, Nov., p. 341.

Receiving Television in an Airplane [Cathode-Ray Tube Receiver : Wavelength 6.7 Metres].—H. R. Lubcke. (*Rad. Engineering*, Oct., 1932, Vol. 12, pp. 12–13 and 24.)

A Synchronising System for Electrical Transmission of Pictures [" Forced Synchronisation," using Tuning-Fork Oscillator at Each End, with Small Synchronising Current to " Pull-In " to Exact Synchronism].—Y. Niwa. (*Elec. Communication*, Oct., 1932, Vol. 11, No. 2, pp. 91–96.)

The Eye : a Link in the Television Chain.—W. D. Wright. (*Journ. Television Soc.*, Sept., 1932, Series II, Vol. 1, Part 5, pp. 150–154.)

A Method of Compensating the Plate Currents [in a Triode Amplifier applicable to Photoelectric Cells].—Donzelot and Divoux. (*See* under " Subsidiary Apparatus and Materials.")

Book Reviews :— Handbook of Phototelegraphy and Television : Photoelectric Cells and Their Use.—F. Schröter : R. Suhrmann. (*Fernsehen u. Tonfilm*, October, 1932, Vol. 3, No. 4, pp. 246–247.)

For a review of the first named book *see* also *Wireless Engineer*, Nov., 1932, Vol. 9, p. 617.

MEASUREMENTS AND STANDARDS

Tourmalinresonatoren bei kurzen und ultrakurzen Wellen (Tourmalin Resonators for Short and Ultra-Short Waves).—V. Petržílka. (*Ann. der Physik*, Oct., 1932, Series 5, Vol. 15, No. 1, pp. 72–88.)

The experiments described in this paper were undertaken with the object of finding out under what conditions tourmalin plates can be used for the exact determination or observation of the frequency of an emitter producing short or ultra-short waves. It was found that the tourmalin resonators may be connected in parallel with an oscillatory circuit and the reaction of the resonator on the circuit observed by means of a glow-lamp. This gives an accurate and unique determination of resonance conditions. A method for determining the energy used up in the vibrating tourmalin plate is given. The logarithmic decrement determined from the absorption curves was 1.5×10^{-4} and was used to calculate the equivalent circuit of a tourmalin plate. *See* also next abstract.

WAVELENGTH MEASUREMENTS ON ULTRA-SHORT WAVES [Use of Small Incandescent Lamp in Tuned Circuit, with Tourmalin Crystal in Parallel].—Leithäuser and Petržílka. (Summary in *Electronics*, Nov., 1932, p. 350.)

The use of quartz or tourmalin crystals in neon or other gas, to give a luminous indication at resonance, presents great difficulties in the case of ultra-short waves (continuance of glow after passing resonance, critical coupling, etc.). When the present circuit is coupled to an oscillating circuit whose frequency is changed slowly, the glow lamp (whose tuned circuit is of approximately the crystal frequency) will light up as this frequency is approached: but at the exact frequency of the crystal the latter will absorb so much energy that the lamp will cease to glow. At 15 megacycles/second the accuracy is about 2/100 000, but this can be improved by observing the glow with a photometer instead of with the eye. *See* also preceding abstract.

THE MODES OF VIBRATION OF QUARTZ PIEZO-ELECTRIC PLATES AS REVEALED BY AN INTERFEROMETER.—W. D. Dye; prepared for publication by P. Vigoureux. (*Proc. Roy. Soc.*, Oct., 1932, Vol. 138, No. A 834, pp. 1–16.)

After a description of Dye's well known fringe-pattern methods and their results (*see* 1930 Abstracts, p. 223—Osterberg), the paper deals with experiments in which the interferometer was used with intermittent light for stroboscopic examination. These experiments showed that the motion of the vibrating plate is non-uniform not only in amplitude but also in phase, which may differ by as much as 180° between various parts of the surface. Models in relief of the configuration of various vibrating surfaces at particular instants were made and photographed.

MEASURING THE TEMPERATURE OF A QUARTZ OSCILLATOR CRYSTAL IN ITS BULB [Thermo-element in contact with One Electrode: used at the Pontoise Station].—(*E.T.Z.*, 27th Oct., 1932, Vol. 53, No. 43, pp. 1039–1040.) *See* also de Gramont and Beretzki, 1932 Abstracts, pp. 473–474.

QUARTZ OSCILLATOR WITH OPTICAL COUPLING TO AMPLIFIER [avoiding all Retroaction: Quartz Crystal between Tourmalin Plates]. —W. G. Cady. (Summary in *Elektrot. u. Masch:bau*, 20th Nov., 1932, Vol. 50, No. 47, p. 652.)

TEMPERATURE COMPENSATION FOR PIEZOELECTRIC OSCILLATORS.—(Summary of German Patent in *Electronics*, Nov., 1932, p. 348.)

By connecting, in series or in parallel with the crystal, a condenser whose capacity varies with the temperature: *e.g.*, two electrodes separated by an expanding and contracting distance piece, or a condenser vane rotated by a bimetallic strip.

HIGH-FREQUENCY MAGNETOSTRICTION VIBRATOR [Nickel-Chrome Alloy Rod or Plate].—M. Matsudaira. (Short summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. p. 10.)

A plate 0.105 cm thick gives strong vibrations at 2 650 kc/sec.

THE JOULE MAGNETOSTRICTIVE EFFECT IN A GROUP OF COBALT-IRON ALLOYS.—S. R. Williams. (*Review Scient. Instr.*, Nov., 1932, Vol. 3, pp. 675–683.)

EINE QUARZUHR FÜR ZEIT- UND FREQUENZMESSUNG SEHR HOHER GENAUIGKEIT (A Quartz Clock for Very Exact Measurements of Time and Frequency).—A. Scheibe and U. Adelsberger. (*Physik. Zeitschr.*, 1st Nov., 1932, Vol. 33, No. 21, pp. 835–841.)

From the authors' summary:—The paper describes the technical construction of a quartz clock, consisting of a control quartz crystal, valve oscillator, two amplification stages, three frequency dividing stages, a synchronous motor and time indicator. Results of measurements on two such clocks are discussed. *See* also next abstract.

EINE QUARZUHR FÜR ZEIT- UND FREQUENZMESSUNG SEHR HOHER GENAUIGKEIT (A Quartz-Controlled Clock for Time and Frequency Measurements of High Precision).—A. Scheibe and U. Adelsberger. (*Zeitschr. f. tech. Phys.*, No. 12, 1932, Vol. 13, pp. 591–593.)

Developed at the Physikalisch-Technische Reichsanstalt, and giving a time constancy within ±0.001 sec. per day, or a frequency constancy of 1×10^{-8}. *See* also preceding abstract.

SYNCHRONOUS ELECTRIC TIME SERVICE.—H. E. Warren. (Summary in *Sci. Abstracts, Sec. B*, Aug., 1932, Vol. 35, No. 416, p. 430.)

A NEW ELECTRIC PENDULUM CLOCK.—W. Zeh Company. (*E.T.Z.*, 23rd June, 1932, Vol. 53, pp. 607–608.)

Driven by a flash-lamp battery lasting from half to one year, this mass-produced clock on test gave a mean variation of ± 0.1 sec. per day.

IMPROVEMENT OF THE ISOCHRONISM OF PENDULUMS BY THE USE OF ELASTIC STOPS.—J. Haag. (*Comptes Rendus*, 7th Nov., 1932, Vol. 195, pp. 756–758.)

EXPERIMENTS ON THE CHANGE OF PERIOD OF A BLADE PENDULUM WHEN AN ADDITIONAL MASS IS PLACED AT DIFFERENT POINTS, AND THE CORRESPONDING THEORY.—H. J. Oosting. (*Physica*, No. 7, Vol. 12, 1932, pp. 229–233.)

SUR QUELQUES PROCÉDÉS DESTINÉS À STABILISER LA FRÉQUENCE DE RADIO-OSCILLATEURS (Some Methods of Stabilising the Frequency of Radio Oscillators [whose Oscillations depend on the Action of Static Negative Resistances]).—M. Bruzau. (*L'Onde Élec.*, Sept., 1932, Vol. 11, No. 129, pp. 296–314.)

The particular type of negative-resistance oscillator used by the writer is a two-grid valve circuit. The action of such a circuit is analysed, and the calculation of the frequency and conditions for stability are shown. Three methods are then described by which the frequency can be stabilised :—(1) by means of a self-inductance connected in series with the negative resistance (*cf.* Mallet, Abstracts, 1930, p. 463 : *also* 1932, p. 342, McLachlan. The present writer remarks that Mallet's method is for a triode, whereas for complete efficacy a negative-resistance oscillator must be used) : (2) by means of an adjustable non-inductive resistance in the branch containing the condenser, and (3) by dividing the inductance into two parts, one in series with the condenser to equilibrate the losses : an essential condition is the absence of any mutual induction between the two parts. The three theoretical methods are verified experimentally. They are only suitable for low-power oscillators, using two-grid receiving valves with comparatively low anode voltages.

THE ABSOLUTE MEASUREMENT AND INTERNATIONAL COMPARISON OF FREQUENCIES.—J. Groszkowski. (*Wiadomości i Prace Inst. Radjotech., Warsaw*, No. 1, Vol. 4, 1932, 16 pp.)

NEW NATIONAL RADIO STANDARDS [for Broadcast Receivers and Components]. (*Rad. Engineering*, Sept., 1932, Vol. 12, p. 16.)

ZEIGERINSTRUMENTE FÜR SCHWEBUNGSMETHODEN (Pointer Instruments for Beat-Note Methods of Measurement [including Harmonic Analysis]).—Th. Laible. (*Bull. Assoc. Suisse d. Élec.*, 14th Oct., 1932, Vol. 23, No. 21, pp. 548–551.)

A paper on the use of an electrodynamic voltmeter in heterodyne methods (*cf.* Nicholson and Perkins, 1932 Abstracts, pp. 416–417).

PORTABLE UNMODULATED RADIO - FREQUENCY GENERATOR AND ATTENUATOR [and Its Use for Measuring Sensitivity and Band Width Characteristics of a Receiver].—Marconi Company. (*Marconi Review*, Sept.–Oct., 1932, No. 38, pp. 8–19.)

MEASUREMENTS OF IMPEDANCES.—A. T. Starr. (*Wireless Engineer*, Oct., 1932, Vol. 9, No. 109, p. 573.)

A reply to Trewman's letter on Starr's method (1932 Abstracts, p. 594).

A NOTE ON IMPEDANCE MEASUREMENT [American Three-Winding Transformer or Hybrid Coil Method : Inductive Ratio Arms in the Wheatstone Bridge].—A. T. Starr. (*Wireless Engineer*, Nov., 1932, Vol. 9, No. 110, pp. 615–617.)

THE BEARING OF THE EARTH'S INTERNAL MAGNETIC PERMEABILITY UPON THE SELF- AND MUTUAL-INDUCTANCE OF COILS WOUND ON ITS SURFACE.—W. F. G. Swann. (*Phys. Review*, 1st Sept., 1932, Series 2, Vol. 41, No. 5, pp. 649–666.)

The full paper, an abstract of which was referred to in January Abstracts, p. 49.

MESSUNG KLEINER KAPAZITÄTEN (Measurement of Small Capacities).—H. Lampe. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 3/4, pp. 254–263.)

The electrostatic and electrodynamic methods of measurement of small capacities are compared and found to agree to within 1%.

SUBSIDIARY APPARATUS AND MATERIALS

THE PROPERTIES OF COPPER-OXIDE DRY-PLATE RECTIFIERS UNDER PROLONGED [17 000 Hours] TEST.—H. Böhm. (*E.T.Z.*, 3rd Nov., 1932, Vol. 53, No. 44, pp. 1052–1054.)

Tests on a 12 V, 0.7 A rectifier in Graetz connection, charging a 12 V battery. The a.c. voltage applied was 15 V, and the charging current was always measured at 12 V battery voltage. Between 2 and 6 thousand hours the current fell from 0.69 to 0.5 A, where it would have kept constant if the conditions had remained unchanged : but the a.c. volts were then increased to 16.2 to raise the current to 0.74 A, at which value it remained practically constant up to the end of the test—17 000 hours. The current drop of 27% mentioned above would have been reduced to 5% or less if the load had been a resistance load, as in test-room working. Various other results are described, and a special circuit is mentioned by which, without the use of any relay, a 10% rise in voltage reduces the charging current practically to zero. Rectifiers for as much as 100 A current and 220 V d.c. voltage can be constructed, with the same properties as the small types.

RECTIFIER VALVE WITH CYLINDRICAL ANODE AND CATHODE OF TUNGSTEN WIRE WOUND ROUND A CALCIUM CYLINDER AND CONTINUED TO A POINT NEAR THE ANODE.—J. Abadie. (Long summary of French Patent in *Rev. Gén. de l'Élec.*, 26th Nov., 1932, Vol. 32, No. 21, p. 165 D.)

The heat given to the calcium by the encircling tungsten wire ensures that the anode is always partly covered with potassium and sodium, volatilised from the commercial calcium : this allows the valve to start up on the application of a low voltage (110 V), like a mercury-vapour rectifier. The constant filtration of calcium along the wire cathode prevents the latter from deteriorating, and the rectifier has a long life. Other cathodes, in which the calcium is replaced by composite materials, are also described.

A FULL-WAVE MERCURY VAPOUR RECTIFIER [RCA-83, Cunningham CX-83]. (*Rad. Engineering*, Sept., 1932, Vol. 12, pp. 21–22.)

Particularly recommended for receivers in which the d.c. requirements are subject to considerable variation, *e.g.*, those employing class B power amplifiers.

DATA OF RECTIFIER VALVES, PHILIPS, RECTRON, TELEFUNKEN AND VALVO.—(*Die Sendung*, 2nd Dec., 1932, Vol. 9, No. 49, p. 1062.)

STUDY OF THE MAGNETIC CONTROL OF THE MERCURY ARC AND OF THE STATIC CONVERSION OF DIRECT INTO ALTERNATING CURRENT.—R. Savagnone. (Summary in *L'Elettrotec.*, 25th Sept., 1932, Vol. 19, No. 27, pp. 689–690.)

[Experimental] COMPARISON OF THE RECTIFYING CHARACTERISTICS OF HOT-CATHODE MERCURY-VAPOUR RECTIFIER TUBES AND HIGH-VACUUM DIODES.—I. Miura aud K. Utsumi. (*Journ. I.T.T.E. Japan*, Vol. 110, 1932, pp. 593–606: in Japanese.)

THE THEORY OF RECTIFICATION IN HOT-CATHODE MERCURY VAPOUR TUBES.—G. H. Brandt and H. L. Smith. (*Rad. Engineering*, Aug., 1932, Vol. 12, pp. 15–16.)

CURRENT AND POTENTIAL RELATIONS IN GRID-CONTROLLED RECTIFIERS.—W. Dällenbach. (*E.T.Z.*, 3rd Nov., 1932, Vol. 53, No. 44, pp. 1059–1060.)

THE PHYSICAL FOUNDATIONS OF THE GRID CONTROL OF GAS-DISCHARGE TUBES [including Mercury-Vapour Rectifiers with Grids].—A. Glaser. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 13, 1932, pp. 549–558.)

INVESTIGATIONS ON MERCURY-VAPOUR DISCHARGES [Probability of Ionisation and Its Effect on the Bending of the Characteristic: Negative Carriers of Large Mass in Low-Pressure Mercury Arcs].—E. Lübcke. (*Ibid.*, pp. 558–560.)

ON THE THEORY OF THE LUMINOUS ARC PLASMA.—D. Gábor. (*Ibid.*, pp. 560–563.)

THE CURRENT RECTIFIER AS AN ALTERNATING CURRENT LOAD.—H. Klemperer. (*Archiv f. Elektrot.*, 7th Oct., 1932, Vol. 26, No. 10, pp. 710–715.)

THE MERCURY VAPOUR VALVE WITH CONTROL GRIDS, AND ITS USE AS A REVERSIBLE RECTIFIER.—H. Hafner. (*Rev. Gén. de l'Élec.*, 10th Sept., 1932, Vol. 32, No. 10, pp. 297–314.)

THE MERCURY VAPOUR VALVE WITH POLARISED GRIDS, AND ITS USE AS A REVERSIBLE CONVERTER.—Ch. Ehrensperger. (*Rev. Gén. de l'Élec.*, 8th Oct., 1932, Vol. 32, No. 14, pp. 469–478.)

THEORY OF [Mercury Vapour] ARC RECTIFIERS WITH RETARDED COMMUTATION: PART I.—M. Demontvignier. (*Rev. Gén. de l'Élec.*, 12th Nov., 1932, Vol. 32, No. 19, pp. 625–635.)

A METHOD OF CLEANING MERCURY [without Distillation and without Loss of Mercury].—W. Burstyn. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, p. 505.)

LIGHTNING TRANSIENTS—MEASUREMENT BY CATHODE-RAY OSCILLOGRAPH [Ferranti Model].—J. L. Miller. (*Electrician*, 23rd Dec., 1932, Vol. 109, pp. 805–807.)

Among the records shown is one taken by external "light blackening" photography, for which the Ferranti oscillograph is suitable (in addition to internal recording) thanks to a thin glass window strengthened by a steel grid (*cf.* Knoll, 1931 Abstracts, p. 51—three) and coated with calcium tungstate. The oscillograph is described and illustrated: a cold cathode is used, and the working voltage is about 60 kv.

CATHODE-RAY TUBES [Two New Gas-Focused Types].—L. Sutherlin and A. J. Harcher. (Short summary in *Review Scient. Instr.*, Nov., 1932, Vol. 3, p. 725.)

THE CATHODE-RAY OSCILLOGRAPH: THE PRODUCTION AND FOCUSING OF THE ELECTRON BEAM.—M. Knoll. (*Ibid.*, p. 725.)

A survey, with bibliography bringing up to date the one referred to in 1932 Abstracts, p. 358.

THE MULTIPLE CATHODE-RAY OSCILLOGRAPH [with Separate Rays for the Simultaneous Recording of Several Phenomena].—M. Knoll. (*E.T.Z.*, 17th Nov., 1932, Vol. 53, No. 46, pp. 1101–1103.)

CATHODE-RAY OSCILLOGRAPH FOR ULTRA-HIGH-FREQUENCY (B.-K.) OSCILLATIONS: ELECTRON PATH-TIME ERROR AUTOMATICALLY COMPENSATED.—Hollmann: von Ardenne. (Paragraph and photograph in *Electronics*, Oct. 1932, p. 318). *See* also 1932 Abstracts, pp. 652–653 (Hollmann).

INTENSITY CONTROL OF GAS-CONCENTRATED CATHODE RAYS BY ELECTRICAL FIELDS—WEHNELT CYLINDER.—Michelssen and Kleen. (*See* under "Phototelegraphy and Television.")

ZUR ERKLÄRUNG DES GASKONZENTRIERTEN ELEKTRONENSTRAHLS (On the Explanation of the Gas-Concentrated Electron-Beam). — W. Rogowski and H. Graupner. (*Archiv f. Elektrot.*, 4th Nov., 1932, Vol. 26, pp. 807–810.)

REMARK ON THE SPACE-CHARGE FIELD OF THE GAS-CONCENTRATED ELECTRON BEAM.—Engel. (*See* under "General Physical Articles.")

EINIGE NEUE KATHODENUNTERSUCHUNGEN MIT DEM ELEKTRISCHEN ELEKTRONENMIKROSKOP (Some New Cathode Investigations with the Electrical Electron Microscope).—E. Brüche and H. Johannson. (*Physik. Zeitschr.*, 15th Nov., 1932, Vol. 33, No. 22, pp. 898–899.)

Pictures of pure and thoriated tungsten are given, similar to those of oxide cathodes recently published (*see* 1932 Abstracts, p. 653).

KINEMATOGRAPHISCHE ELEKTRONENMIKROSKOPIE VON OXYDKATHODEN (Cinematograph Records of Oxide Cathodes using an Electron Microscope).—E. Brüche and H. Johannson. (*Ann. der Physik*, 1932, Series 5, Vol. 15, No. 2, pp. 145–166.)

The pictures (*see* above abstract) are now taken as a cinematograph film and the course of events in the disintegration of the oxide cathode as shown by the film is discussed in three typical cases.

A New Exhaust Pump for High Vacuum [Cenco Aristovac Pump, Molecular Drag Principle].—H. V. Cadwell. (*Rad. Engineering*, Aug., 1932, Vol. 12, pp. 25 and 28.)

On the Possibility of Binding Mercury Vapour and other Unwanted Vapours in Air by Photochemical Methods.—H. Klumb. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, p. 496.)

A Metal X-Ray Tube [using Stainless Steel, Pyrex Glass, Sealing Wax. Absence of Ground Cone Joints and the Use of Vacuum Grease].—C. J. Ksanda. (*Rev. Scient. Instr.*, Oct., 1932, Vol. 3, pp. 531–534.)

Cinematography with High Picture Frequency [up to 80 000 per Sec.].—W. Ende. (*Zeitschr.f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 483–487.)

The Application of Resonant Shunt Damping to Oscillographs.—E. J. Martin and D. F. Caris. (*Rev. Scient. Instr.*, Oct., 1932, Vol. 3, pp. 598–615.)

The Two-Element Portable Oscillograph Improved.—M. A. Rusher. (*Gen. Elec. Review*, Sept., 1932, Vol. 35, pp. 493–494.)

Secondary Electrons in X-Ray Tubes [Avoidance of Their Effects].—A. Bouwers and J. H. van der Tuuk. (*Physica*, No. 8, Vol. 12, 1932, pp. 274–283.)

Measurement of Gas Pressure by Negative Glow.—H. C. Rentschler. (*Electronics*, Sept., 1932, p. 292.)

The Heavy-Current Glow Discharge at Atmospheric Pressure: a New Type of Discharge.—H. Thoma and L. Heer. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 464–470.)

Neon-Lamp Method [Relaxation Oscillation Circuit] for the Measurement and Registration of Photoelectrically Active and Ionising Radiations.—A. Stäger. (Summaries in *Sci. Abstracts, Sec. A*, Sept., 1932, Vol. 35, No. 417, pp. 852 and 853.)

Stabilised "B" Supply for A.C. Receivers [using Commercial Neon Glow Lamps].—D. Dekker and W. Keeman. (*QST*, Oct., 1932, Vol. 16, pp. 18–20.)

A Theory of Neon Tube Operation.—C. M. Summers. (*Elec. Engineering*, Nov., 1932, Vol. 51, pp. 772–775.)

Methods of Power-Supply Voltage Regulation during Keying. (*QST*, Oct., 1932, Vol. 16, pp. 78, 80 and 82.)

An Automatic Regulating Device for Thermostats or Adiabatic Calorimeters.—H. Rieche: Semm. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 498–499.)

Simplification of the arrangement referred to in 1931 Abstracts, p. 512. A similar device is described by Semm in *T.F.T.*, August, 1932, as used for the quartz thermostat at the Breslau Station.

Triode Regulators [for Rapid and Accurate Voltage Control: Philips Company].—N. A. J. Voorhoeve and F. H. de Jong. (*Elec. Review*, 23rd Sept., 1932, Vol. 111, p. 422.) *See* 1932 Abstracts, p. 538.

On the Regulation of Voltage [Various Systems, including the Tirrill Regulator].—M. de Querquis. (*L'Elettrotec.*, 25th Oct., 1932, Vol. 19, No. 30, pp. 745–755.)

Research brings Remarkable New Liquid Insulator—"Pyranol" [Non-inflammable, Non-explosive, High Dielectric Constant].—General Electric Company. (*Elec. World*, 17th Sept., 1932, pp. 373–374.)

New Liquid Insulator Devised for Transformers [Will Not Mix with Water: Decomposes into Non-Combustible Gases].—F. M. Clark: G.E.C. (*Sci. News Letter*, 3rd Dec., 1932, Vol. 22, No. 608, p. 356.)

On the Temperature Coefficient of the Electrical Resistance of Silicon, and a Thermoelectric Phenomenon of Unipolar Substances.—Ch. Bedel. (*Comptes Rendus*, 14th Nov., 1932, Vol. 195, pp. 871–873.)

Variable [Pressure-Regulated] Carbon Resistances [with Conical Surfaces of Contact].—Le Carbone Company. (Summary of French Patent in *Rev. Gén. de l'Élec.*, 26th Nov., 1932, Vol. 32, No. 21, pp. 166–167 d.)

The Measurement of the Capacity of Commercial Electrolytic Condensers, and an Investigation of Its Dependence on Temperature, Voltage and Prolonged Loading.—R. Bauder and K. Jannsen. (*Elektrot. u. Masch:bau*, 23rd Oct., 1932, Vol. 50, No. 43, pp. 581–586.)

Gang Condensers of Variable Capacity for Modern Receivers [including the Problem of "Microphonics"].—E. D. Koepping. (*Rad. Engineering*, Sept., 1932, Vol. 12, pp. 7–10.)

Commercial Materials of Great Magnetic Softness [and a Quick and Accurate Method of Measuring Small Coercive Forces].—F. Stäblein. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 13, 1932, pp. 532–534.)

"After-Effect" Losses in Ferromagnetic Materials for Weak Alternating Fields.—R. Goldschmidt. (*Ibid.*, pp. 534–539.)

The writer shows that the "after-effect" losses (so called by Jordan) may considerably exceed the losses due to eddy currents and hysteresis. Their dependence on frequency and temperature is investigated, and their resemblance in many ways to the Wagner-Debye effects in dielectrics is pointed out.

ÜBER MASSEKERNE (Compressed Powder Cores [for Pupin Coils, etc.]).—W. Deutschmann. (*E.N.T.*, Nov., 1932, Vol. 9, pp. 421–433.)

Author's summary :—The demands of practice require an effective core-permeability of from 18 to 80. Compressed iron powder cores allow these values to be obtained practically. The theories of Doebke (Abstracts, 1930, p. 348) and Ollendorff (1931, p. 627) approximately predict this result. The superiority of the compressed core over the solid core as regards losses and non-linearity factor is explained by the use of Ollendorff's relationships and illustrated by a numerical example. The limits of validity of the equations are proved by measurements.

A NEW MATERIAL FOR VARIOUS RADIO PURPOSES—"SVEA" IRON.—Todd. (*See* abstract under "Valves and Thermionics.")

UN PROCÉDÉ DE COMPENSATION DES COURANTS PLAQUES (A Method of Compensating the Plate Currents [in a Triode Amplifier, to allow the use of a Sensitive Instrument]).—P. Donzelot and J. Divoux. (*Comptes Rendus*, 28th Nov., 1932, Vol. 195, p. 1008.)

The usual method of compensation is by a constant source of current regulated by a rheostat. The writers obtain better results by compensating the plate current of the final valve L by an identical valve L' connected in opposition. The same anode battery feeds both these valves, and the sensitive instrument is connected between the lead joining plate of L to filament of L' and the mid-point of a potentiometer connected to the anode battery. By this method the writers have been able to use a galvanometer sensitive to 5×10^{-9} A for a bridge circuit for measuring resistances of the order of 100–1 000 megohms. Thus the use of high voltages for the bridge, leading to appreciable currents and consequent heating, is avoided. Another satisfactory application is in connection with photoelectric cells.

[Tone-Frequency Valve Relay employing] RECTIFIED REACTION.—L. H. Harris. (*P.O. Elec. Eng. Journ.*, Oct., 1932, Vol. 25, Part 3, pp. 190–194.)

A COMMERCIAL ("SSW") GLOW-DISCHARGE RELAY. (*E.T.Z.*, 27th Oct., 1932, Vol. 53, No. 43, p. 1039.)

A NEW SLIDE-WIRE POTENTIOMETER [Rotatable Cylinder with External Helical Groove holding Contact Ball which bridges between the Resistance Element and a Parallel Contact Rod].—J. S. P. Robertson. (*Elec. Communication*, Oct., 1932, Vol. 11, No. 2, pp. 80–82.)

AN IMPROVED RHEOSTAT [with Screw-Drive Mechanism].—T. B. Whitson. (*Rev. Scient. Instr.*, Oct., 1932, Vol. 3, pp. 596–597.)

DISTORTION OF CURVE FORM BY UNSUITABLE SLIDING-CONTACT POTENTIOMETERS [due to Magnetic Effects of Iron Rods used in their Construction].—H. Kind. (*E.T.Z.*, 24th Nov., 1932, Vol. 53, No. 47, pp. 1128–1129.)

A TUNING-FORK-CONTROLLED STROBOSCOPIC LIGHT SOURCE.—J. Kluge. (*E.T.Z.*, 17th Nov., 1932, Vol. 53, No. 46, pp. 1107–1108.)

The tuning fork is driven either electro-mechanically (mercury contact) or by a thyratron in relaxation-oscillation connection (*cf.* Reich, Jan. Abstracts, p. 53) with grid control. The latter method, which is particularly advantageous, is described in some detail. Stroboscopic measurements can be made with an absolute accuracy of 0.01%.

VERSCHÄRFUNG STROBOSKOPISCHER MESSUNGEN DURCH VERWENDUNG KURZZEITIGER SPANNUNGSSTÖSSE (Focusing Stroboscopic Measurements by means of Short Voltage Impulses [as the Source of Lamp Illumination]).—W. Fucks and H. Weyrauch. (*Archiv f. Elektrot.*, 4th Nov., 1932, Vol. 26, pp. 801–802.)

THE MERCURY ARC AS AN ACTINIC STROBOSCOPIC LIGHT SOURCE.—H. E. Edgerton and K. J. Germeshausen. (*Rev. Scient. Instr.*, Oct., 1932, Vol. 3, pp. 535–542.)

A NEW "AMPLITUDE-LIMITING" GLOW DISCHARGE LAMP TYPE AR 220 FOR PREVENTING EXCESSIVE OUTPUT FROM AN AMPLIFIER. (*Die Sendung*, 7th Oct., 1932, Vol. 9, No. 41, p. 887.)

SIMPLE AMPLIFIER FOR GEIGER-MÜLLER COUNTERS.—W. F. Libby. (*Phys. Review*, 1st Nov., 1932, Series 2, Vol. 42, No. 3, pp. 440–441.)

ELECTRONIC TIMER FOR VERY SHORT INTERVALS [Double Thyratron Circuit suitable for use with Photoelectric Cell].—H. W. Lord. (*Electronics*, Oct., 1932, p. 309.)

A TRIODE INSTRUMENT FOR THE REGULATION OF ELECTRICAL QUANTITIES ACCORDING TO A PREDETERMINED PROGRAMME.—J. Picker : Fehr. (*L'Elettrotec.*, 25th Sept., 1932, Vol. 19, No. 27, p. 691.)

THE RESONANCE METHOD OF WAVE-FORM ANALYSIS [and a Résumé of Other Methods].—C. F. J. Morgan. (*Journ. I.E.E.*, Nov., 1932, Vol. 71, No. 431, pp. 819–829.)

AN INSTRUMENT FOR TESTING WINDINGS FOR SHORT-CIRCUITED TURNS.—W. Geyger. (*E.T.Z.*, 3rd Nov., 1932, Vol. 53, No. 44, pp. 1063–1064.)

"BANANA" PLUGS FOR LABORATORY USE.—W. Bader. (*E.T.Z.*, 10th Nov., 1932, Vol. 53, No. 45, p. 1089.)

STATIONS, DESIGN AND OPERATION

NOTE ON THE FIELD INTENSITY OF THE MARCONI BROADCASTING STATION ERECTED AT WARSAW [Comparison of Observed Results with the Eckersley "Modified Watson Diffraction Formula"].—T. L. Eckersley. (*Marconi Review*, Sept.–Oct., 1932, No. 38, pp. 20–22.)

The wavelength was 1 400 m, and the systematic survey reached distances of about 500 km. Taking $\sigma = 1.14 \times 10^{-13}$, the modified formula with its exponential attenuation factor (function of earth conductivity as well as of wavelength) gives extremely good agreement with the observed results up to the maximum distance of the survey. On the other hand, a day-time reading in England (1 400 km) gave 40 μv/m, while the calculated value would be 15 μv/m; but the path includes 200 km of sea and the space ray may not have been completely eliminated. The Sommerfeld formula would have given about 500 v/m. For the distances of the survey, the curves show that no value of σ will give a Sommerfeld curve of the right shape, while even the unmodified Watson formula (curve *B*) gives values considerably too high at the longer distances.

THE BRESLAU HIGH-POWER BROADCASTING STATION [and the "One-Wire" Aerial Results]. (*Radio, B., F. f. Alle*, Nov., 1932, pp. 495–500.)

The transmitter is described stage by stage, and the results obtained with the "one-wire" aerial for suppressing the space-wave are given (*see* also under "Aerials and Aerial Systems," Böhm). "Thus with the new aerial the reception at 160 km is distinctly better than at 80 km with the ordinary aerial. . . . One of our readers reports good reception in South Africa."

CHINA'S FIRST HIGH-POWER BROADCASTING STATION, AT NANKING. (*Telefunken-Zeit.*, July, 1932 [publication delayed], Vol. 13, No. 61, pp. 55–56.)

THE EMPIRE TRANSMITTING STATION: TECHNICAL DETAILS OF THE NEW SHORT-WAVE EQUIPMENT. (*World Radio*, 18th and 25th Nov., 1932, Vol. 15, Nos. 382 and 383, pp. 1148 and 1189–1190.)

EMPIRE BROADCASTING—DETAILS OF EQUIPMENT AT DAVENTRY—NEW SHORT-WAVE TRANSMITTERS. (*Electrician*, 16th Dec., 1932, Vol. 109, pp. 771 and 781–782.)

THE TECHNIQUE OF BROADCASTING.—PART I. (*World Radio*, 21st Oct., 1932, Vol. 50, No. 378, pp. 926 and 928.)

THE COLTANO RADIO-MARITIME CENTRE.—G. Pession, G. Montefinale and A. Marzoli. (*L'Elettrotec.*, 25th Sept., 1932, Vol. 19, No. 27, pp. 683–686.)

SPEECH FROM SHIP TO SHORE.—T. W. Bennington. (*Wireless World*, 9th December, 1932, Vol. 31, pp. 514–516.)

A short description of the apparatus and methods employed in the ship-to-shore telephone service.

MOBILE RADIOTELEPHONY [Passenger Ships, Whaling Ships, Trawlers, Aircraft, Trains].—F. G. Loring and H. H. Buttner. (*Elec. Engineering*, Oct., 1932, Vol. 11, No. 2, pp. 97–108.)

LE ONDE CORTISSIME E IL LORO IMPIEGO NELLE RADIOCOMUNICAZIONI (Ultra-Short Waves and Their Use in Radio Communication).—N. Carrara. (*L'Elettrotec.*, 15th Sept., 1932, Vol. 19, No. 26, pp. 652–653.)

A survey. Recent increases in the power of ultra-short-wave transmitters are mentioned: Marconi ("no technical details are available for reference"), Kozanowski (2.5 A on 67 cm, with a two-triode circuit "substantially the same as that previously described by Carrara"—1932 Abstracts, pp. 404 and 581: 222). Among methods of duplex working are mentioned the use of two distinct wavelengths (as in Dover–Calais service), automatic relays (Marconi), and double modulation (Carrara, January Abstracts, p. 54).

THE ULTRA-SHORT-WAVE LINK ACROSS THE BRISTOL CHANNEL. (*World Radio*, 4th Nov., 1932, Vol. 15, No. 380, p. 1070.)

Short note on the 12-mile link on a 5 m wavelength, from Lavernock to Hutton, now being tried for connecting the land-line telephone systems across the Channel.

SIMULTANEOUS TELEGRAPHY AND TELEPHONY ON SHORT-WAVE CIRCUITS.—D. Thierbach. (*Telefunken-Zeit.*, July, 1932 [publication delayed], Vol. 13, No. 61, pp. 19–35.)

Continuation and end of the paper dealt with in 1932 Abstracts, pp. 538–539. The preliminary experiments are described, and then the successful tests between Berlin and Buenos Aires. These included trials with telephony and two independent telegraphy channels, with telephony and two telegraphy channels combined to reduce errors, and with printing telegraphy. There are three appendices, of which the last deals with the highest telegraphic speed attainable with one or more channels if each channel is limited in its frequency breadth and if fading is allowed for.

SIMULTANEOUS TELEPHONY AND TELEGRAPHY ON SHORT WAVES.—Lüschen. (*See* abstract under "Miscellaneous.")

GENERAL PHYSICAL ARTICLES

ON THE ELECTROMAGNETIC FIELD OF THE WAVE OF LIGHT.—L. de Broglie. (*Comptes Rendus*, 14th Nov., 1932, Vol. 195, pp. 862–864.)

Continuing the work referred to in Jan. Abstracts, p. 54.

ON THE QUANTUM THEORY OF THE DIFFUSION OF ELECTRONS.—L. Goldstein. (*Ibid.*, pp. 864–866.)

ON THE FUNCTION IN QUANTUM MECHANICS WHICH CORRESPONDS TO A GIVEN FUNCTION IN CLASSICAL MECHANICS.—N. H. McCoy. (*Proc. Nat. Acad. Sci.*, Nov., 1932, Vol. 18, pp. 674–676.)

ON THE RELATION BETWEEN THE INTEGRAL AND THE DIFFERENTIAL BIOT-SAVART LAW.—H. Greinacher. (*Bull. Assoc. Suisse d. Élec.*, 14th Oct., 1932, Vol. 23, No. 21, pp. 551–552.)

ON MEASUREMENTS OF e/m FOR THREAD-LIKE ELECTRON BEAMS.—K. Siebertz. (*Physik. Zeitschr.*, 15th Nov., 1932, Vol. 33, No. 22, pp. 895–897.)

BEMERKUNG ÜBER DAS RAUMLADUNGSFELD DES GASKONZENTRIERTEN ELEKTRONENSTRAHLS (Remark on the Space-Charge Field of the Gas-Concentrated Electron Beam).—K. Engel. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 3/4, pp. 231–234.)

The positions of the nodes of slow-electron beams give a numerical estimate of the magnitude of the positive space-charge within the beam.

ON THE CONSERVATION OF THE QUANTITY OF MOTION IN THE PROCESSES OF ELECTRON COLLISION.—L. Goldstein. (*Comptes Rendus*, 28th Nov., 1932, Vol. 195, pp. 999–1002.)

ACCOMMODATION COEFFICIENT OF GASEOUS IONS AT CATHODES.—K. T. Compton. (*Proc. Nat. Acad. Sci.*, Dec., 1932, Vol. 18, pp. 705–711.)

EMISSION OF POSITIVE IONS FROM COLD SURFACES UNDER THE INFLUENCE OF STRONG ELECTRIC FIELDS.—W. R. Harper. (*Nature*, 19th Nov., 1932, Vol. 130, p. 775.)

SOME EVIDENCE INDICATING A REMOVAL OF POSITIVE IONS FROM COLD SURFACES BY ELECTRIC FIELDS.—J. W. Beams. (*Phys. Review*, 1st Sept., 1932, Series 2, Vol. 41, No. 5, pp. 687–688.)

GAS DISCHARGE AND BREAKDOWN.—W. Rogowski. (*Archiv f. Elektrot*, 3rd Sept., 1932, Vol. 26, No. 9, pp. 643–678.)

NON-CONDUCTING MODIFICATIONS OF METALS.—J. Kramer and H. Zahn. (*Naturwiss.*, 21st Oct., 1932, Vol. 20, No. 43, p. 792.)

The writers have made, by cathode spraying and by vaporisation, thin films of a number of metals with conductivities very small compared with those of the metals in their normal state. They are chiefly made at low temperatures and, on raising the temperature, the conductivity first increases and at a certain " transition " temperature, characteristic of the metal, the film begins to change to the normal form. The non-conducting films also show increased conductivity on illumination.

SUPRACONDUCTIVITY [Survey and Bibliography].—K. Clusius. (*Zeitschr. f. Elektrochemie*, May, 1932, Vol. 38, pp. 312–326.)

PARAMAGNETIC ROTATORY POLARISATION [especially the Enormous Rotating Power of Tysonite].—J. Becquerel and W. J. de Haas. (Summary in *Physik. Ber.*, 15th Sept., 1932, Vol. 13, No. 18, pp. 1702–1703.)

MISCELLANEOUS

OLYMPIA, 1932: IMPRESSIONS OF THE RADIO EXHIBITION. (*Wireless Engineer*, Oct., 1932, Vol. 9, No. 109, pp. 564–572.)

Approximate census of types: " straight h.f." *versus* " superhet ": pentode in large majority among output valves: variable-mu valve has nearly ousted ordinary s.g. valve for r.f. and i.f. amplification, and has prevented band-pass filter from appreciable increase in popularity (though still common, especially in 3-valve sets, where it gives very acceptable increase in selectivity): signs that next year the supremacy of triode as detector may be very seriously challenged by s.g. valve: even as oscillator for superheterodynes the triode has to compete with bi-grids, dynatrons, etc.: need for enhanced selectivity has resulted in a " mild tendency to increase the efficiency of the tuning coils " (*e.g.*, 15-strand Litzendraht on glass former): superheterodyne tendencies (*e.g.*, unusual arrangement of single tuned circuit connected to aerial, with b.p. filter between r.f. valve and first det.—reducing valve noise: duo-diode for second det. and a.v.c.: preliminary r.f. stage dispensed with, second-channel interference being counterbalanced by voltage through very small aerial/det. grid condenser): battery sets — a.v.c. applied to output pentode to limit anode current on loud signals: " micromesh " valves: complete set-testing equipment for works: etc., etc.

THE POST OFFICE EXHIBIT AT THE NATIONAL RADIO EXHIBITION.—A. Morris. (*P.O. Elec. Eng. Journ.*, Oct., 1932, Vol. 25, Part 3, pp. 235–237.)

THIS YEAR'S RADIO SHOW [Olympia].—P. K. Turner. (*Elec. Review*, 26th Aug., 1932, Vol. 111, pp. 275–276.)

FROM THE GREAT GERMAN RADIO EXHIBITION, BERLIN, 1932.—W. Burstyn. (*E.T.Z.*, 27th Oct., 1932, Vol. 53, No. 43, pp. 1025–1029.)

Including numerous components. In addition to the Ferrocart cores (finely divided iron and cardboard—" karton," whence the name) dealt with in previous abstracts, there is Ferro-X (Budich Company), which is an asphalt-like material containing iron powder. A wall plug with slip rings and silver brushes, giving negligible friction and preventing the flexible lead from getting twisted up, is described and illustrated.

TECHNICAL ADVANCES AT RADIO SHOW, BERLIN, 1932 [especially Superheterodyne Receivers]. (Summary in *Electronics*, Oct., 1932, p. 323.)

WIRELESS AND OTHER ELECTRICAL APPARATUS AT THE GERMAN AIRCRAFT EXHIBITION, 1932. (*E.T.Z.*, 3rd Nov., 1932, Vol. 53, No. 44, pp. 1066–1067.)

YEARLY REPORT OF THE ELECTRICAL ENGINEERING AND WIRELESS DIVISION OF THE "DEUTSCHE VERSUCHSANSTALT FÜR LUFTFAHRT" (DVL: German Aircraft Research Establishment).—H. Fassbender. (*E.T.Z.*, 20th Oct., 1932, Vol. 53, No. 42, pp. 1010–1012.)

RADIO-ELECTRICITY AT THE INTERNATIONAL ELECTRICAL CONGRESS, PARIS, 1932 [Summaries]. (*La Ricerca Scientifica*, 15th–30th Sept., 1932, Vol. 2, Nos. 5–6, pp. 200–210; *Zeitschr. V.D.I.*, 24th Sept., 1932, Vol. 76, No. 39, pp. 944–945.)

MODERN COMMUNICATION SYSTEMS [including Multiple Utilisation of Transmission Systems, as in Two-Band Telephone Systems and Simultaneous Telephony and Telegraphy on Short Waves].—F. Lüschen. (*Journ. I.E.E.*, Nov., 1932, Vol. 71, No. 431, pp. 776–787 : Discussions, pp. 787–798.)

Among numerous points in the Discussions, Hines discusses the fact that to get as high intelligibility on a good loud speaker as on a telephone receiver, a greater band width is necessary : if loud-speaking telephones succeed in replacing the present hand telephone, the 2 400 c/s band at present adequate will have to be increased. Angwin suggests that limitation of available power and liability to intermodulation effects are economically adverse to the application of multiplex to radio telegraphy. Lüschen agrees, but stresses the advantages in special cases. Ritter denies that a filter passing a band of N c/s is sufficient to transmit N bauds : " in practice a considerably wider band is necessary " : Lüschen controverts this. Stretch suggests that a frequency-modulation method requires a much narrower band than the amplitude-modulation method : Lüschen explains that this is not the case.

POINT TO POINT RADIO TELEGRAPHY : PRESENT POSITION AND POSSIBLE FUTURE DEVELOPMENT.—N. Wells. (*Marconi Review*, Sept.–Oct., 1932, No. 38, pp. 23–26.)

Last section of a long paper submitted to the International Electricity Congress at Paris. Among the points briefly dealt with are the following :— (1) Anti-fading methods : regarding tone-modulation, " though perhaps not as efficient as diversity reception, this method is of considerable value when correctly applied. In practice a combination of diversity reception and tone modulated transmission gives the most satisfactory results." (2) Anti-distortion and anti-atmospheric methods : " high short-wave receiving aerials, by narrowing the width of the total effective angle of incidence in the vertical field, form one of the surest safeguards against that insidious form of distortion due to secondary signal paths arriving at high angles." (3) Frequency stability of transmitters : a stability of 1/25 000 c/s can be guaranteed on commercial services : greater stability will probably be achieved soon : attention is being given to vibrating steel cylindrical rods, the structure of which can be controlled and made virtually homogeneous. (4) Ultra-short waves (5 to 0.5 m) : for ranges up to about 300 km, the obtaining of an uninterrupted straight-line path ensures freedom from fading and similar effects. In some cases buildings are partially transparent to continuous waves of about 5 m, good reception within these buildings being possible. (5) Facsimile telegraphy : " multiple " and " echo " effects can be ignored if the frequency is reduced to between 250 and 500 spots per second : several methods of obtaining half-tone effects are mentioned.

A NEW SYSTEM OF MULTIPLE TELEGRAPHY BY CARRIER CURRENT [including the " Amplifilter "].—T. Kajii and S. Matsumae. (Summary in *Rev. Gén. de l'Élec.*, 26th Nov., 1932, Vol. 32, No. 21, pp. 689–690.)

The " amplifilter," applicable to harmonic telegraphy, consists of an amplifier whose plate circuit contains a resonant circuit and a rejector circuit, both tuned to the same frequency and coupled to the input circuit in such a way as to reinforce strongly the currents of the selected frequency and suppress those of other frequencies. A special modification, including a bridge circuit, is used to obtain the maximum selectivity, which occurs when the potential at the terminals of the resonant circuit is $\pi/2$ out of phase.

AN ALL-MAINS, VOICE FREQUENCY SINGLE-CHANNEL HIGH SPEED DUPLEX TELEGRAPH SYSTEM.—J. M. Owen and W. F. Bevis. (*P.O. Elec. Eng. Journ.*, Oct., 1932, Vol. 25, Part 3, pp. 182–190.)

THE USE OF THE SELENIUM BARRIER-LAYER PHOTOCELL FOR PHYSICAL MEASUREMENTS.—L. Bergmann. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 13, 1932, pp. 568–573 : *Physik. Zeitschr.*, 1st Nov., 1932, Vol. 33, No. 21, pp. 824–826.)

As a null instrument for the measurement of small rotations (1932 Abstracts, pp. 53–54) ; in the special form of a differential photocell for measuring small differences in illumination, and hence for indicating at a distance the readings of a manometer, etc. ; and as a magnifier or relay for a d.c. galvanometer (*cf.* Sell, 1932 Abstracts, p. 535.)

A PHOTOELECTRIC TRANSPARENCY METER [Direct Reading Electrophotometer avoiding Amplification Errors by use of Electrometer Valve Circuit].—Geffcken and Richter. (*E.T.Z.*, 15th Sept., 1932, Vol. 53, No. 37, pp. 893–894.)

THE DEVELOPMENT OF COMMERCIAL PHOTOELECTRIC PHOTOMETERS.—G. T. Winch and C. T. Harper. (*G.E.C. Journal*, Aug., 1932, Vol. 3, No. 3, pp. 149–156.)

PHOTOELECTRIC COMPENSATION METHOD FOR PHOTOMETRIC MEASUREMENTS [using Two Selenium Barrier-Layer Cells].—M. Richter. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 491–493.)

A NEW [Barrier-Layer] PHOTOELECTRIC MICROPHOTOMETER WITH SYNCHRONOUS RECORDING EQUIPMENT.—B. Lange. (*Zeitschr. f. tech. Phys.*, No. 12, 1932, Vol. 13, pp. 600–606.)

PORTABLE COLOUR-MATCHER OPERATING AT THREE POINTS OF THE SPECTRUM.—Westinghouse Company. (*Electronics*, Nov., 1932, p. 342.)

PHOTOELECTRIC CONTROL IN THE PRINTING ARTS [with List of Sixteen Applications to Printing, Publishing, etc.].—(*Electronics*, Nov., 1932, pp. 334–335.)

THE AUTOMATIC CONTROL OF STREET LIGHTING BY PHOTOELECTRIC CELLS.—D. Hauser. (*Rev. Gén. de l'Élec.*, 3rd Dec., 1932, Vol. 32, No. 22, pp. 737–740.)

TESTING OF RAW SILKS FOR UNIFORMITY OF THREAD DIAMETER BY PHOTOELECTRIC CELL. —(*Electronics*, Nov., 1932, p. 343.)

RADIO TUBES AMPLIFY AND MEASURE NERVE MESSAGES [Difference between Effects of Weak and Strong Stimuli is due to Different Number of Fibres used and to Different Frequency of Impulses along Each Fibre].—D. W. Bronk. (*Sci. News Letter*, 29th Oct., 1932, p. 271.)

THE BIOLOGICAL EFFECT OF COSMIC RAYS [and the Possibility of Increasing Human Vitality by Screening from Electromagnetic Fields: Longevity of Deep-Sea Fish].—G. Lakhovsky: Rivera. (*Lincei, Atti d. R. Accad. d., Rendic.*, 6th March, 1932, Vol. 15, pp. 403–405.)

Starting with a confirmation of Rivera's experiments showing a greater speed of development of seeds with increasing depth below the surface of a lake.

ON SOME PROCESSES OF ELECTRO-CULTURE AND ON THE DISTANT ACTION OF METALLIC CIRCUITS ON THE GROWTH OF PLANTS.—R. Failletaz: Lakhovsky. (*Rev. Gén. de l'Élec.*, 22nd Oct., 1932, Vol. 32, No. 16, pp. 539–540.)

A STUDY OF STRAY EARTH CURRENTS [from D.C. Lines] AND OF ELECTROLYTIC PHENOMENA. —C. and M. Schlumberger. (*Ann. des P.T.T.*, Sept., 1932, Vol. 21, pp. 745–763.)

SHORT WAVE H.F. CURRENTS. THEIR HEATING EFFECTS — SHORT WAVE DIATHERMY.—H. H. U. Cross. (*Electrician*, 25th Nov., 1932, Vol. 109, pp. 683–684.)

A STUDY OF HIGH-FREQUENCY HEATING [in connection with the Production of Artificial Fever]. — K. C. De Watt: Whitney. (*Electronics*, Nov., 1932, pp. 338–340 and 345.)

RADIOTHERMY [including Artificial Fever: with Bibliography].—W. R. Whitney. (*Rad. Engineering*, Sept., 1932, Vol. 12, pp. 23–24.)

From the paper presented at the International Electricity Congress, Paris, 1932.

A PORTABLE AMPLIFYING ELECTRO-CARDIOGRAPH. —Siemens Company. (*E.T.Z.*, 27th Oct., 1932, Vol. 53, No. 43, pp. 1042–1043.)

HIGH-FREQUENCY HEATING IN INDUSTRY [Possible Applications: for Parts to be Lacquered or Drop-Forged: for Killing Bugs in Stored Wheat]. (*Electronics*, Sept., 1932, p. 291.)

THE NITRIDING OF STEEL BY THE USE OF HIGH-FREQUENCY CURRENTS. (Summary in *E.T.Z.*, 10th Nov., 1932, Vol. 53, No. 45, p. 1089.) *Cf.* Egan, 1932 Abstracts, p. 53, and back references.

INFRA-RED, THE NEXT PLAYGROUND OF VACUUM TUBES [Sextant, Locating Aeroplanes by Heat of Exhaust, Warships by Funnel Heat, Iceberg Warning].—Macneil. (Paragraph in *Electronics*, pp. 320–321.) *See* also 1932 Abstracts, p. 480.

ELECTRONIC DEVICES IN A TESTING LABORATORY.—C. H. Sharp. (*Electronics*, Sept., 1932, pp. 284–286.)

GLOW TUBE CHECKS OVER- AND UNDER-VOLTAGES [for Testing Coin Relays in Coin Collectors]. (*Ibid.*, p. 290.)

MOVING TRACK FOR WALKING EXERCISES, WITH SPEED CONTROLLED BY WALKING SPEED THROUGH THYRATRONS AND PHOTOCELLS OR CONDENSER EFFECT.—British Thomson-Houston Company. (Patent summary in *Electrician*, 25th Nov., 1932, Vol. 109, p. 671.)

TUNING IN ON MOSQUITOES. (*Sci. News Letter*, 3rd Dec., 1932, Vol. 22, No. 608, p. 361.)

The Physics Laboratory of the U.S. Public Health Service has designed a sound generator in an effort to produce a sound (below, within or above the range of the ear) which will attract mosquitoes in large numbers so that they may be exterminated. *Cf.* D'Orsay Bell, 1928 Abstracts, p. 694.

PHYSICO-CHEMICAL METHOD OF ANALYSIS IN AN ORGANIC SOLUTION BY MEASURING THE DIELECTRIC CONSTANT.—A. Chrétien and P. Laurent. (*Comptes Rendus*, 7th Nov., 1932, Vol. 195, pp. 792–794.)

Using the method of measurement dealt with in 1931 Abstracts, p. 447.

PIEZOELECTRIC METHODS OF MEASURING MECHANICAL FORCES.—I. J. Saxl: Kluge and Linckh. (*Electronics*, Sept., 1932, p. 292.)

A short article based on the paper by Kluge and Linckh dealt with in 1930 Abstracts, p. 118, and on another paper by the same writers in *Zeitschr. f. Forschung auf dem Gebiete des Ingenieurwesens*.

MEASURING INSTANTANEOUS PRESSURE IN SHOT GUNS [Piezoelectric Gauge].—(*Electronics*, Oct., 1932, p. 314.)

THE VIBRATION OF TAUT ELECTRIC WIRES [and the Avoidance of Resonance Effects].—L. Respighi. (*L'Elettrotec.*, 25th Oct., 1932, Vol. 19, No. 30, pp. 755–757.)

CHANGES IN PATENT PROCEDURE.—(*Wireless Engineer*, Oct., 1932, Vol. 9, No. 109, pp. 557–558.)

THE NEW GERMAN PATENT AND TRADE MARK LAW.—H. Neumann. (*Zeitschr. V.D.I.*, 27th Aug., 1932, Vol. 76, No. 35, pp. 833–835.)

PATENT PROBLEMS IN THE FIELD OF ELECTRONICS [and the Need of Careful Study of Previous Patents].—H. A. Toulmin. (*Electronics*, Oct., 1932, pp. 306–307 and 324.)

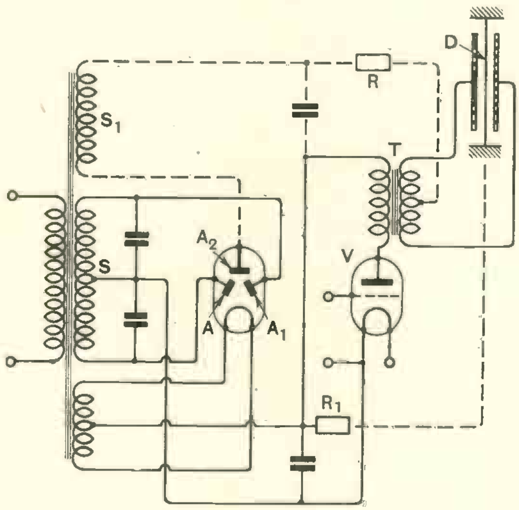
Some Recent Patents

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.

ELECTROSTATIC LOUD SPEAKERS

Application date, 24th August, 1931. No. 378212.

A high biasing-voltage for the diaphragm of an electrostatic loud-speaker is derived from a special electrode inserted in the mains rectifier valve. As shown, the secondary winding *S* is connected across the usual anodes A, A_1 of a full-wave mains



No. 378212.

rectifier. One terminal of a further winding S_1 is connected to a third anode A_2, the other terminal being connected through a resistance *R* to a centre tapping on the input transformer *T* to the speaker. The central diaphragm *D* of the speaker is connected to the positive terminal or filament of the rectifier through a resistance R_1, so that it retains the full rectified voltage from the winding S_1. The speech-frequency currents are applied to the speaker from the amplifier *V* in the ordinary way. Alternatively one of the L.F. valves may be fitted with an extra anode, so as to provide a biasing-voltage for the speaker, without interfering with its normal amplifying action.

Patent issued to H. Vogt.

VALVE CONSTRUCTION

Application date, 29th May, 1931. No. 378994.

The lead-in wires to the internal electrodes of a valve, instead of being embedded in the glass, are held correctly spaced in an annular metal member of mild steel, copper, or nickel, with an interposed strip of mica or similar insulation. The annular member and strip of insulation are deformed by pressure around the lead-in wires so as to grip them firmly. The assembly is inserted in a glass base which is surmounted by a copper portion forming the anode. The valve is stated to be suitable for broadcast reception.

Patent issued to M-O Valve Co., Ltd., and A. E. McLeod.

RECEIVING SETS

Convention date (U.S.A.), 6th January, 1931. No. 379195.

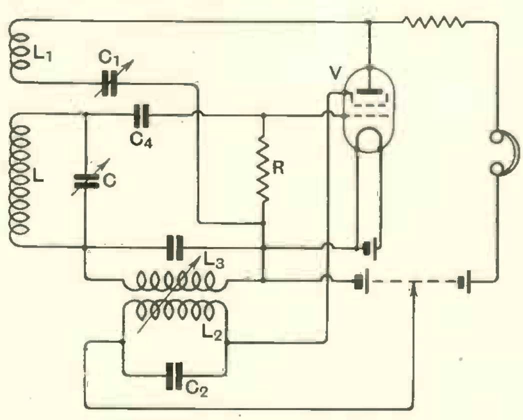
A multivalve receiver is characterised by the combination of a radio-frequency stage having a predetermined overall selectivity curve, a detector stage, and a low-frequency stage designed to have a frequency characteristic substantially the reciprocal of the radio-frequency stage, thus ensuring a uniform quality of reproduction at all points on a wavelength range.

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

SUPER-REGENERATIVE RECEIVERS

Application date, 15th June, 1931. No. 379426.

A screen-grid valve *V* is utilised as a combined high-frequency amplifier and detector, and also as a generator of local "quenching" oscillations to give a super-regenerative effect. As shown, the input circuit *L*, *C* is coupled with a reaction circuit L_1, C_1 connected across the plate and filament, grid-leak rectification being ensured by the condenser C_4 and resistance *R*. A circuit L_2, C_2 in the screen-grid output is back-coupled to a coil L_3 in series with the coil *L*, in order to generate and superpose quenching oscillations on the



No. 379426.

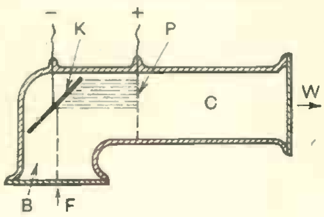
input circuit. The reaction circuit L_1, C_1 and quenching circuit L_2, C_2 may be interchanged with respect to the two grids of the valve.

Patent issued to J. Croysdale and S. R. Wright.

LIGHT INTENSIFIER

Convention date (*Germany*), 20*th January*, 1931.
No. 379609.

The device is intended to intensify a source of comparatively weak light, as for instance in television. A glass container is divided by a partition *P* of thin metal foil, which is permeable by electrons, into two portions, one *B* being highly evacuated whilst the other *C* contains a suitable gas under low pressure. Incident light-rays of low intensity enter the container at *F* and fall upon a photoelectric cathode *K*. The resulting electron stream, accelerated by the positive voltage on the portion *P*, penetrates the latter and sets up a glow discharge across the vessel *C*, so that light of greater intensity is delivered from a window *W*.



No. 379609.

Patent issued to Telefunken Ges. für Drahtlose Telegraphie m.b.H.

SELECTIVITY DEVICES

Convention date (*Germany*), 23*rd April*, 1931.
No. 379249.

A tuned circuit, to be interposed between the aerial and the set, comprises two coils in series, one mounted inside and at right-angles to the other. The coils are shunted by two condensers also in series, one being fixed and the other variable. The selector circuit may be coupled directly or indirectly to the aerial, through suitable tappings, and is preferably constructed as a separate unit.

Patent issued to Deutsche Philips G.m.b.H.

ELIMINATING HETERODYNE "WHISTLE"

Convention date (*U.S.A.*), 10*th January*, 1931.
No. 376175.

Heterodyne interference caused in the overlapping "service area" of two common-wave stations, when one or the other "drifts" away from its allotted frequency, is eliminated by shunting a piezo-electric crystal across a broadly-tuned circuit coupling the intermediate-frequency amplifier to the input of the second detector. The crystal is tuned to the middle of the band of frequencies passed by the intermediate-frequency amplifier, so that the heterodyne whistle can be cut out without causing any serious side-band "cutting" of the received programme.

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

"GLOW-DISCHARGE" AMPLIFIERS

Convention date (*Germany*), 21*st November*, 1930.
No. 377540.

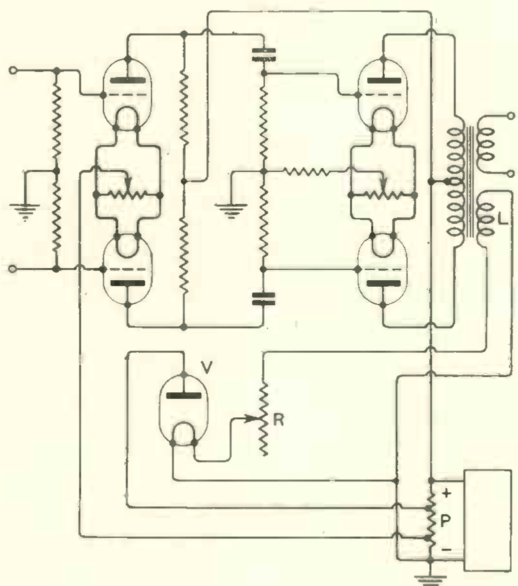
The usual heated filament is replaced by two adjacent plate-electrodes which are biased by a voltage sufficient to set up a glow discharge across them. This is used as the source of the electrons forming the main discharge stream through the valve. The bulb must contain gas in order to create the discharge, and in order to prevent undesirably large grid currents, due to gas ionization, a space-charge grid is located between the control grid and the glow-discharge "filament," and is negatively biased in order to attract and retain any positive ions formed by shock-collision. The electron emission passes beyond the space-charge grid to the anode via a control grid to which the voltages to be amplified are applied.

Patent issued to Telefunken Ges. für Drahtlose Telegraphie m.b.H.

AUTOMATIC VOLUME CONTROL

Convention date (*U.S.A.*), 26*th November*, 1930.
No. 379916.

A coil *L* coupled to the output from a final stage of push-pull amplification supplies energising current to the filament of a diode control valve *V*. For an input signal of average amplitude a rheostat *R* is adjusted so that the valve *V* passes no current. When the signal level rises beyond this point, the valve *V* starts to conduct. In doing so it diverts some of the current normally passing through the potentiometer *P* and so reduces the biasing voltages for the preceding amplifiers. The arrangement is particularly suitable for a receiver fitted with automatic "fading" or volume control, as it allows the correct reproduction of orchestral passages varying from pianissimo to full strength, even though the gain control on the H.F. side tends to maintain the signal intensity at a steady average value.



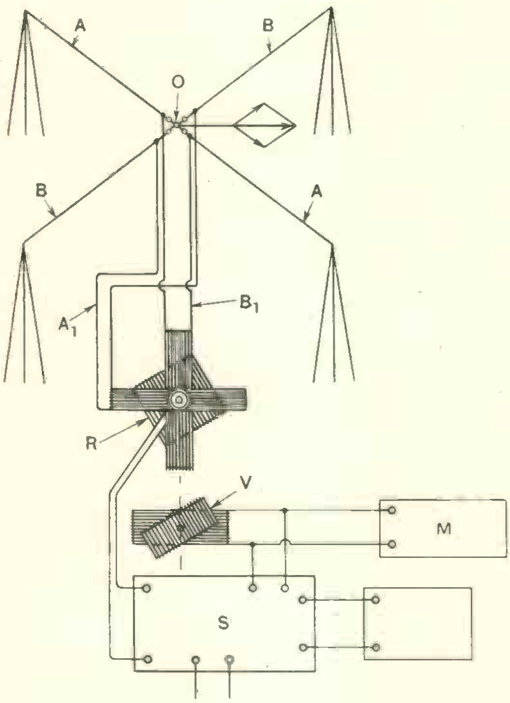
No. 379916.

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

DIRECTION-FINDING APPARATUS

Convention date (France), 13th June, 1930.
No. 380466.

The position of a navigator is defined by the comparison of two rotating beams, oriented at right-angles, each beam being differently modulated in cyclic fashion over 360°. Two horizontal



No. 380466.

aerials A, B are fed through leads A_1, B_1 from a goniometer arrangement comprising a rotary coil R which is energised from a high-frequency source S. Modulating frequencies, which vary cyclically, are superposed from a source M through a variometer V, the moving coil of which is mounted on the same shaft as the coil R of the goniometer. The result is that the radiation from each of the aerials A, B simulates that which would be emitted if the aerial system as a whole were rotating about the point O with the angular velocity of the coil R. A second modulator, similar to M, imparts a separate cyclic characteristic to the second beam. An aviator is able to "home" on to the transmitter by maintaining a constant relation between the two modulating notes. Or he can ascertain his actual position in space by comparing the signals, as received, with a prepared chart.

Patent issued to L. Levi.

DIRECTION FINDING

Convention date (France), 21st November, 1930.
No. 380842.

A frame aerial and an open aerial are coupled together to give a cardioid response free from the usual 180° ambiguity. The two aerials are tuned by impedance elements which are designed to preserve a constant ratio between the frame "pick-up" voltage and the voltage induced into the frame by its coupling with the open aerial. The "open" aerial circuit also includes phase-changing means, so that both aerials can be ganged together to a single control over a wide range of signal frequencies.

Patent issued to Standard Telephones and Cables, Ltd.

DIRECTION-FINDERS

Convention date (Belgium), 3rd April, 1931.
No. 380385.

The signal pick-up from a constantly-rotating frame aerial is amplified and rectified, and the resultant current is made to deflect a mirror galvanometer mounted on the shaft that drives the rotating frame aerial. The speed of the galvanometer mirror is such that the locus of the luminous spot reflected by it from a source of light appears as a continuous polar curve when projected on to a screen. The projector is arranged so that the curve is seen as a whole, and is correlated with a second indicator such as a magnetic or gyroscopic compass.

Patent issued to R. Braillard, J. Marique, and Soc. Anonyme Internationale de T.S.F.

TUNING COILS

Application date, 26th May, 1931. No. 379310.

In transmitters there is a known tendency for the carrier-wave to "drift" in frequency owing to the expansion of the tuning coils as their temperature increases. To overcome this difficulty the tuning-coils are constructed so that each individual turn consists of a split ring, which can expand circumferentially but not radially as it warms up. The free ends of adjacent rings are connected together by flexible conductors to form a continuous coil of constant diameter.

Patent issued to W. B. MacKenzie, W. Ure, and C. Matthews.

AUTOMATIC GAIN CONTROL

Application date, 28th March, 1931.
No. 377307.

A highly sensitive multi-stage amplifier, particularly suitable for short-wave reception, is characterised by the feature that the rectified output from a diode detector is utilised first to control the gain of one H.F. stage, and is thereafter applied in succession to control the gain of a second or third H.F. stage, thus giving an automatic and elastic system competent to counteract severe "fading." The method is described as applied to a superheterodyne circuit comprising a second frequency-changer and two distinct stages of intermediate-frequency amplification, one operating at a different frequency from the other. The volume-control biasing-voltages may be applied either to the control or screening grids of the amplifiers.

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

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