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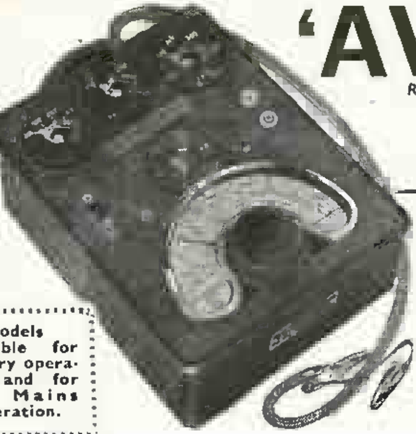

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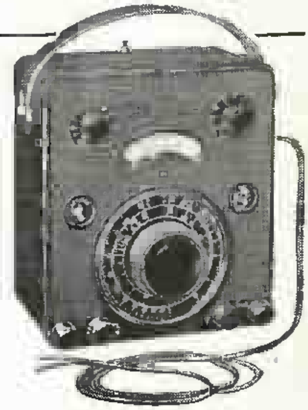

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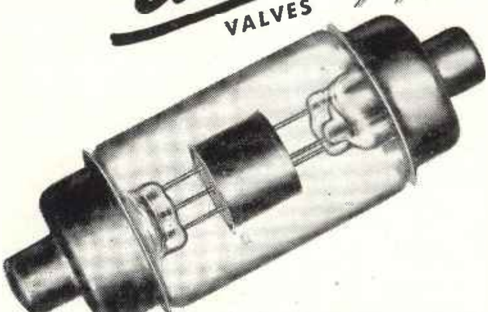

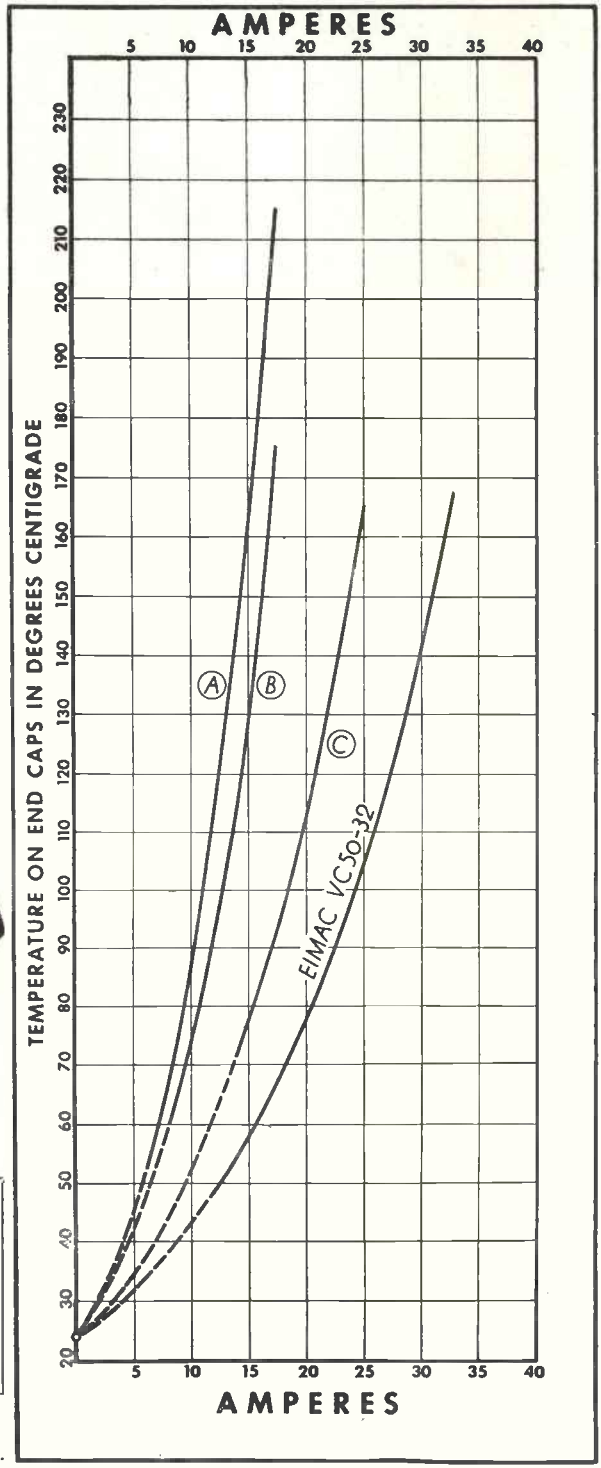

EIMAC VACUUM CAPACITOR TYPE VC50-32

General Characteristics

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Maximum Overall Dimensions

Length	6.531 inches
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Maximum Peak Voltage	32,000 volts
Maximum RMS Current	28 amps.

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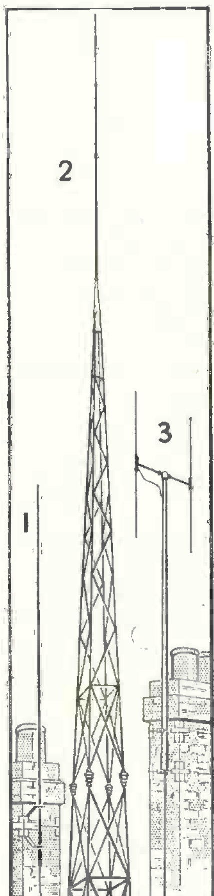

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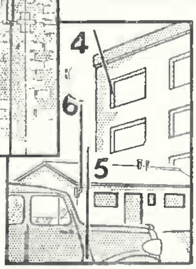

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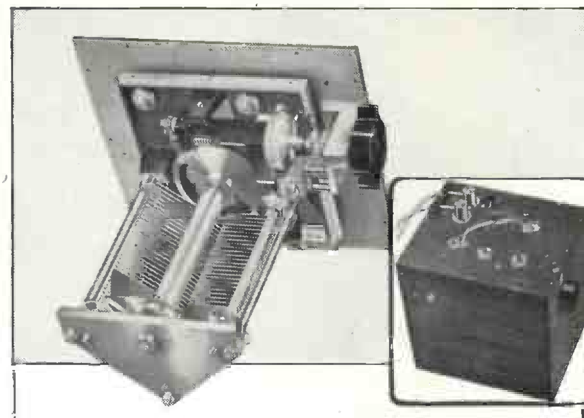

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CAPACITANCE. 50 $\mu\mu$F min. 1,250 $\mu\mu$F max.
LOSS ANGLE. Approximately 1 micro-radian in a dry atmosphere: 7 micro-radians in 75% relative humidity, for the frequency range 50 c.p.s. to 10,000 c.p.s.
DRIVE. Worm reduction gear, 50 : 1 ratio.
SCALE READING. To 1 part in 5,000 direct reading; To 1 part in 20,000 by interpolation.
BACKLASH. Not exceeding 1 part in 20,000.
DIMENSIONS. 12.7/8" x 10" x 13.5/8".
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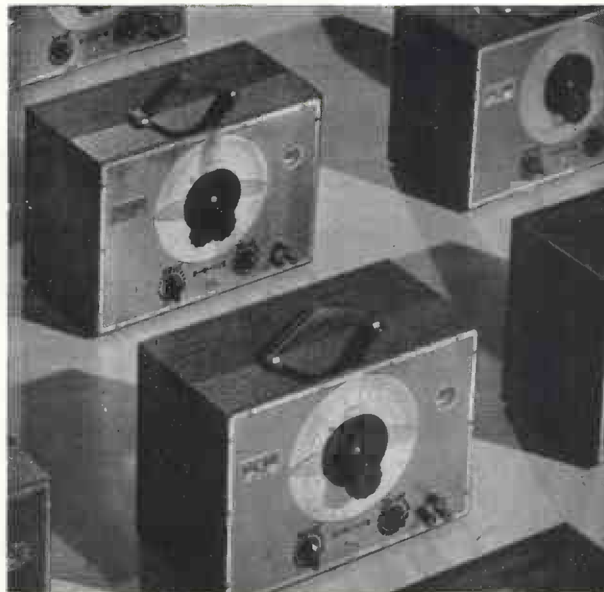

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RADIO TELEGRAPH INSPECTORS required for the Nigerian Government Posts and Telegraphs Department for one tour of 12 to 24 months in the first instance. Salary £600 a year plus local allowance £24 a year. Separation allowance for married men between £72 and £192 a year, according to number of children. Outfit allowance £60. Free quarters and passages. The duties of the post are those of a construction foreman engaged on the installation of radio diffusion or relay systems including fitting central receiving stations with diversity reception receivers, aerial arrays, etc., and subscribers' lines and apparatus. Candidates should preferably have had experience with a company operating radio relay services in England or elsewhere. A sound practical knowledge of radio reception apparatus is of more importance than experience in underground and overhead distribution.

Written applications (no interviews) giving the following essential details (1) Full name, (2) Date of Birth, (3) Industrial training and experience, (4) Name and address of present employers, (5) Details of present work should be sent to The Secretary, Overseas Manpower Committee (Ref. 1436), Ministry of Labour and National Service, York House, Kingsway London, W.C.2. Applications cannot be acknowledged. (9.10.A.41.)

WHY ERSIN MULTICORE

the Solder wire with 3 cores of non-corrosive ERSIN FLUX is preferred by the majority of firms manufacturing the best radio and electrical equipment under Government Contracts.

WHY THEY USE CORED SOLDER

Cored solder is in the form of a wire or tube containing one or more cores of flux. Its principal advantages over stick solder and a separate flux are :

(a) it obviates need for separate fluxing (b) if the correct proportion of flux is contained in cored solder wire the correct amount is automatically applied to the joint when the solder wire is melted. This is important in wartime when unskilled labour is employed.

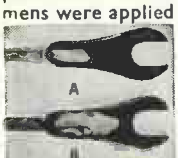
WHY THEY PREFER MULTICORE SOLDER. 3 Cores—Easier Melting
Multicore Solder wire contains 3 cores of flux to ensure flux continuity. In Multicore there is always sufficient proportion of flux to solder. If only two cores were filled with flux, satisfactory joints are obtained. In practice, the care with which Multicore Solder is made means that there are always 3 cores of flux evenly distributed over the cross section of the solder, so making thinner solder walls than single cored solder, thus giving more rapid melting and speeding up soldering.

ERSIN FLUX

For soldering radio and electrical equipment non-corrosive flux should be employed. For this reason either pure resin is specified by Government Departments as the flux to be used, or the flux residue must be pure resin. Resin is a comparatively non-active flux and gives poor results on oxidised, dirty or "difficult" surfaces such as nickel. The flux in the cores of Multicore is "Ersin"—a pure, high-grade resin subjected to chemical process to increase its fluxing action without impairing its non-corrosive and protective properties. The activating agent added by this process is dissipated during the soldering operation and the flux residue is pure resin. Ersin Multicore Solder is approved by A.I.D., G.P.O., and other Ministries where resin cored solder is specified.

PRACTICAL SOLDERING TEST OF FLUXES

The illustration shows the result of a practical test made using nickel-plated spade tags and bare copper braid. The parts were heated in air to 250° C, and to identical specimens were applied ½" lengths of 14 S.W.G. 40/60 solder. To sample A, single cored solder with resin flux was applied. The solder fused only at point of contact without spreading. A dry joint resulted, having poor mechanical strength and high electrical resistance. To sample B, Ersin Multicore Solder was applied, and the solder spread evenly over both nickel and copper surfaces, giving a sound mechanical and electrical joint.



ECONOMY OF USING ERSIN MULTICORE SOLDER

The initial cost of Ersin Multicore Solder per lb. or per cwt. when compared with stick solder is greater. Ordinary solder involves only melting and casting, whereas high chemical skill is required for the manufacture of the Ersin flux and engineering skill for the Multicore Solder incorporating the 3 cores of Ersin Flux. However, for the majority of soldering processes in electrical and radio equipment Multicore Solder will show a considerable saving in cost, both in material and labour time, as compared either with stick solder or single cored solder. Cored solder ensures that the solder and flux are put just where they are required, and by choice of suitable gauge, economy in use of material is obtained. The quick wetting of the Ersin flux as compared with resin flux in single core resin solder ensures that with the correct temperature and reasonably clean surface, immediate alloying will be obtained, and no portions of solder will drop off the job and be wasted. Even an unskilled worker, provided with irons of correct temperature, is able to use every inch of Multicore Solder without waste.

ALLOYS

Soft solders are made in various alloys of tin and lead, the tin content usually being specified first, i.e. 40/60 alloy means an alloy containining 40% tin and 60% lead. The need for conserving tin has led the Government to restrict the proportion of tin in solders of all kinds. Thus, the highest tin content permitted for Government contracts without a special licence is 45/55 alloy. The radio and electrical industry previously used large quantities of 60/40 alloy, and lowering of tin content has meant that the melting point of the solder has risen. The chart below gives approximate melting points and recommended bit temperatures.

ALLOY Tin Lead	Equivalent B.S. Grade	Solidus C.°	Liquidus C.°	Recommended bit Temperature C.°
45/55	M	183°	227°	267°
40/60	C	183°	238°	278°
30/70	D	183°	257°	297°
18.5/81.5	N	187°	277°	317°

VIRGIN METALS — ANTIMONY FREE

The wider use of zinc plated components in radio and electrical equipment has made it advantageous to use solder which is antimony free, and thus Multicore Solder is now made from virgin metals to B.S. Specification 219/1942 but without the antimony content.

IMPORTANCE OF CORRECT GAUGE

Ersin Multicore Solder Wire is made in gauges from 10 S.W.G. (.128"—3.251 m/ms) to 22 S.W.G. (.028"—.711 m/ms). The choice of a suitable gauge for the majority of the soldering undertaken by a manufacturer results in considerable saving. Many firms previously using 14 S.W.G. have found they can save approximately 33 1/3%, or even more by using 16 S.W.G. The table gives the approximate lengths per lb. in feet of Ersin Multicore Solder in a representative alloy, 40/60.

S.W.G.	10	13	14	16	18	22
Feet per lb.	23	44.5	58.9	92.1	163.5	481

CORRECT SOLDERING TECHNIQUE

Ersin Multicore Solder Wire should be applied simultaneously with the iron, to the component. By this means maximum efficiency will be obtained from the Ersin flux contained in the 3 cores of the Ersin Multicore Solder Wire. It should only be applied direct to the iron to tin it. The iron should not be used as a means of carrying the solder to the joints. When possible, the solder wire should be applied to the component and the bit placed on top, the solder should not be "pushed in" to the side of the bit.

ERSIN MULTICORE SOLDER WIRE is now restricted to firms on Government Contracts and other essential Home Civil requirements. Firms not yet using Multicore Solder are invited to write for fuller technical information and samples.

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WIRELESS ENGINEER

Editor HUGH S. POCOCK, M.I.E.E. Technical Editor Prof. G. W. O. HOWE, D.Sc., M.I.E.E.

Vol. XXII DECEMBER, 1945 No. 267

EDITORIAL

The Equivalent Circuit of the Multivibrator

THE multivibrator was devised by Abraham and Bloch* for producing a wave-form rich in harmonics for the purpose of frequency measurement. It was employed at the N.P.L. by Dye† for the measurement of frequency to a very high degree of accuracy. In recent years, however, it has come into general use as a pulse generator and an interesting discussion of its operation appeared in a recent number of the Proceedings of the American Institute of Radio Engineers.‡ As an introduction, the authors considered the transients occurring in resistance-capacitance circuits and gave the three following rules. (1) When a sudden change occurs in a circuit containing one capacitor and any number of resistors, the change occurs, then the voltage between the points after the circuit again reaches equilibrium and then connecting these points by an exponential curve having the proper time constant. This time constant can be found by applying the Helmholtz theorem (often ascribed to Thévenin) to the network connected to the capacitor terminals. This gives the effective resistance which is multiplied by the capacitance to obtain the time constant. (2) To determine the voltages in the circuit just after the sudden change, find the voltage across the capacitor just before the change. Since the voltage across the capacitor cannot change instantly, the other voltages can be found by simple direct current methods. (3) Equilibrium condi-

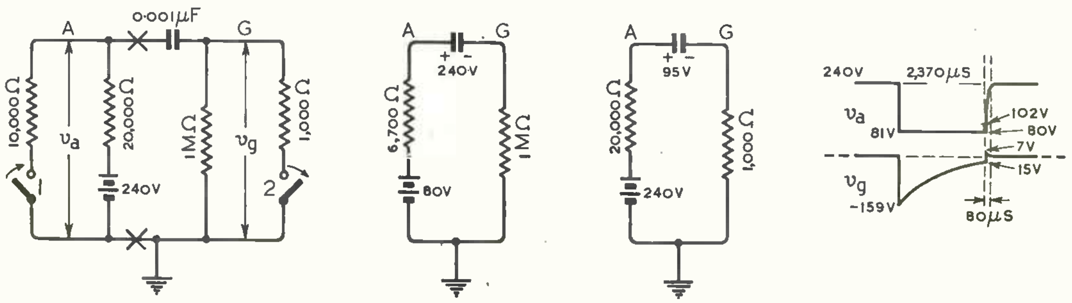


Fig. 1.

the voltage between any two points in the circuit can be plotted by determining first the voltage between the points just after tions can be determined by considering the capacitor to be an open circuit. The application of these rules to the equivalent circuit of a multivibrator is shown in Fig. 1. It is assumed that switch 1 has been open and switch 2 closed, but at the moment considered switch 1 is closed and

* *Annales de Phys.*, 1919, xii, p. 237.
† *Phil. Trans. Royal Soc.*, 1924A, ccxxiv, p. 259.
‡ M. V. Kiebert and A. F. Inglis, August 1945, p. 534.

switch 2 opened. When switch 1 was open the battery was supplying no current and the capacitor voltage was 240 V. On closing switch 1 the circuit to the left of *XX* is equivalent by the Helmholtz theorem to a source of 80 V in series with a resistance of 6,700 Ω, since the open-circuit voltage across *XX* is 80 V and the resistance of the 10,000 Ω and 20,000 Ω in parallel is 6,700 Ω. Fig. 1(b) represents therefore the equivalent circuit the moment after switching over. The current is therefore (240–80)/1006.7 mA, and it is easy to see that $v_a = 81$ V and $v_g = -159$ V, the voltages being those of the points A and G relative to earth. As the capacitor discharges, these voltages vary exponentially; v_a would eventually become 80 and v_g would become zero. The time constant $CR = 1.007$ milliseconds. We assume, however, that when v_g has fallen (or risen) to -15 V the grid of the multivibrator valve reaches the cut-in voltage and the two switches jump back to their original positions. The time taken for the voltage to change from V_1 to V_2 is always equal to $CR \log_e (V_1/V_2)$ where V_1 and V_2 are expressed relatively to the final steady state voltage. In the present case $t = 1.007 \log_e (159/15) = 2.37$ milliseconds. If the voltage drop across 1 *M*Ω is 15 V that across 6,700 Ω is negligible and v_a is little more than 80 V; hence, the voltage across the capacitor is 95 V. Fig. 1 (*c*) shows the new equivalent circuit; as switch 1 is now open the left-

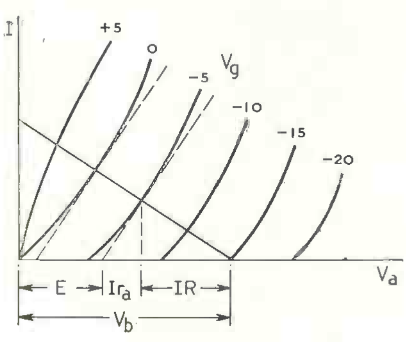


Fig. 2.

hand side is simply the 240-volt supply in series with 20,000 Ω, and on the right-hand side the 1-*M*Ω resistor can be neglected since it is in parallel with 1,000 Ω. Although the switch-over does not cause any sudden change in the voltage across the capacitor it does cause a jump in the potential of each of its terminals, v_a jumping from 80 to 102 V, and v_g from -15 to $+7$ V. As the capacitor re-charges v_a will approach 240 V and v_g fall to zero. The time constant is now quite different from what it was before, since now $CR = 21$ microseconds and in about four times this, that is, in about 80 microseconds, conditions will approximate very closely to the steady state.

If the grid voltage of a valve alternates between two values, one of which is below the cut-off and the other in the conducting region, the valve acts as a switch in series with a resistor r_a and a source of e.m.f. E. When the grid voltage is below the cut-off value the switch is open and when it reaches a conducting value V_g we have $I = (V_b - E)/(R + r_a)$ where V_b is the battery voltage, and R the external anode resistance. This can be seen from the formula

$$I = \alpha V_a + \beta V_g + \gamma$$

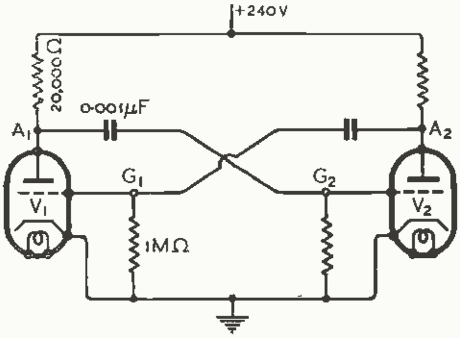
in which $\alpha = 1/r_a$ and $\beta = g_m$; putting $V_a = V_b - IR$ this becomes

$$I = \frac{V_b + (\mu V_g + \gamma r_a)}{R + r_a}.$$

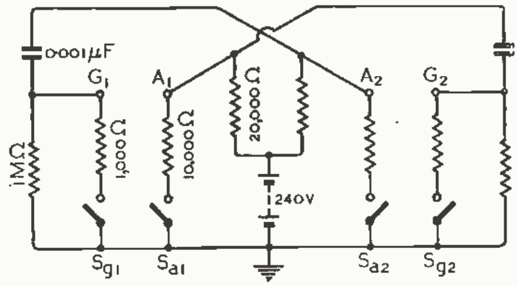
Hence $\quad E = -(\mu V_g + \gamma r_a)$.

This can be seen from Fig. 2, in which $V_b - E$ is made up of the two parts IR and Ir_a; E is found by drawing a tangent to the curve for the assumed value of -5 volts for V_g where it crosses the the load line. On applying a square wave grid voltage alternating between -5 volts and something below the cut-off value the effect is similar to that of closing and opening a switch which applies V_b to a circuit containing a back e.m.f. E and resistances r_a and R. If V_g alternates between a cut-off value and zero or a positive value, it can be seen from Fig. 2 that E becomes small and as an approximation may be neglected. The wave forms given by a multivibrator are greatly affected by grid conduction, because of the heavy load thus put upon the anode circuit of the valve driving the grid. As an approximation it may be assumed that the grid current is proportional to the positive grid voltage and although the apparent resistance may vary from 500 to 2,000 ohms in different small valves, little error is introduced by assuming the resistance to be 1,000 ohms in all cases. When the grid is positive in Fig. 3(a), which shows a typical basic multivibrator, the grid leak of 1 megohm is thus shunted by 1,000 ohms and may therefore be neglected. In the equivalent circuit, Fig. 3(b), this is achieved by closing switch

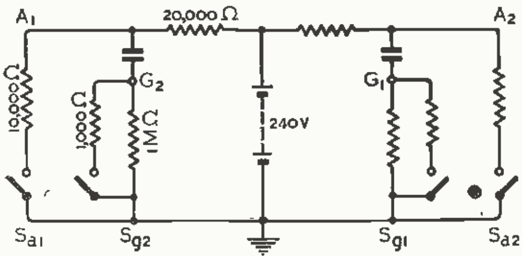
S_{g1} or S_{g2}. By drawing the diagram as in Fig. 3(c) the cross-over is avoided but at the expense of a re-arrangement of the switches. The valves employed in the experiments in which the curves shown in Fig. 3(d) were obtained were such that a 20,000-ohm load-line intersected the characteristic for $V_g = 0$ at $V_a = 80$ volts and $I_a = 8$ milliamperes. It can be seen from the curves that V_g is always either below the cut-off value or at zero or a slightly positive value and we have seen that under these circumstances the valve can be represented simply by a resistance and a switch. The value of the resistance is V_a/I_a, *i.e.*, 10,000 ohms.



(a)

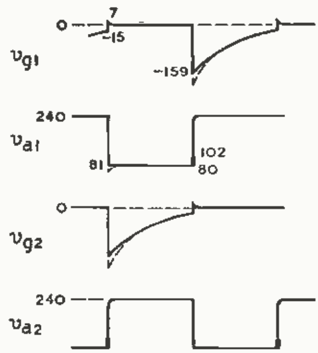


(b)



(c)

Fig. 3.



(d)

The values are therefore as shown in Fig. 3(b) and (c), and it will be noticed that the circuit on each side of the battery in Fig. 3(c) is exactly the same as that already considered in Fig. 1. The wave-forms of the various voltages of the multivibrator as shown in Fig. 3(d) are consequently identically the same as those in Fig. 1(d). The experimentally observed wave-forms only differed in one respect and that was in the slight overshoot in v_{a1} and v_{g2} when v_{g1} suddenly changed from -15 to $+7$ volts, and a similar overshoot in v_{a2} and v_{g1} when v_{g2} made the same sudden change. These are shown dotted in Fig. 3(d). The sudden change in v_{g1} from -15 to $+7$ volts causes an excessive current in the left-hand valve with a consequent excessive drop in the 20,000-Ω resistance and therefore also in v_{a1} and through the condenser to v_{g2}. Owing, however, to the very short time constant when the grid is passing current (Fig. 1(c)), v_{g1} falls rapidly to zero and the steady state is established in valve V_1 with $v_{g1} = 0$ until v_{g2} reaches the cut-in value of -15 volts, when the same overshoot occurs in v_{a2} and v_{g1}. As explained earlier, when v_{g1} jumps from -15 to $+7$ volts, v_{a2} must jump from 80 to 102 since the voltage across the condenser cannot change instantly. Although the valve V_2 is now passing no current—its grid voltage v_{g2} being very negative—current does flow for a short time down the 20,000-Ω resistance in order to charge the condenser. Thus v_{a2} does not instantly jump to 240 volts but has a slightly rounded wave-form as shown.

These equivalent circuits should enable a student to trace more readily the causes of the wave-forms obtained under various conditions.

G. W. O. H.

MULTICHANNEL COMMUNICATION SYSTEMS

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(P.O. Radio Branch)

(Concluded from page 549 of the November issue)

CONTENTS

PART II

2.1. Description of Experimental Equipment providing seven channels by means of Amplitude Modulated Pulses

A WORKING system employing the principles discussed in Part 1 was set up after a considerable amount of experimentation—the latter due to unforeseen complications which arose in connection with interchannel cross-talk. The simple amplitude-modulated pulse system was adopted[3, 16, *] and ease of construction using available valves and components was placed high among the requirements. Preliminary work with delay networks of the artificial line type was inconclusive, and the system finally employed made use of extremely simple phase-shifting networks associated with individual pulse generation for each channel. Pulse-shape approximated to that of the probability function.[22]

The demonstration apparatus consisted of two panels at the transmitting end and four at the receiving end—all panels being 19 inches wide and $10\frac{1}{2}$ inches high. A block schematic of the layout is shown in Fig. 10. The two additional panels at the receiving end were required for filtering and amplifying the audio-frequency outputs and need not be described in detail. Power supplies were, of course, additional to the panels mentioned. The main panels will now be discussed individually. All valves except the diodes were small receiving type R.F. pentodes.

2.1.1. *Oscillator and Phase Divider Panel.*

This is the first panel at the transmitting end. The circuit layout of this panel is shown in Fig. 11. It will be seen that the oscillator is of the now well-known resistance-capacitance type[19]. After a buffer amplifier stage, the sinusoidal output from the oscillator, at a frequency of approximately 8 kc/s, is separated into two parts differing in phase by 45 degrees. Each of these parts is then split into two further parts in relative phase opposition by means of the second pair of valves shown. The use of valves here rather than transformers was determined by the improved phase stability and lower circuit impedances possible while maintaining the desired high voltage level. The four phase outputs so provided were finally each split into two in such a way that the panel output consisted of eight phases, equally

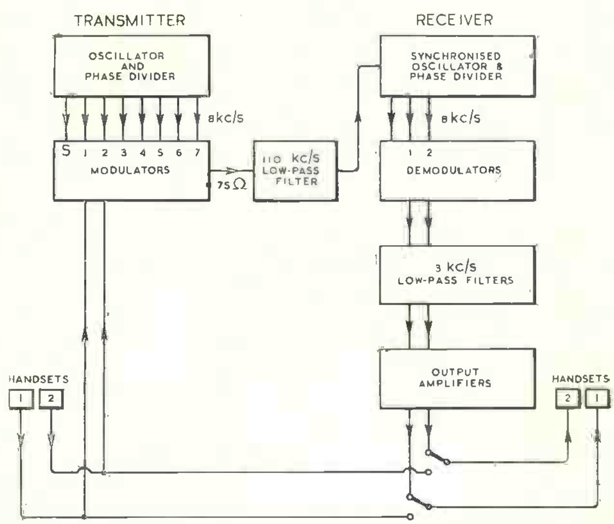

Fig. 10. *Block schematic of demonstration layout.*

* See Bibliography at end of Part I.

spaced every 45 degrees, at a frequency of 8 kc/s and a peak amplitude of 30 volts or more. These eight outputs served to generate directly the 8 pulse chains in the next panel.

pulse is at least twice as large as the channel pulses when the latter are unmodulated. In order to provide a margin between the peak values of the synchronising pulse and of a 100 per cent. modulated channel pulse, the

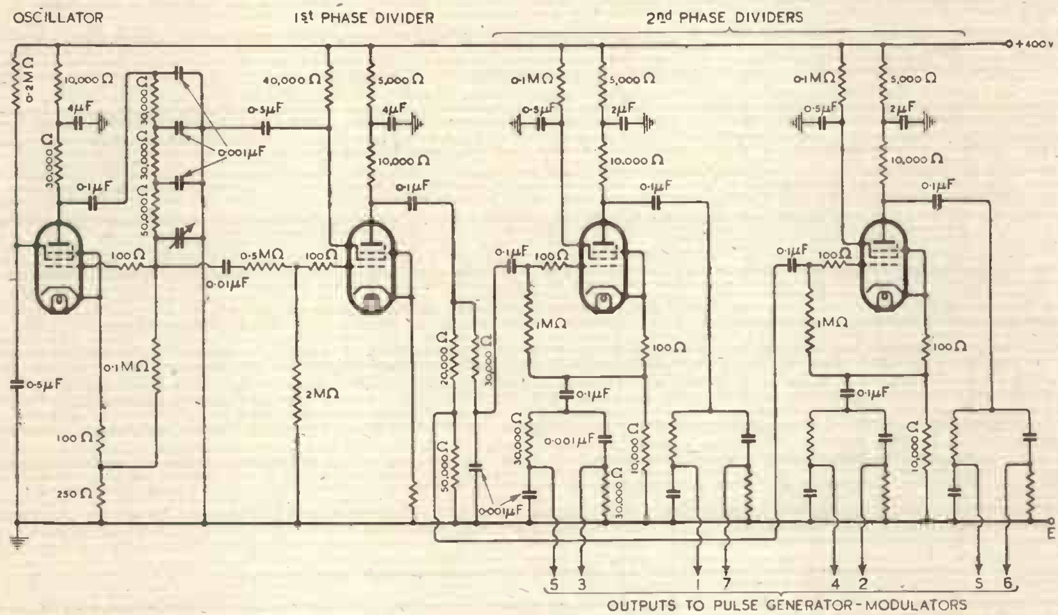

Fig. 11. *Transmitter oscillator and phase divider circuits.*

2.1.2. *Pulse Generator and Modulator Panel.*

The circuit of this panel is shown schematically in Fig. 12. The pulse generators consist of pentode valves—one for each working channel and one for the synchronising pulse. Pulse generation relies upon the approximately exponential anode-current/grid-volts cut-off characteristic of the valve[22]. The first grid is biased back so that its voltage is still negative even at the peak of the superposed signal from the phase-divider panel—the actual bias value is stabilised at this point by means of the diode valves shown. Now the first grid essentially controls the cathode current. The proportion of this current reaching the anode is determined by the voltage on the third grid. This grid is therefore biased to the middle of its linear range and the audio-frequency channel signal superposed—in this way giving fairly linear amplitude modulation of the anode current pulse chain.

The anodes of all eight pulse-generating valves feed a common load. Zero bias is applied to the third grid of the synchronising pulse generating valve so that its current

screen-grid potential on the channel-modulator valves is made appreciably lower than that on the synchronising pulse generator.

The resultant voltage is taken through a cathode-follower to the 75-ohm output socket. An anode load on the cathode-follower provides a convenient point for connection to a cathode-ray oscilloscope waveform monitor. One complete cycle of the final output pulse waveform is shown in Fig. 13.

For demonstration purposes the 75-ohm output was fed directly through a low-pass filter to the receiving equipment.

2.1.3. *Receiver Synchronising Panel.*

The synchronising panel finally adopted, and shown schematically in Fig. 14, is somewhat more elaborate than the simple amplitude-selective arrangement for separating the synchronising pulse that was first built. The circuit used is essentially a self-maintained oscillator whose phase is accurately controlled by the incoming synchronising pulses. The control path carries only D.C. and very low frequencies, and is insensitive to interference and cross talk. A somewhat similar scheme has since been described for obtaining the same advantages for line and frame synchronism in television receivers[21]. The method of operation may be briefly described as follows. The larger synchronising pulse is separated from the incoming waveform by a limiting process in valves V_1, V_2 and V_3. Valve V_7 is a self-maintaining $R-C$ oscillator similar to that employed at the sending equipment. Its output is fed via the buffer-amplifier stage V_9 to phase-dividing networks also similar to those at the transmitting end. A second output is taken from the other blocking amplifier V_8 to the first grid of valve V_4, which is adjusted to operate as a pulse generator on this grid and as a modulator on the third grid in the same way as the eight pulsing valves at the sending panel. To the third grid of V_4, however, is applied the separated incoming synchronising pulse with positive polarity and sufficient amplitude to modulate the space current of V_4 by a full 100 per cent. No significant current can therefore flow in this valve anode circuit unless the pulse of space current (controlled by the first grid) and of the modulating voltage (on the third grid) coincide for at least part of their respective durations. When this partial coincidence occurs, anode current pulses are produced at the synchronising frequency but of a width determined by the amount of overlap between the input pulses. Owing to the fact that the space-current pulse shape is rounded (as previously mentioned, it approximates the probability function) while the separated incoming synchronising pulse is practically rectangular, the anode current waveshape from V_4 is in general asymmetrical and its peak amplitude, as well as its width, varies with the overlap of the two input pulses. In the panel here described, this amplitude variation was employed to control the instantaneous frequency of the oscillator V_7 in the following manner. The variable output pulse from V_4 was rectified by the peak voltmeter diode circuit V_5, and the resulting D.C. output fed to control the bias on the "reactance" valve V_6, whose anode is effectively parallel with that of the oscillator V_7. The reactance valve in the present case behaves approximately like an inductance of value $L = CR/g$, where C and R are the feedback components indicated in Fig. 14 and g is the mutual conductance of the (pentode) valve. It is assumed that $1/(CR)$ is large compared with the oscillator frequency. The variable voltage output from

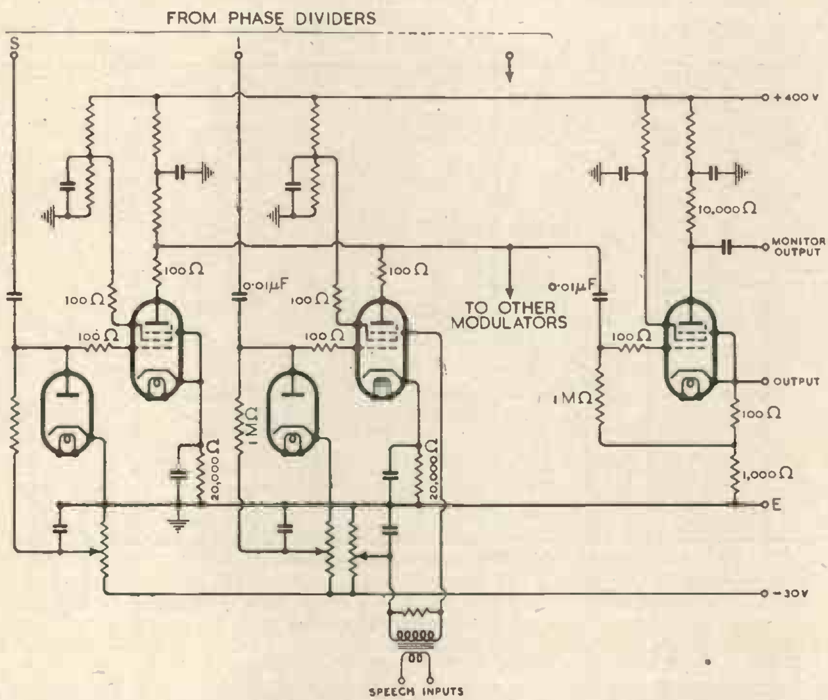

Fig. 12. *Circuit arrangement of modulator panel.*

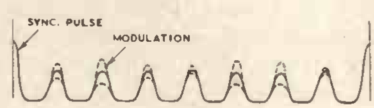

Fig. 13. *Output waveform of transmitting equipment.*

V_5 changes the value of g and so of L. In order that this control system should be stable, it is necessary that its response to transient frequency variations should be sufficiently rapid but without " overshoot." On the other hand the frequency bandwidth passed by the " D.C." link must be as small as possible in order to provide sufficient suppression of noise and cross talk. The most stringent condition in practice was found to be that occurring just at the moment of switching on the receiver H.T. supply. At this instant the receiver oscillator will tend to run at a frequency somewhat different from the transmitted pulse train frequency. The same situation arises if the transmitter is switched off and then on again. In V_4 of the receiver synchronising panel, therefore, the two series of pulses will be crossing initially at a rate of perhaps

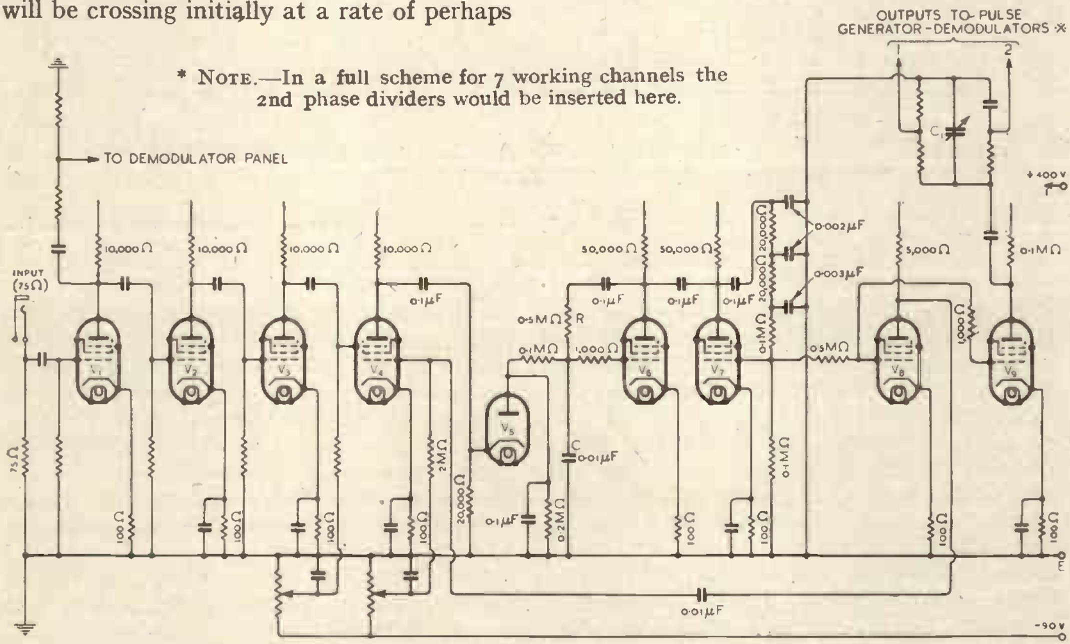

Fig. 14. *Receiver synchronising panel scheme.*

50 per second, determined by the control limit of the reactance valve. The diode rectifier circuit must bring this frequency difference down to zero at a rapid rate and must then hold the oscillator in phase synchronism. No difficulty was found in the development stage in obtaining satisfactory circuit values once the lay-out described had been determined. An overall phase adjustment is provided by the condenser C_1.

2.1.4. *Demodulator Panel.*

This panel consists, as will be seen from the diagram in Fig. 15, of seven pulsing valves operating under similar bias conditions to those at the sending end. The conditions on the first grid are identical. All the third grids, however, are fed in common from the incoming composite pulse waveform, and the actual bias is adjusted to allow for the " D.C. component " in the incoming pulses. The relative phase of the received pulses and the demodulating pulses is adjusted (by means of C_1 mentioned in connection with the previous panel) so that each received channel pulse coincides with a demodulating pulse. The anode output from each demodulating valve, consisting of the modulated pulses of a single channel alone, is fed to the next panel for filtering to remove the pulse harmonics and the lowest sideband, and finally for audio amplification to a suitable level for passing on to the telephone line through the usual hybrid.

2.2. Results obtained with the Experimental Apparatus

An audio-frequency test tone was fed into one channel at a level of one milliwatt. To simulate a sharp cut-off in the gain/

frequency characteristic of the transmitter-to-receiver path, a low-pass filter was inserted in the 75-ohm line connecting the two sets of equipment. This filter consisted of a constant-*k* section and two *m*-derived sections having a cut-off frequency at 110 kc/s and infinity points at 140 kc/s and 170 kc/s, so that the initial build up of attenuation was rapid and the loss remained above 26 db. even at the lowest point (400 kc/s). With this filter in circuit, the measured cross talk was 42 db. between adjacent channels, and 45 db. to other channels. This test is probably more severe than would occur on a typical ultra-short wave radio link, but a similar sharp boundary to the transmission band may be expected on a multi-repeatered and equalised transmission line.

In speech tests, independent observers found it impossible to distinguish transmission through the equipment from that passing directly at audio frequency from the transmitting micro-telephone. Cross talk was just audible on the adjacent channel, but unintelligible. When there are a large number of channels, cross talk might be classed as noise, since all would contribute to a similar extent to give a substantially unintelligible interference background.

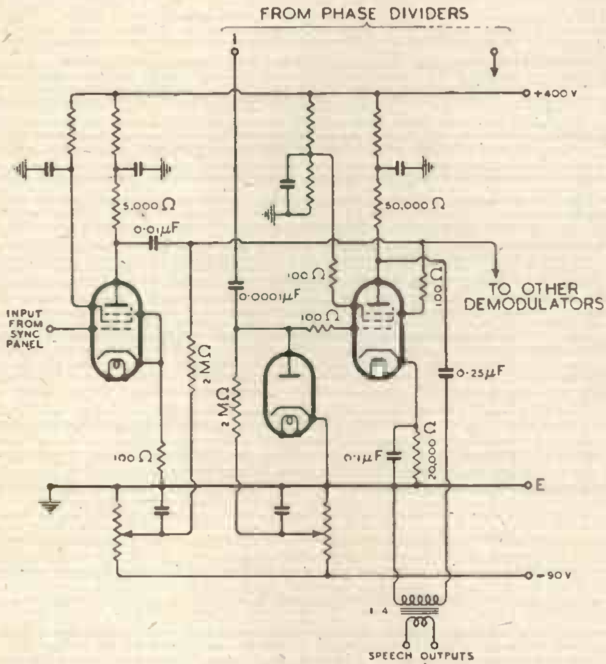

Fig. 15. *Demodulator panel*

The channel audio-frequency response was determined primarily by the output filters and amplifiers, though the fundamental upper limit is, of course, given by half the pulse chain frequency. In the present case the effective audio band was from 200 to 3,500 c/s.

Conclusions

Time allocation systems of multiplex, as compared with conventional frequency-allocation systems, occupy an appreciably greater frequency band for a given number of telephone channels. In the case of simple amplitude modulation of the pulses, the signal-to-noise ratio is also notably inferior. However, by modulating the width of the pulses or the delay between successive pulses in a given channel, a performance may be expected which is analogous to that obtainable with conventional frequency modulation: the signal-to-noise ratio will be greatly improved and the system will be unaffected by amplitude non-linearity in the transmitter or receiver. There exists, however, a realm where the time-allocation system may reign supreme—this is in the centimetre-wave range where the power generators largely used are more efficient when pulse modulated.

The apparatus used for the amplitude-modulated pulse system is of a simpler and more robust nature than that required for the usual frequency allocation system, and this factor may in some circumstances weigh the balance in favour of the pulse system.

This paper is published with the permission of the Engineer-in-Chief of the Post Office Engineering Department, and the authors would like to express their gratitude to Dr. R. F. J. Jarvis for his constructive criticism and continued interest whilst the work was in progress.

A DELAY LINE FREQUENCY MODULATOR*

By D. Weighton, M.A.

Summary.—A method of phase (or frequency) modulation is described in which the signal from a crystal-controlled source may be shifted in phase by a large angle. Both frequency and harmonic distortion are shown to exist in the system, and equations are developed from which the distortion may be calculated. It is estimated that for 2 per cent. harmonic distortion, and frequency distortion amounting to 1 db drop at 10 kc/s., a phase shift of not less than 12 radians and more probably about 90 radians may be realised in practice.

1. Introduction

SINCE the publication by Armstrong in 1936 of a paper, describing a stable frequency-modulated generator,[1] several alternative systems have been proposed for broadcast purposes. These may be divided into two classes : those in which reactance-valve circuits operate directly on an oscillator, and those in which the signal from a crystal-controlled source is made to suffer a variable phase shift determined by the modulating voltage. Modulators of the former type include those described by Crosby[2] and Morrison[3] and are characterised by the ease with which a large frequency excursion can be obtained and the difficulty experienced in stabilising the carrier frequency to a degree sufficient for broadcast transmitters. Those of the second kind are in fact phase modulators but may be used for frequency modulation by integration of the modulating signal. They are characterised by high frequency-stability and the small frequency excursion that can be attained in the modulator proper. The latter feature necessitates the use of a large number of frequency-multiplying stages and one or more frequency changers to obtain the degree of modulation required for broadcast transmission.

Thus with the Armstrong modulator Jaffe[4] has shown that a phase shift of only about 30 degrees can be realised without undue distortion, and a similar figure applies to a system proposed by Robertson and elaborated by Seeley, Kimball and Barco[5]. The cathode-ray tube modulator devised by Shelby[6] offers the possibility of generating much greater phase shifts since distortion is not inherent in the system, and the maximum shift is limited only by practical difficulties in the construction of the spiral collector electrode. A phase deviation of $\pm$ 15 radians represents about the most that has yet been obtained with this system.

The delay line modulator belongs to the second class, i.e., it is used to phase-modulate the signal from a crystal-controlled source, and has the advantage of allowing a large phase deviation to be obtained without the necessity for any special electronic device. In the present paper the various kinds of distortion occurring in the system will be analysed, and an estimate will be made of the maximum phase deviation that may be realised in practice.

2. Operation of the Delay Line Modulator

The system is described with reference to the block schematic diagram of Fig. 1. In the first mixing stage the signal from the crystal-controlled source is heterodyned with a frequency-modulated signal derived from a reactor-valve modulator, and the difference frequency is fed to a phase-shifting network which is required to have a linear phase-frequency characteristic. The crystal frequency is restored in the second mixing stage by heterodyning again with the frequency-modulated signal and selecting the summation component with a filter.

The signal from the frequency-modulated oscillator may be written in the form

$$E = E_0 \sin\left\{\omega_1 t + \int_0^t f(t)\, dt\right\} \quad .. \quad (1)$$

where E_0 is the amplitude of the oscillation, ω_1 is $2\pi \times$ the mean frequency and $f(t)/2\pi$ is the instantaneous frequency excursion and is a linear function of the modulating voltage.

If $\omega/2\pi$ is the crystal frequency then the beat produced in the first mixing stage has the form

$$\sin\left\{(\omega - \omega_1)t - \int_0^t f(t)\, dt\right\} \quad . \quad (2)$$

omitting the amplitude constant.

* MS. accepted by the Editor, July 1945.

If the delay network has a linear phase–frequency characteristic, its effect will be to introduce a constant delay time T, and (2) becomes

$$\sin\left\{(\omega - \omega_1)(t - T) - \int_0^{t-T} f(t)\,dt\right\} \qquad (3)$$

at the output terminals of the filter. In the second mixing-stage a beat is produced between this wave and the frequency-modulated signal (1). The summation component is then

$$\sin\left\{(\omega - \omega_1)(t - T) - \int_0^{t-T} f(t)\,dt + w_1 t + \int_0^t f(t)\,dt\right\}$$

$$= \sin\left\{\omega t - T(\omega - \omega_1) + \int_0^t f(t)\,dt - \int_0^{t-T} f(t)\,dt\right\} \quad \ldots \quad \ldots \quad (4)$$

Using Taylor's theorem

$$\int_0^{t-T} f(t)\,dt = \int_0^t f(t)\,dt - Tf(t) + T^2/2\,!\,.\,f'(t) + \ldots$$

so that provided the function $f(t)$ changes by only a small amount in the interval T

$$\int_0 f(t)\,dt - \int_0^{t-T} f(t)\,dt = Tf(t) \quad \ldots \quad (5)$$

and (4) becomes

$$\sin\left\{\omega t - T(\omega - \omega_1) + Tf(t)\right\} \quad \ldots \quad (6)$$

which represents a phase-modulated wave of mean frequency $\omega/2\pi$, i.e., that of the crystal source unaffected by changes in the auxiliary oscillator. The reactor-valve modulator is not therefore required to have any high degree of frequency stability and may be of simple construction.

If the system is required to produce a frequency-modulated signal, the modulating waveform is fed through an integrating network so that the signal applied to the reactor-valve modulator is of the form $\int_0^t f(t)\,dt$. Replacing $f(t)$ by this integral in the above expressions, the final waveform is seen to be frequency modulated.

From equation (6) the maximum phase displacement produced by the system is equal to the product of the delay time of the network and the maximum angular frequency excursion of the modulated oscillator. In practice, a limit is imposed on both these factors by the incidence of distortion. Increasing the delay time causes frequency distortion since the approximation involved in equation (5) is valid only for small values of T and the higher terms of the series are larger for higher modulating frequencies. Increasing the frequency excursion of the modulated oscillator causes harmonic distortion for two reasons. If a low-pass or band-pass filter is used for the delay network, the phase–frequency characteristic will approximate to linearity only over a small band, and distortion in the reactor-valve modulator itself will increase with the amplitude of the frequency excursion.

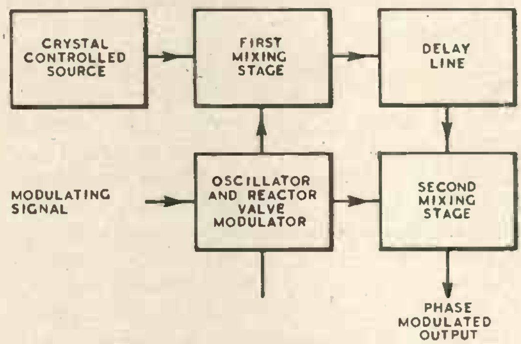

Fig. 1. *Block diagram of the modulator.*

It is therefore necessary to calculate the distortion which may be produced by these three causes in order to determine the maximum phase displacement that can be realised with the system.

3. Frequency Distortion

If the modulating waveform $f(t)$ be a single tone of angular frequency p, then

$$f(t) = \Delta\omega\,.\,\sin pt$$

where $\Delta\omega$ is the maximum angular frequency excursion of the oscillator, and the expression (4) becomes

$$\sin\left[\omega t - T(\omega - \omega_1) + \Delta\omega\left\{\int_0 \sin pt\,.\,dt - \int_0^{t-T} \sin pt\,.\,dt\right\}\right]$$

$$= \sin\left[\omega t - T(\omega - \omega_1) + \Delta\omega\,.\,T\left(\frac{\sin \frac{1}{2}pT}{\frac{1}{2}pT}\right).\sin\left(pt - \tfrac{1}{2}pT\right)\right] \quad \ldots \quad \ldots \quad (7)$$

The maximum phase shift is therefore $T\Delta\omega$ for low values of p and falls for higher modulating frequencies, becoming zero when $p = 2\pi/T$, i.e., the modulating frequency is the reciprocal of the delay. The frequency distortion has been calculated from equation (7) and the curves are plotted in Fig. 2 for several values of delay time. For the transmission of audible frequencies, the delay time for a loss of 1 db. at 10 kc/s is of interest. Then

$$\frac{\sin \frac{1}{2} pT}{\frac{1}{2} pT} = 0.8913$$

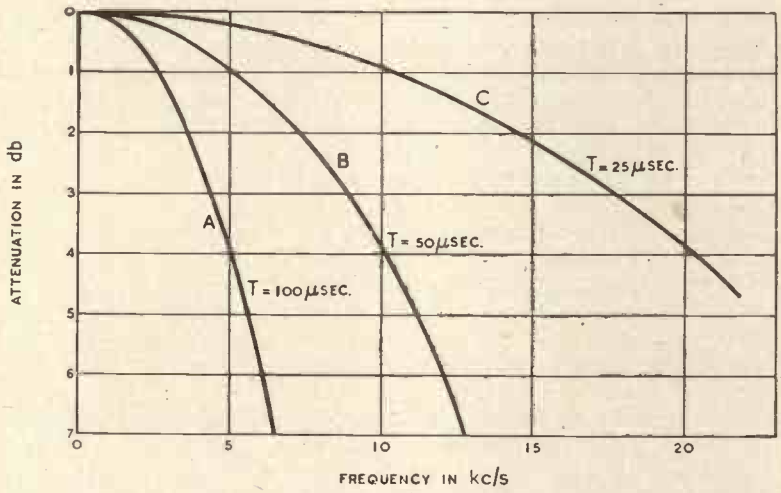

Fig. 2. *Frequency distortion for three values of time delay. The values of the time delay T are shown against the curves.*

and putting $p = 2\pi \times 10^4$ radians per second

$T = 26.4$ microseconds.

4. Distortion in the Reactor-Valve Modulator

The relation between the frequency shift produced by a reactor-valve modulator and the impressed modulating potential will not in general be linear, and harmonics of the applied potential will therefore be present in the signal applied to the delay network. This distortion may be ascribed to three causes.

(a) It has been shown by Van der Pol[7] and others that a sinusoidal variation of one of the reactive elements of a tuned circuit does not produce a sinusoidal frequency change except as a first approximation when the maximum frequency shift is small compared with the carrier frequency.

(b) The reactance presented by the modulator valve will be proportional to the modulation only for small impressed voltages.

(c) Harmonic distortion will be generated in limiting stages which may be necessary to suppress any amplitude modulation produced by the reactor valve.

J. F. Morrison has shown that these effects may be minimised by proper design of the reactor-valve circuits.[3] In particular distortion due to (b) may be reduced by the use of a balanced modulator which eliminates even harmonics, and (c) may be avoided by negative feed-back from the oscillator which tends to maintain the amplitude constant and make limiting stages unnecessary. According to Morrison, a maximum frequency deviation of ± 75 kc/s. may be realised with less than 2 per cent. total harmonic distortion, and combining this figure with the maximum permissible interval of the delay network calculated in the preceding paragraph, the maximum phase shift produced by the system is

$$T\Delta\omega = 26.4 \times 10^{-6} \times 2\pi \times 75 \times 10^3 = 12.45 \text{ radians.}$$

5. Distortion Generated in the Delay Line

The simplest network which will approximate to the requirement of a linear phase–frequency relation is the conventional low-pass filter. In this case the phase shift is

$$\theta = 2n \,.\, \sin^{-1} f/f_c \quad \ldots \quad (8)$$

where n is the number of sections, f the frequency and f_c the cut-off frequency of the filter. This relation applies strictly only when there are no losses in the filter components and the terminating impedance is equal to the iterative impedance for all frequencies within the pass-band. Both these requirements are, however, sufficiently approximated in practice if the coils are of high Q and the number of sections is large.

Equation (8) may then be expanded in ascending powers of f/f_c

$$\theta = 2n(f/f_c) + n/3 \,.\, (f/f_c)^3 + \ldots$$

and the relation approximates to a linear one when f is small compared with f_c.

In order to keep the distortion small, it is therefore necessary that the cut-off frequency be high compared with the highest frequency component of the wave to be propagated. This restricts the time delay per section of the filter, but by using a sufficiently large number of sections it will always be possible to achieve the maximum allowable delay calculated in Section 3 above. It is, however, relevant to enquire how many sections will be required to produce this delay without undue distortion since more than two or three hundred sections would add considerably to the cost and size of the modulator.

Now for a low-pass filter the linear portion of the phase-frequency characteristic is employed to the full when the lowest frequency component of the wave to be propagated approaches zero, and it is therefore desirable that the frequency excursion be of the same order as the carrier frequency; a condition which is difficult to satisfy in practice. The use of a band-pass filter, however, enables a comparable shift to be obtained when the excursion is small compared with the mean frequency and has the added advantage that since the phase-frequency relation is symmetrical about the centre of the band only odd harmonics of the modulation may be expected to be present in the output. The calculation of harmonic distortion will therefore be confined to a band-pass filter centred on the carrier frequency of the signal.

The phase shift in the pass band is then

$$\theta = 2n \cdot \sin^{-1} \frac{\omega(1 - \omega_0^2/\omega^2)}{\omega_4 - \omega_3} \quad \ldots \quad (9)$$

(see for example L. C. Jackson "Wave Filters," p. 21.)

where ω_0 is the angular frequency at the centre of the band, ω_3 and ω_4 are the cut-off angular frequencies and n is the number of sections in the filter. Rearranging (9)

$$\theta = 2n \cdot \sin^{-1} \frac{(\omega + \omega_0)(\omega - \omega_0)}{\omega(\omega_4 - \omega_3)}$$

and if the band-width is small compared with the mean frequency

$$\theta = 2n \cdot \sin^{-1} \frac{2(\omega - \omega_0)}{\omega_4 - \omega_3}$$

which may be written

$$\theta = 2n \cdot \sin^{-1}(s \cdot \delta\omega) \quad \ldots \quad \ldots \quad (10)$$

where s is a filter constant having the dimensions of time and equal to the reciprocal of the half-band width multiplied by 2π, and $\delta\omega$ is the angular frequency deviation.

The frequency-modulated wave at the input terminals of the filter is obtained from equation (2) by substituting $f(t) = \Delta\omega \cos pt$ and will be written in the exponential form

$$e^{j(\omega_0 t + m \sin pt)} \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

where $m = \Delta\omega/p$ is the modulation index and $\omega_0 = \omega - \omega_1$.

The exponential may then be expanded

$$J_0(m) \cdot e^{j\omega_0 t} + \sum_{r=1}^{r=\infty} \Big\{ J_r(m) \cdot e^{j(\omega_0 t + rpt)} + J_{-r}(m) \cdot e^{j(\omega_0 t - rpt)} \Big\}$$

where $J_r(m)$ is a Bessel function of the first kind and order r.

The steady state equations of the filter may now be applied to each term of the expansion, and a phase shift will be introduced equal to $2n \cdot \sin^{-1}(srp)$ (see equation (10)).

At the output terminals of the filter the wave will have the form

$$J_0(m)e^{j\omega_0 t} + \sum_{r=1}^{r=\infty} \Big\{ J_r(m) \cdot e^{j(\omega_0 t + rpt + 2n \sin^{-1} srp)} + J_{-r}(m)\, e^{j(\omega_0 t - rpt - 2n \cdot \sin^{-1} srp)} \Big\}$$

since $\sin^{-1}(srp) = -\sin^{-1}(-srp)$

$$= e^{j\omega_0 t} \Big[J_0(m) + \sum_{r=1}^{r=\infty} \Big\{ J_r(m) \cdot e^{j(rpt + 2n \sin^{-1} srp)} + J_{-r}(m) \cdot e^{-j(rpt + 2n \sin^{-1} srp)} \Big\} \Big] \quad \ldots \quad \ldots \quad (12)$$

Since srp is less than one, the phase shift may be expanded in ascending powers of rp.

$$2n \cdot \sin^{-1} srp = 2n \cdot srp + \frac{n}{3} s^3 r^3 p^3 + \frac{3}{20} n\, s^5 r^5 p^5 + \ldots$$

and (12) becomes

$$e^{j\omega_0} \Big[J_0(m) + \sum_{r=1}^{=\infty} \Big\{ J_r(m) \cdot e^{j(n/3\, s^3 r^3 p^3 + \ldots)} \cdot e^{jrp(t + 2ns)} + J_{-r}(m) \cdot e^{-j(n/3\, s^3 r^3 p^3 + \ldots)}\, e^{-jrp(t + 2ns)} \Big\} \Big] \quad \ldots \quad \ldots \quad (13)$$

If the departure from linearity is a small angle for values of r for which $J_r(m)$ is not negligible, then a first approximation for (13) is

$$e^{j\omega_0 t}\left[J_0(m) + \sum_{r=1}^{r=\infty}\left\{J_r(m).(1+j\,n/3\,s^3r^3p^3).\,e^{jrp\,(t+2ns)} + J_{-r}(m).(1-j\,n/3\,s^3r^3p^3).\,e^{-jrp\,(t+2ns)}\right\}\right]$$

$$= e^{j\omega_0 t}\left[e^{jm\sin p(t+2ns)} - n/3\,s^3 . \frac{d^3}{dt^3} . e^{jm\sin p(t+2ns)}\right]$$

Solving the differential, and writing $p(t+2ns) = x$ for brevity, this becomes

$$e^{j\omega_0 t} . e^{jm\sin x}\left[1 - \frac{ns^3}{3}\left\{3m^2p^3\sin x . \cos x - jmp^3(1+m^2\cos^2 x) . \cos x\right\}\right]$$

and the instantaneous phase is therefore

$$\omega_0 t + m\sin x - j\log\left[1 - \frac{ns^3}{3}\left\{3\,m^2p^3\sin x . \cos x - jmp^3(1+m^2\cos^2 x)\cos x\right\}\right]$$

$$= \omega_0 t + m\sin x + \tan^{-1}\left[\frac{(R/m^2)(1+m^2\cos^2 x) . \cos x}{1 - 3(R/m)\sin x . \cos x}\right]$$

where $R = \frac{n}{3}s^3m^3p^3$ is the angle by which the phase shift departs from linearity at the maximum frequency excursion.

Since R is small and $m > 1$ then the distortion term may be expanded in multiple angles of x and the instantaneous phase is

$$\omega_0 t + m\sin x + \tfrac{3}{4}R\cos x + R/4 . \cos 3x + \ldots .$$

where the co-efficients of higher multiple angles are very small.

After mixing at the second detector, the instantaneous phase is

$$\omega t + 2m\sin(nps) . \cos x + \tfrac{3}{4}R\cos x + R/4 . \cos 3x$$

and the instantaneous angular frequency is

$$\omega - 2\,mp . \sin(nps) . \sin x - \tfrac{3}{4}Rp\sin x - \tfrac{3}{4}Rp\sin 3x$$

The major part of the distortion is therefore contributed by third harmonic, and the percentage distortion is

$$\frac{100 . \frac{3}{4}Rp}{2\,mp . \sin(nps) + \frac{3}{4}Rp}$$

or approximately $100\,\dfrac{\frac{3}{4}Rp}{2\,mnp^2s}$

$$= 12.5\,(smp)^2 \quad .. \quad (14)$$

Now the maximum phase shift produced by the system is $\psi = 2\,nmps$ and (14) may therefore be written

$$\text{percentage harmonic} = 3.125 . \psi^2/n^2 \quad .. \quad (15)$$

The distortion is greatest at the lowest modulating frequency which it is desired to use, since ψ has then its maximum value.

The number of sections required in the filter for the phase shift calculated in Section 4 may now be estimated using the relation (15)

For 1 per cent. third harmonic

$$n = \sqrt{3.125}\,\psi$$

and when $\psi = 12.45$ radians

$n = 22$ to the nearest integer.

The construction of a filter of 22 sections presents no practical difficulty, and the number may conveniently be increased to make the harmonic distortion much less than 1 per cent. Under these conditions, the distortion occurring in the reactor-valve modulator is the factor which limits the peak phase-shift attainable with the system.

6. Conclusions

It may be concluded from the calculations in Sections 3, 4 and 5 that a phase shift of at least 12.5 radians could be obtained with a delay-line modulator of the type described.

It is, however, probable that this figure could be much increased in practice. Thus, the frequency distortion might be reduced by the use of an equaliser, which would permit a greater delay to be employed in the phase-shifting network. This method cannot, however, be used to extend T indefinitely since the attenuation becomes infinite when $p = 2\pi/T$ [see equation (7)], and inspection of the curves in Fig. 2 indicates about 50 microseconds to be the greatest value that could be used.

The limit of $\pm$ 75 kc/s for the excursion of the frequency-modulated oscillator might also be increased. This figure is taken from a design[3] in which stability of the carrier frequency was of great importance, and the removal of this requirement in the present arrangement will evidently permit a greater frequency excursion. The author has obtained as much as $\pm$ 300 kc/s with a reactor-valve modulator without observing undue distortion, although no precise figures of harmonic content are available. Combining this figure with a delay of 50 microseconds, a tentative estimate of 94 radians may be made.

Using equation (15) this would require 167 sections in the filter for 1 per cent. harmonic distortion.

The author is indebted to Messrs. Pye Limited for permission to publish this work.

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BOOK REVIEW

Radio Receiver Design, Part II

By K. R. Sturley, Ph.D., B.Sc., M.I.E.E. Pp. 480 + xv. Chapman & Hall, Ltd., 37, Essex St., London, W.C.2. 28*s*.

Some two years ago in a review of Part I of this book, it was said that it had an air of incompleteness, because it was only one-half of a complete book. This has now been remedied by the publication of Part II, which covers A.F. amplification, power stages, A.C. power supplies, A.G.C., automatic tuning control, frequency modulation and television.

With the exception of one chapter, the book is excellent, for the treatment is clear and accurate. It is largely mathematical, but of such a simple nature that no one should be put off by the arrays of equations which appear on some pages. It is worthy of note that the treatment of discriminators and reactance valves, which are so important in both A.F.C. systems and in frequency modulation, is particularly good.

The book is not confined to circuit analysis, for the design of output and mains transformers and of smoothing chokes is dealt with, and there is a chapter on overall receiver measurements. Push-pull amplifiers could with advantage have been more fully treated and the space devoted to Class AB and Class B amplification—some 5 pages only—is certainly disappointing.

One good feature is the extensive bibliography appended to every chapter and the placing of chapter and section numbers at the top of every page makes it easy to find one's way about. With the one exception referred to above, the book is a worthy companion to Part I and is one which few receiver designers will not wish to keep handy for reference.

The exception to the otherwise general excellence of the book is the chapter on television. It is a long chapter of some 100 pages, but it is completely inadequate and on some important points inaccurate.

The first point of criticism is on the author's application of the R.F. and I.F. coupling design formulæ, which are approximate expressions derived in Part I for the condition of a bandwidth small in comparison with the mean frequency. In the wide-band amplifier of Part II, however, they are applied without modification to cases where the band-width is 3.5 Mc/s and the mid-band frequency 10.5 Mc/s.

Probably as a result of using these approximate formulæ, the author states that "the objection to single tuned circuits with staggered resonant frequencies is that overall amplification is lower than for coupled circuits of the same pass-band width." No evidence is put forward in support of this statement and the precise basis of comparison is not stated. In actual fact, there is little to choose between the two on the score of amplification, and much depends on how much variation of response within the pass-band is permissible. In general, staggered single circuits give somewhat higher amplification and are mechanically simpler than coupled pairs, but they provide less selectivity.

One serious error is in Fig. 16.18 (*c*), which purports to show the output waveform of an integrator having applied to it a series of line and frame synchronising pulses. For each line pulse the diagram shows a small amplitude output pulse having a sharp leading edge and a long trailing edge. The maximum amplitude is reached and the decay started long before the line pulse has ceased. The first frame pulse, however, is shown as providing a leading edge of equal sharpness to the line but of much greater amplitude. This also is completed and the decay started in a time less than that of one line pulse. The text states that the greater amplitude of the frame pulse output is because of its longer duration.

This is just impossible. If the rise of output voltage is completed in a time less than that of a line pulse, then the capacitance of the integrator is fully charged in a time less than that of a line pulse and it cannot charge to a higher voltage on any pulse of longer duration. In actual practice the time constant of the integrator is chosen so that the capacitance is far from fully charged at the end of a line pulse. It is then charged to a greater extent during the longer frame pulse and a greater output voltage is obtained. The leading edges of the pulses are by no means sharp, but are markedly exponential in form and very similar to the trailing edges.

In spite of the length of this chapter, time-bases are treated very cursorily and the three pages devoted to electromagnetic deflection are singularly unhelpful.

The author would have done better had he omitted this chapter on television and deferred all mention of the subject until he could produce a third volume, for in no less space could he do it justice. As it is, it mars an otherwise excellent book.

W. T. C.

AERIAL IMPEDANCE MEASUREMENTS*

By L. Essen, Ph.D., A.M.I.E.E., and M. H. Oliver, Ph.D., A.M.I.E.E.

(Radio Division, National Physical Laboratory)

SUMMARY.—The paper contains the results of the measurement of the impedance of some cylindrical dipole aerials of various cross sections, and of some conical aerials. Curves are given which illustrate the general behaviour of the aerials investigated. One set of curves shows the way in which the properties of a cylindrical dipole vary as the diameter of the arms is increased. The impedance of a cone unipole is plotted on a second graph, over a frequency range of 200 Mc/s to 1,000 Mc/s, together with curves showing the impedance, over the same frequency range, of a dipole composed of two cones of the same dimensions as that used for the unipole aerial. Some investigations of the input impedance of a dipole fed from a concentric cable, with and without a balancing transformer, are also described. The paper concludes with a general discussion of the technique of aerial impedance measurements.

1. Introduction

THE theoretical treatment of aerial impedances is difficult and laborious, and even when applied to relatively simple systems involves simplifying approximations. Moreover, solutions are not in general obtainable in explicit form in terms of known and tabulated functions and the significance of individual parameters is only obtainable by a multiplicity of computations. In such cases it may be found that direct measurement is, in spite of its difficulties and limitations of accuracy, a more practicable and economic way of getting the required information. It has, in any case, the advantage that the results can be accepted with confidence as representing, within the experimental accuracy, the actual behaviour of the physical system concerned, however complicated it may be.

The present paper gives the results of the measurement of the impedance, expressed as series resistance and reactance, of some cylindrical dipole aerials of various diameters, and of some conical aerials. A brief account of the impedance of a dipole connected to a coaxial line with and without a transformer, is included.

The accuracy of the measurements is limited by a number of features of the apparatus and environment which are detailed in the last section of the paper. Nevertheless the results are considered adequate for a comparison of the various aerial systems concerned and for showing the significance of the relevant dimensional variations.

* MS. accepted by the Editor, July 1945.

2. Method of Measurement

All the measurements described in this paper were made by a resonant line method. Three forms of resonant line apparatus were used, namely :—

(*a*) An unscreened twin line.
(*b*) A screened twin line.
(*c*) A concentric line.

A description of the technique of impedance measurements using these lines and details of screened twin and concentric lines such as were used in the present work, were recently presented by one of the authors in a paper[1] read before Radio Section of the Institution of Electrical Engineers.

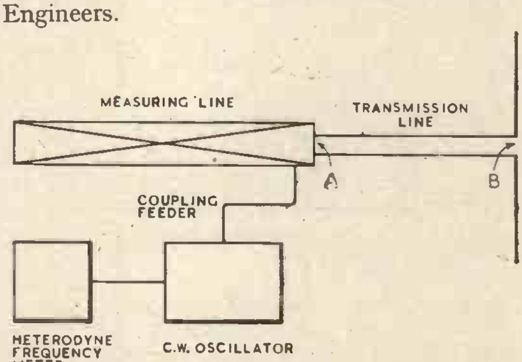


Fig. 1. *General arrangement of the apparatus. In some of the experiments the transmission line connecting the aerial B to the measuring line A was about 1 metre in length.*

The general arrangement of the apparatus is shown diagrammatically in Fig. 1. In some of the experiments the aerial was connected to the measuring equipment by means of a length (usually about 1 metre) of transmission line, which was either a parallel air-spaced line or a good concentric cable. Other measurements were carried out by connecting the aerial directly to the measuring line. In those cases where an intervening transmission line was used, the impedance at the terminals A was first measured, and that presented at B by the aerial alone calculated from this result, using the known constants of the transmission line.

The measurements were carried out indoors in a large room in which all metal objects were removed from the vicinity of the aerial. Movements of the observer were sometimes troublesome, but their effects were lessened in those cases where a transmission line was used to connect the aerial to the measuring gear, as this increased the distance between the observer and the aerial, and also in cases where a unipole was being investigated as the observer was then able to stand at the back of the reflecting sheet.

The system was excited by means of a continuous wave oscillator, the frequency of which was measured by a heterodyne wavemeter. Various methods of excitation which were tried all gave the same result. It was usually convenient to use a coupling feeder from the oscillator, the feeder being terminated by a small loop projecting into the measuring line.

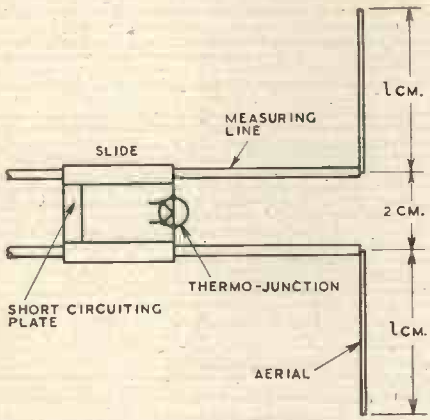


Fig. 2. *This diagram shows the layout of apparatus for measuring the impedance of dipoles of various diameters.*

In most cases the curves of series resistance and reactance have been plotted against $2l/\lambda$, where l is the length of one arm of the aerial. The change in $2l/\lambda$ was effected, when convenient, by varying the length of the aerial at a fixed frequency, but in cases where this was difficult it was effected by varying the frequency. It should be noted that the two sets of curves are not quite equivalent, since in one case the ratio between the diameter of the aerial and the wavelength is fixed, whereas in the other case it is variable.

3. Measurements on Dipoles of various Diameters

The dipole aerial was mounted in a horizontal plane at the ends of two parallel conductors which formed the unscreened twin measuring line. A slide carrying a thermo-junction backed by a short-circuiting plate could be moved up and down the line. Observations were made of the position of the slide for maximum current in the junction, and of the width of the current resonance curve. From these observations the impedance of the aerial connected to the line was calculated. The arrangement is shown diagrammatically in Fig. 2. The arms of the dipole were about 10 cm. above a wooden bench, and the oscillator and other metal parts were at a distance of about one wavelength away. It is therefore probable that the impedance of the dipole was influenced to some extent by reflections from these objects, but measurements made as the aerial was moved relative to them indicated that such effects were not greater than a few per cent.

Four aerials, each of different diameter, were investigated in this way. In each case tinned copper wire, stiff enough to be self-supporting, was used for the arms of the dipole. The measurements were made at a fixed frequency of 454 Mc/s. The length of the arms of the dipole was reduced, by cutting, from about one wavelength down to about one-tenth of a wavelength.

The curves of resistance and reactance of these four aerials are shown in Fig. 3. It will be observed that the resistance at full-wave resonance decreases rapidly as the aerial diameter is increased. The resistance at the half-wave resonance, however, varies little with the diameter, the values for the four aerials investigated all lying between 73 and 78 ohms. Further, the lengths of both the full and half-wave aerials for zero reactance progressively decrease as the aerial diameter increases.

It is interesting to compare the curves of Fig. 3 with some theoretical curves published by King and Blake.[2] The theoretical curves all refer to aerials thinner than those used in the present investigation ; but the curves for the largest diameter aerial which King and Blake considered ($\lambda/d = 500$) may be compared with the curves for the thinnest aerial in Fig. 3 ($\lambda/d = 412$). The agreement is as good as can be expected up to a value of $2\,l/\lambda$ of about 1.5, but for values of $2\,l/\lambda$ larger than this there is a considerable discrepancy between the calculated and measured peak values of both resistance and reactance. King and Blake calculate that the resistance of a half-wave aerial is lower than is indicated by the measurements described in this paper. Their value for an aerial for which $\lambda/d = 500$ is about 60 ohms.

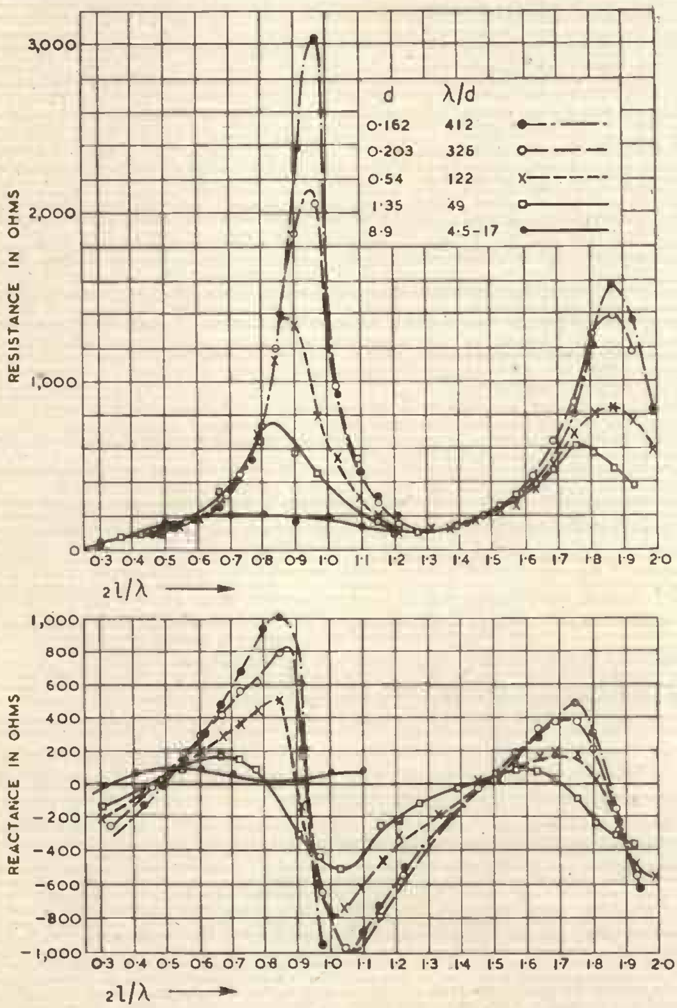


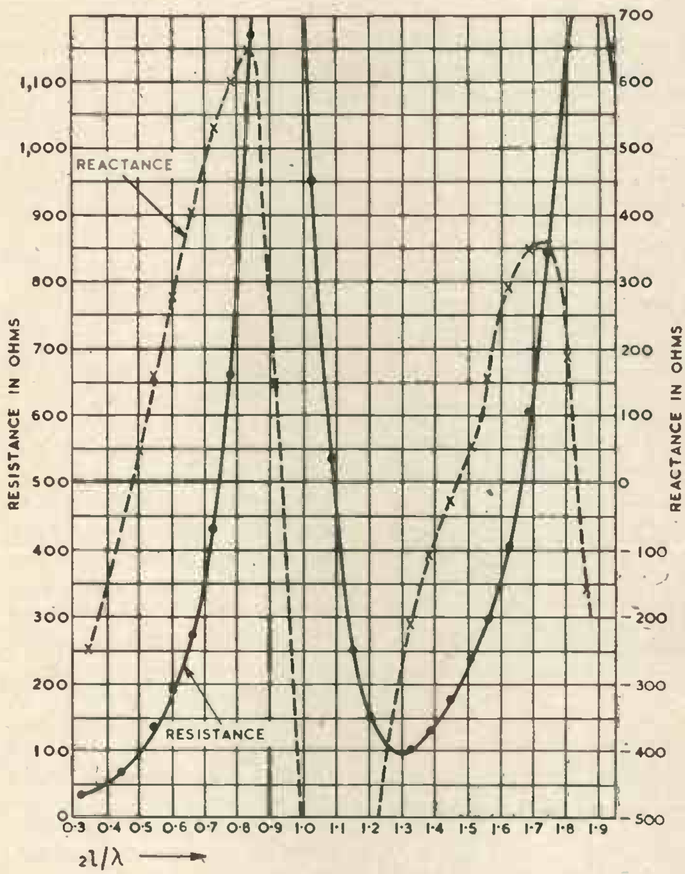
Fig. 3. *Resistance and reactance at the mid-point of a number of dipole aerials at 454 Mc/s.; d = diam. of arms (cm.), l = length of one arm (centre-spacing = 2 cm.)*

In order to give a better picture of the precision of measurement in the region of greatest interest—the $\lambda/2$ dipole—this portion of the curve has been redrawn on a larger scale in Fig. 4 for one of the dipoles.

A fifth pair of curves which refers to a dipole aerial of very large diameter, has been added to the curves of Fig. 3. This aerial was constructed with arms of brass tubing 8.9 cm. in diameter, as shown in Fig. 5. The inner ends of the two arms were made conical to cut down the capacitance and to enable a symmetrical connection to be made to the aerial. The tubing was left open at the outer ends of the arms. The aerial was supported with the arms horizontal and about 1 metre above the floor by means of a system of guy ropes. In this case the screened twin measuring gear was used, connection to the aerial being made by means of an air-spaced line 1.25 metres long, consisting of two parallel lengths of tinned copper wire, and having a characteristic impedance of 415 ohms. This technique had previously been used to measure the impedance of a thin wire dipole, when results in reasonable agreement with those of Fig. 3 were obtained. As it was impracticable to cut the large diameter dipole after each reading, the impedance was measured over the frequency range 200–700 Mc/s.

The measured values of resistance and reactance showed a greater degree of scattering about the curves than in the case of the thinner dipoles. This was thought to be at least partly due to the values of resistance presented to the measuring line being of the order of 200 ohms, as the measurement of such values was not easy with the power available. There was also evidence of cyclical variations which could not easily be associated with the characteristics of the aerial.

These effects are, however, not very obvious in the curve plotted on the scale of Fig. 3, and the results fit into the general pattern of those obtained for the other aerials. The



peak values of resistance and reactance are small and there is little variation over a wide frequency range. The resistance of the aerial in the condition of its first series resonance is approximately 50 ohms, the value of $2l/\lambda$ being 0.35.

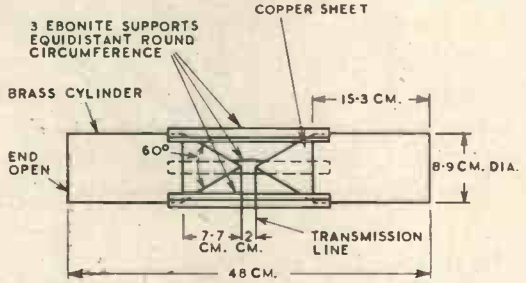
It should be observed that λ/d is not a constant for these curves but that it varies from 4.5 to 17 due to the fact that the measurements were not made at a fixed frequency.

4. Measurements of Conical Aerials

A right circular cone of axial length 23.1 cm. was constructed of copper sheet, and supported with its axis horizontal at the end of the concentric line measuring gear. A reflecting sheet of aluminium, 91.6 cm. in diameter, was supported on the outer cylinder of the measuring line with its surface at right angles to the axis of the cone. The arrangement is shown in Fig. 6. The cone was connected to the central conductor of the measuring line through a hole in the reflecting sheet. The impedance of this aerial was measured over the frequency range 200–1,000 Mc/s, the results being plotted in Fig. 7. The extreme flatness of both resistance and reactance curves over a very wide frequency range is at once apparent. The maximum resistance is about 110 ohms, and for a 2 : 1 frequency range above full wave resonance, the resistance and reactance are almost constant, being 55 ohms ± 15 and −25 ohms ± 15, respectively.

Fig. 4 (Left). *Resistance and reactance at the mid-point of a dipole aerial having a diameter of* 0.203 *cm. at a frequency of* 454 *Mc/s.*

Fig. 5 (Below). *This sketch shows the construction of the large diameter dipole to which the curves of* d = 8.9 *in Fig.* 3 *refer.*



Further experiments showed that the impedance of the aerial was not affected by changing the diameter of the hole in the centre of the reflecting sheet, but the sizes of the holes used were such as to allow a large clearance between the cone and the sheet. However, the impedance values were altered when a square reflecting sheet of side 91.6 cm. was substituted for the circular sheet. The circular sheet used cannot, therefore, be regarded as "infinite."

Measurements were also made on a dipole

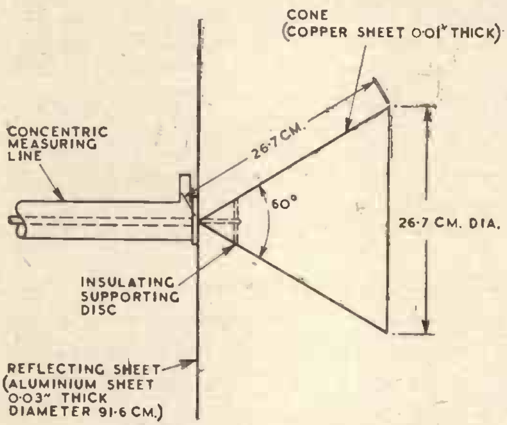


Fig. 6. *A conical aerial attached to the end of the measuring line is shown here.*

aerial made from two-sheet copper cones of the same dimensions as the one investigated previously, the overall length of the aerial being 48 cm. The method of measurement was similar to that used for the large diameter cylindrical dipole, described previously.

Again there was a considerable amount of random variation of the measured values about the curves of resistance and reactance, shown in Fig. 7, and also pronounced cyclical variations. It is thought that the dotted curves in which the random and cyclical variations are smoothed out gives a better qualitative idea of the behaviour of the double cone aerial. The resistance of the single cone aerial appears to be, in general, rather less than one-half that of the cone dipole.

5. Dipoles used with Concentric Cable

Measurements were made of the impedance of a dipole aerial connected to a concentric cable by means of a quarter-wave balancing transformer at frequencies near that at which the transformer was a quarter-wavelength long as shown diagrammatically in Fig. 8. Over a frequency range of 6 per cent. the curves of resistance and reactance resembled those for a symmetrically-fed dipole, very closely when the conditions were in the region of half-wave resonance as shown in Fig. 9, but the values near to full-wave resonance were very different from those exhibited by a balanced dipole. It appeared that a fair approxima-

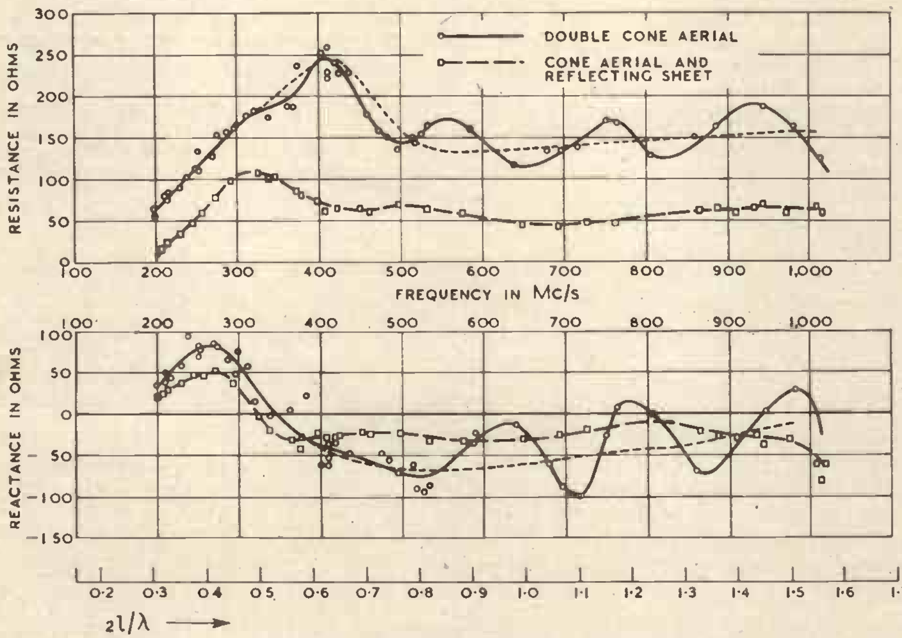


Fig. 7. *Resistance and reactance curves of a conical aerial.*

tion to the curves near full-wave resonance could be obtained at one frequency. It is, however, difficult to construct a balancing transformer of this type without introducing some stray capacitances which are not present in the case of the balanced dipole, and these capacitances affect the impedance values near to full-wave resonance.

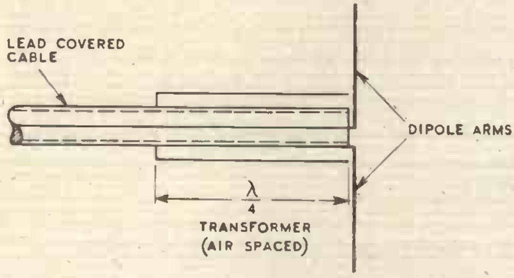


Fig. 8 (Above). *This sketch gives details of the matching transformer used with a concentric measuring line.*

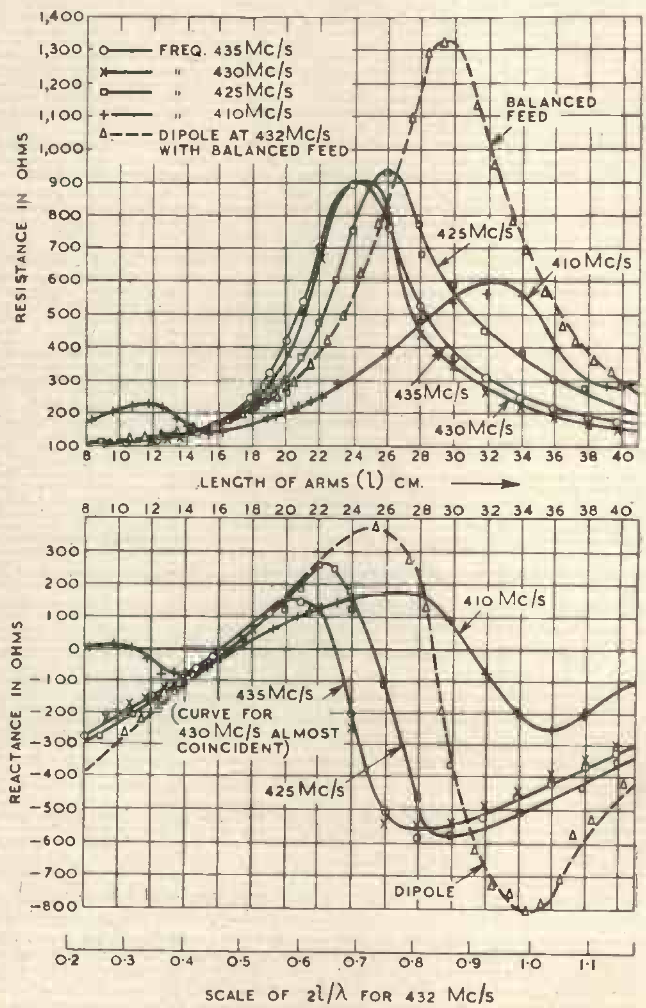


Fig. 9 (Right). *Impedance of dipole connected to concentric cable through a quarter-wave transformer. Diam. of arms = 0.262 cm., centre-spacing = 0.7 cm.*

A further experiment was also performed, in which the impedance of a dipole aerial, connected to a concentric cable with no balancing transformer, was measured with the concentric measuring line. At the half-wave resonance point the impedance was of the order of 80 ohms, but when the aerial was longer than a half-wavelength, the values of resistance and reactance were very different from the values exhibited by a balanced dipole. No experiments were made to determine the symmetry of the field produced, but it is evidently satisfactory from the point of view of matching, to connect a half-wave dipole to a concentric cable without using any balancing device.

6. General Discussion of Results and Conclusions

As was stated in Section 1, no great accuracy is claimed for the measurements described in this paper, the purpose of the work being to show the general properties of the various aerials, and to illustrate the nature of the results that can be obtained with the apparatus and technique described. Some of the difficulties encountered in this work are peculiar to the technique employed, but many are of a more general nature, inherent in all aerial impedance measurements. A brief discussion of the difficulties and the extent to which they might be overcome by altering the experimental conditions is therefore appropriate.

The resonant line measurement apparatus used is best suited for the measurement of resistance of values considerably above or below that of the characteristic impedance of the line (approximately 85 ohms for the unbalanced and 150 for the balanced line). It is not well suited for the measurement of resistances of the order of 100 ohms such as are presented by wide band aerials. This difficulty was in part due to the power limitation and harmonic content of the oscillators available, and could therefore be overcome to some extent by the provision of more powerful oscillators with less harmonic content.

In the case of unbalanced aerials the effects owing to reflections from near-by bodies could be overcome by conducting the measurements in the field. The reflecting screen forming part of the aerial system could be made sufficiently large to screen the measuring apparatus and observer. Under such conditions and with a suitable oscillator it should be possible to achieve accuracies of ± 2 per cent. over a wide range of values.

Although some of the errors in the results on balanced aerials would be eliminated by operation in the field, it is not possible to screen the measuring apparatus and observer from the aerial. The effect of reflections from them can be reduced by the use of a long connecting line, but some additional uncertainties are then introduced as the propagation constants of the line are not known with sufficient precision, and the overall accuracy would probably be limited to 5 per cent. or 10 per cent.

Some uncertainties are introduced by the effects of small stray capacitances which are liable to be introduced at various parts of the system, notably at the junction between the measuring line and the aerial or transmission line. These effects will be most pronounced for high resistive and reactive impedances, and if accurate values are required in this region it is essential that the method of connecting the aerial to the measuring line should be as similar as possible to the method of connecting it to the operational equipment.

7. Acknowledgments

The work described in this paper was carried out as part of the programme of the Radio Research Board to which the results were communicated in confidential reports dated August 1941 and July 1943. The paper is now published by permission of the Department of Scientific and Industrial Research.

Mr. D. R. Dicks assisted in the somewhat tedious observations and calculations involved.

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CORRESPONDENCE

Time-Base Converter

To the Editor, "Wireless Engineer."

SIR,—Referring to my article "Time-Base Converter and Frequency Divider" in the August, 1945, issue of *Wireless Engineer*, The British Broadcasting Corporation have drawn my attention to the fact that they are in possession (by assignment) of a patent specification No. 566102, the substance of which essentially anticipates the circuit which I have described in the above article.

Before publication I made a fairly extensive search of the literature covering the subject matter without finding any reference to closely related work, but I did not also take the trouble to consult patent specifications. The specification in question was accepted on December 13th, 1944.

I apologise to the B.B.C. for any inconvenience caused by my failure to acknowledge this prior work of which I was ignorant.

To the inventors, Messrs. Calvert, Gouriet and Davies, I tender my congratulations for having anticipated me in this interesting circuit.

The disclosures contained in their specification, while slightly different in detail (notably in the position of the delay net and the use of a bi-grid valve for the "gate,") substantially contain all the features described in my article.

London, N.5. H. Moss.

An Electrodynamical Problem

To the Editor, "Wireless Engineer."

SIR,—Dr. Howe's Editorial in the October issue is another of his valuable contributions to clear thinking in electrical theory. It might seem unnecessary to point out that paradoxical conclusions may well emerge from the analysis of physically impossible and unrealisable systems, such as the finite current-element of the Biot-Savart Law, but other examples could be found in contemporary literature to show that the caution is by no means superfluous. I will emphasise this by referring to a similar case in which I fell headlong into the same trap.

In 1940 I calculated the radiation field from a linear conductor of finite length carrying a progressive current wave and found to my surprise hat the field, even at great distances, had an electric omponent *in* the direction of propagation. Fortunately, a colleague (W. Ross) to whom I reported this interesting conclusion, pointed out the possible explanation in the physical inconsistency of the system analysed, and, sure enough, when the system was made, at least, self-consistent if not realisable, by assuming appropriate terminal charges, the scalar potential of those added an electric component which exactly cancelled the anomalous radial component referred to. Similarly, as in the case quoted by Dr. Howe, the anomalous radial component vanished for a complete integration round a closed, and therefore physically realisable, system of linear conductors. (The detail of these calculations is given in a paper on p. 169–178 of Vol. 86, of the J.I.E.E.) In short, with apologies to Lewis Carroll, " Take care of the grounds, and the sense will take care of itself."

F. M. COLEBROOK.

Teddington, Middlesex.

Stabilisation of Feedback Oscillators

To the Editor, " The Wireless Engineer."

SIR,—Mr. Bell's letter in the October number of *Wireless Engineer* shows that he has appreciated that I was more interested in the elegance of the method of analysis than the utility of the results. Indeed, I say so in the first paragraph of the paper. The premises and results are those of Stevenson (*loc. cit.*). There are occasions when the valve parameters are changed, however, in spite of Mr. Bell's discussion. One, which is not trivial, is when the valve itself is replaced by a fresh valve of the same or similar type. Another is when a tetrode or pentode is used and the electrode potentials are allowed to vary. The use of a triode in the circuit of Fig. 1 of the paper was quite arbitrary; the other electrodes of a multigrid valve were assumed to have no direct effect on the oscillation function of the circuit, but to act only as controls on the parameters.

London, S.W.1. H. JEFFERSON.

Preferred Numbers

To the Editor, " Wireless Engineer."

SIR,—With reference to the article by H. Jefferson on " Preferred Numbers and Filter Design," in the October issue of *Wireless Engineer*, I wish to point out the following errors in his calculations in the first half of his paper.

On page 485, half-way down column one, he has derived the defining relationship:

$$\frac{N_r}{p} = \frac{N_{r+1}}{q} \qquad (1)$$

p and q are chosen to provide the common tolerances " s " previously used.

$$\text{Thus necessarily} \quad \left.\begin{aligned} \frac{1}{p} &= 1 + \frac{s}{100} \\ \text{and} \quad \frac{1}{q} &= 1 - \frac{s}{100} \end{aligned}\right\} \qquad (2)$$

From (1) and (2) it follows:

$$N_r\,(1 + s/100) = N_{r+1}\,(1 - s/100)$$

$$\text{Thus} \quad N_r = \frac{1 - s/100}{1 + s/100} \,.\, N_{r+1} \qquad (3)$$

$$\left\{ \text{and not as stated} \quad N_r = \frac{1 + s/100}{1 - s/100} \,.\, N_{r+1} \right\}$$

Writing (3) as $N_r = KN_{r+1}$ .. .. (4)

Thus for α an integer

$$N_r = K^\alpha \,.\, N_{r+\alpha} \qquad (5)$$

Since powers of ten are to be members of the series, then:

$$N_{r+\alpha} = 10\, N_r \qquad (6)$$

where α is such as to fulfil this condition.

From (5) and (6)

$$\frac{N_{r\ \alpha}}{N_r} = 10 = K^{-\alpha} = \left(\frac{1}{K}\right)^\alpha$$

Thus $10 = \left(\frac{1}{K}\right)^\alpha$ where α is integer.

$\left\{ \text{and not as stated} \quad 10 = K^\alpha \right\}$

However, in his further treatment, these two errors cancel out.

From the defining relationship (1)

$$K \text{ should be the ratio } \frac{N_r}{N_{r+1}} = \frac{P}{q}$$

and if N_r, N_{r+1}, N_{r+2} . . . is an increasing series then the value of K must be less than unity

The " K's " enumerated in the treatment are greater than unity and these being $= K^1$.

$$\therefore \quad K^1 = \frac{1}{K}$$

Hayes, Middlesex. M. N. MCLEAN.

THE AUTHOR REPLIES:—

I must thank Mr. McLean for pointing out an error in my paper. Reference to the manuscript shows that this crept in at the typescript, when the suffixes became interchanged. The correction can be most easily made by amending the equation numbered (3) by Mr. McLean to read:

$$N_{r+1} = \frac{1 + \delta/100}{1 - \delta/100} N_r = kN_r$$

No further corrections are needed in the text.

Professional Engineers' Appointments Bureau

Applications for registration for employment from members of the Institutions of Civil, Mechanical and Electrical Engineers are invited by the Professional Engineers' Appointments Bureau. The necessary forms may be obtained from the Registrar, 13, Victoria St., Westminster, London, S.W.1, by sending a stamped addressed foolscap envelope.

Employers are also invited to submit details of positions vacant.

Indexes

As is our custom the Index to the Articles and Authors for the current volume is included in this issue.

The Index to the Abstracts and References published throughout the year is in course of preparation and will, it is hoped, be available in February, priced 2*s*. 8*d*. (including postage). As supplies will be limited our Publishers ask us to stress the need for early application for copies.

WIRELESS 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.

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS AND APPARATUS

569 510.—Hearing-aid device with a piezo-electric microphone or transducer unit to increase the low-frequency response.

The Brush Development Co. (assignees of H. B. Shapiro). Convention date (U.S.A.) 27th June, 1942.

569 990.—Balanced diode rectifier arranged to feed a push-pull amplifier with greater potentials than those appearing across the diode load.

The British Thomson-Houston Co. Ltd. (communicated by the General Electric Co.). Application date 14th October, 1943.

570 043.—Guard ring for reducing leakage paths from a piezo-electric pick-up which is coupled to a high-impedance amplifier.

The Brush Development Co. Convention date (U.S.A.) 8th January, 1942.

AERIALS AND AERIAL SYSTEMS

569 841.—Construction of collapsible kite for elevating the wireless aerial of an aeroplane dinghy or like life-saving craft.

J. S. Wheelwright. Application date 7th December, 1943.

RECEIVING CIRCUITS AND APPARATUS

569 562.—Detecting ultra-short waves by utilising the electron movements that occur in the plasma of a gas-filled discharge tube.

D. Weighton and Pye, Ltd. Application date 17th May, 1943.

569 567.—Calibrated band-spread device to enable a receiver to be rapidly and accurately tuned to commercial transmissions.

Marconi's W.T. Co., Ltd. and G. L. Grisdale. Application date 29th September, 1943.

569 576.—Receiver with a highly-sensitive automatic gain control, suitable for use alone, or as one of the units in a diversity reception system.

Marconi's W.T. Co., Ltd. and C. P. Beanland. Application date 25th October, 1943.

569 845.—Multi-range tuning system in which the length of arc separating adjacent frequency units is constant for each and every range.

T. D. Parkin. Application date 1st January, 1942.

569 905.—Frequency-changing system comprising two local oscillators for accurately aligning the tuned circuits of a superheterodyne with ganged control.

Standard Telephones and Cables, Ltd. (communicated by International Standard Electric Corpn.). Application date 26th November, 1943.

569 956.—Lever switch with click control designed to replace the rotary tuning knob on a wireless receiver.

Marconi's W.T. Co. Ltd.; F. E. Baum; and J. W. Graham. Application date 8th September, 1943.

TRANSMITTING CIRCUITS AND APPARATUS

569 961.—Wireless transmitter with a record-strip control which is adapted to regulate the repetition in accordance with prevailing atmospheric conditions.

Cable and Wireless Ltd. and F. Warburton. Application date 16th September, 1943.

570 080.—Glow-discharge tube arranged in a slot in the walls of a wave guide for indicating the presence of standing waves.

C. J. Carter and Pye Ltd. Application date 23rd February, 1943.

SIGNALLING SYSTEMS OF DISTINCTIVE TYPE

569 637.—Automatic tuning device for the individual sets of a short-wave inter-communication system using different frequencies for transmission and reception.

J. G. Murdoch & Co., Ltd. and B. J. Henderson. Application date 10th August, 1943.

570 140.—Signalling system in which secrecy is ensured by simultaneously modulating selected frequencies and sub-frequencies.

D. S. B. Shannon and H. Craske. Application date 17th December, 1941.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

569 776.—Process for mechanically cleaning or sand-blasting the contact-pins of a thermionic valve.

Standard Telephones and Cables, Ltd.; P. K. Chatterjea and T. W. Wingent. Application date 3rd December, 1943.

569 819.—Carbonising the electrodes of a thermionic valve by induction heating in the presence of acetylene.

Standard Telephones and Cables, Ltd. and S. J. Powers. Application date 17th September, 1943.

SUBSIDIARY APPARATUS AND MATERIALS

569 544.—Control of the timing of the make-and-break, to increase the life of the contacts, in current converters of the vibrator type.

Wright and Weaire, Ltd., and E. S. Buckley. Application date 21st October, 1943.

569 571.—Construction of the inner and outer cases, and end pieces, of a fixed-capacitance condenser.

Telephone Manufacturing Co., Ltd., and C. O. L. Ward. Application date 15th October, 1943.

569 612.—Storage battery with protective packing designed to minimise the danger from explosive gases generated during the charging cycle.

A. A. Thornton (communicated by Philco Radio and Television Corp.). Application date 10th September, 1943.

ABSTRACTS AND REFERENCES

Compiled by the Radio Research Board and published by arrangement with the Department of Scientific and Industrial Research

Comparative Length of the Abstracts.—*It is explained to new readers that the length of an abstract is no sign, by itself, of the importance of the work concerned. An important paper in English may be dealt with by a short abstract, or even, if it is in a journal readily obtainable, by a square-bracketed addition to the title; while a paper of similar importance in a language other than English may be given a long abstract. In addition to these questions of language and accessibility, the nature of the work has, of course, a great effect on the useful length of its abstract.*

PROPAGATION OF WAVES

3777. THE SCIENTIFIC PRINCIPLES OF RADIOLOCATION.—E. V. Appleton. (*Journ. I.E.E.*, Part I, Sept. 1945, Vol. 92, No. 57, pp. 340–353.)

The thirty-sixth Kelvin Lecture. For summaries see also *Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, pp. 679–680, and *Electrician*, 24th Aug. 1945, Vol. 135, No. 3508, pp. 193–194.

3778. TELEVISION VS. FOLIAGE.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 88–90, 194, 198.)

Experiences of set-owners in wooded areas confirm that the field strength of television signals drops during summer months when trees are in leaf. Satisfactory reception is restored by raising the antenna height to give an uninterrupted line of sight.

3779. MULTIPATH INTERFERENCE IN TELEVISION TRANSMISSION.—Lawson. (*See* 3958.)

3780. ON THE VARIATION OF THE APPARENT VELOCITY OF SHORT WAVES.—N. Stoyko. (*Comptes Rendus* [Paris], 22nd Jan. 1945, Vol. 220, No. 4, pp. 139–140.)

The apparent velocity is the quotient of the shortest great-circle route between transmitter and receiver, and the time of propagation. An empirical equation is formulated giving the propagation time as a function of the distance between stations, the apparent velocities by day and night, the frequency, and the local time at the middle of the path. For previous work *see* 2924 and 2925 of 1935.

3781. SIGNAL CORPS RADIO RELAY IN NORTH AFRICA: THE FIRST APPLICATION OF A V.H.F. RADIO RELAY SYSTEM TO MILITARY OPERATION.—O. D. Perkins & A. D. Middleton. (*QST*, *Sept.* 1945, Vol. 29, No. 9, pp. 11..96.)

The 30–40 Mc/s band was used in relay circuits established during the Tunisian campaign and in Sicily in 1943. Profile drawings of the actual terrain refute line-of-sight theories for such transmissions.

3782. CHOOSING U.H.F. SITES USING CONTOUR STRIPS TO PREDICT CIRCUIT PERFORMANCE.—P. S. Rand. (*QST*, Sept. 1945, Vol. 29, No. 9, pp. 16..82.)

Explains how standard contour maps may be used to plot the path between any two points, with information on the interpretation of the path in terms of probable signal strength.

3783. A THEORETICAL SURVEY OF THE POSSIBILITIES OF DETERMINING THE DISTRIBUTION OF THE FREE ELECTRONS IN THE UPPER ATMOSPHERE.—O. E. H. Rydbeck. (*Chalmers Tekniska Högskolas Handlingar* [Gotenburg], 1945, No. 3, 74 pp. In English.)

The method here very completely discussed is that based on the measurement of the pulse-echo time difference. An introductory section describes the propagation and dispersion of such a pulse in the familiar optical terms and shows that under most conditions dispersion will not vitiate the accuracy of the time measurement. This section contains some calculated pictures of the effect of dispersion on the shape of the envelope of the original pulse, for a few typical cases. The following section gives a more accurate solution in terms of "B.W.K.-approximations" (i.e. the methods of Brillouin, Wentzel, and Kramers). It is shown that when the time of travel is known as a function of frequency it is generally possible to determine the distribution of free electrons over most of the lower part of the ionized layers, and that quite accurate solutions can be obtained for regions where the magnetic inclination is either great or small.

The variation of collisional frequency with height can be determined from sweep-frequency reflection coefficient measurements if the electron-density distribution is determined at the same time. The method has not been tested practically but is considered to appear promising.

A number of ionosphere records have been studied and the corresponding electron distribution deduced and shown to be generally parabolic over a wide density range. There are examples where it is a good approximation over practically the whole layer. The characteristic frequency (i.e. that for which the virtual reflection height equals the time height of maximum-electron density) is determined for each distribution and it is shown that it is not generally permissible to scale ionosphere records in terms of the ratio of a fixed characteristic frequency to critical frequency.

"Finally, the exact wave functions for a parabolic layer are studied briefly. It is shown that the travel time and the dispersion are finite at the critical frequency and that the reflection coefficient differs appreciably from the classical one only when the layer thickness becomes less than about four wave lengths. Asymptotic expansions of the wave functions will appear in a later communication."

The paper, though theoretical and mathematical throughout is continually illustrated by reference to published experimental data.

3784. On the Electrical State of the Upper Atmosphere.—V. C. A. Ferraro. (*Terr. Mag. & Atmos. Elec.*, Sept. 1945, Vol. 50, No. 3, pp. 223–229.)

A theoretical note to show that Wu's hypothesis (2139 of July) on recombination processes in the E layer is untenable, "first as the space-charge required by the dynamo theory of the [terrestrial magnetic] field is exceedingly small . . . Secondly, such a large concentration of positive charges in the atmosphere as postulated by Wu would produce electric fields so large that the atmosphere could not hold together under gravity against the mutual repulsion of its parts."

3785. Diffusion of Ions in the Ionosphere.—V. C. A. Ferraro. (*Terr. Mag. & Atmos–Elec.*, Sept. 1945, Vol. 50, No. 3, pp. 215. 222.)

A theoretical paper leading to the conclusion that the effect of ionic diffusion is negligible in the E and F_1 layers, and is small and possibly negligible in the F_2 layer also.

3786. On an Anomaly shown by Gases subjected to the Action of Various Ionizing Agents.—G. Reboul & G. Vassails. (*Comptes Rendus* [Paris], 29th Jan. 1945, Vol. 220, No. 5, pp. 157–158.)

The phenomenon noted in 3431 of 1939 is explained in terms of the production during ionization, not only of large Langevin ions, but also of molecular aggregates with neutral charge. These aggregates are transformed, in the presence of small ions, into large ions of low mobility that recombine slowly. Experiments tend to confirm this theory.

3787. The Light-Effect under Electric Discharge: The Probability of Recombination.—Sahay. (*See* 4080.)

3788. The Possibilities of Astronomical Radio Soundings with Metre Waves.—P. Lombardini. (*Commentationes* [Vatican City], 1944, Vol. 8, No. 2, 18 pp.)

Reference is made to echoes of very long delay occurring in the frequency band 9–15 Mc/s with a discussion of possible explanations. Another part of the paper deals with the possibility of obtaining echoes from the moon and from other planets, using radiation in the metre wave-band.

3789. Meteors and VHF Bursts.—H. T. Stetson. (*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 112–113, 166, 170, 174.)

There is little doubt that meteors, particularly meteoric showers, contribute to the ionization of the E layer of the ionosphere, and consequently affect radio reception.

3790. On the Relation Between Geomagnetism and the Circulatory Motions of the Air in the Atmosphere.—O. R. Wulf. (*Terr. Mag. & Atmos. Elec.*, Sept. 1945, Vol. 50, No. 3, pp. 185–197.)

Author's summary:—"The possibility of a prevailing large-scale atmospheric circulation in the altitudes at which the diurnal wind-system of the dynamo-theory occurs, this circulation containing both zonal and meridional components and being subject to similar variations as is the air-flow in the lower atmosphere, offers a reasonable explanation of a considerable portion of the behaviour of the geomagnetic elements from hour to hour, day to day, and month to month, and may also have an important bearing on the origin of the Earth's field and its secular variation. It suggests, moreover, that a part of the magnetic disturbance may find its origin in the fluctuations which this upper atmospheric circulation undergoes, and it leads naturally to a latitudinal and seasonal dependence of this disturbance. Finally it points to the value of a comparative study of magnetic observations and the character of atmospheric observations and the character of atmospheric circulation to as great altitudes as this can be defined."

3791. [Earth-Current] Diurnal-Variation Anomalies at Tucson.—W. J. Rooney. (*Terr. Mag. & Atmos. Elec.*, Sept. 1945, Vol. 50, No. 3, pp. 175–184.)

Changes are generally consistent with the recognised movement of the current systems in the ionosphere northward and southward with the sun. A large increase in amplitude in January and a decrease and irregularity in March are observed and correspond to anomalies in the magnetic diurnal variations. The increase may be due to a zone of unusually high conductivity in the ionosphere into which the current system passes at its southernmost position. The March anomaly may be due to erratic shifting of the latitude of the current centre to the northward. *See also* 1606 of 1941.

3792. Principal Magnetic Storms [Recorded at Seven Observatories, April–June 1945].—(*Terr. Mag. & Atmos. Elec.*, Sept. 1945, Vol. 50, No. 3, pp. 245–247.)

3793. American Magnetic Character-Figure, C_A, Three-Hour-Range Indices, K, and Mean K-Indices, K_A for April to June, 1945.—H. F. Johnston. (*Terr. Mag. &*

Atmos. Elec., Sept. 1945, Vol. 50, No. 3, pp. 237–240.)

3794. Final Relative Sunspot-Numbers for 1944 [based on Observations at Zürich].—W. Brunner. (*Terr. Mag. & Atmos. Elec.*, Sept. 1945, Vol. 50, No. 3, pp. 231–232.)

3795. Provisional Sunspot-Numbers for March to June, 1945 [from Observations at Zürich].—W. Brunner. (*Terr. Mag. & Atmos. Elec.*, Sept. 1945, Vol. 50, No. 3, p. 198.)

3796. On the Theory of Sun-Spots : Additional Note.—C. Walén. (*Arkiv för Mat., Astron. och Fysik* [Stockholm], 30th Dec. 1944, Vol. 31, Part 2, Section B, No. 3, 3 pp. In English.)

Two minor errors in 3470 of November are corrected, and solution of one of the equations in that paper is discussed in detail.

3797. Solar Radiation at Different Latitudes and Declinations of the Sun.—T. E. Aurén. (*Arkiv för Mat., Astron. och Fysik* [Stockholm], 30th Dec. 1944, Vol. 31, Part 2, Section A, No. 11, 26 pp. In English.)

For clear skies the spectral composition of the solar radiation is almost constant for altitudes above about 8°. The mean value of the global radiation in cal/cm² on the Smithsonian scale is given for different solar latitudes. The sum of the total energy irradiated daily (the insolation) is calculated for a clear sky and for different latitudes and solar declinations. The spectral distribution of the insolation depends on the state of the atmosphere. The relation between the energy irradiated at wavelengths $> \lambda 623$ mμ and the total radiation is studied for different solar declinations.

3798. On the Solar Corona.—H. Alfvén. (*Arkiv för Mat., Astron. och Fysik* [Stockholm], 10th Dec. 1941, Vol. 27, Part 4, Section A, No. 25, 23 pp. In English.)

There is evidence that electrons and ions with energies far above thermal energies exist in the corona. It is suggested that the corona might consist entirely of such particles. The effective temperature is calculated from the density function assuming solar gravitation to be the only force on the corona. The value obtained ($\sim 10^6$ degrees) is consistent with values found in other ways. The energy necessary to maintain this temperature is small because the radiation losses are negligible. A more complete theory is outlined, introducing forces due to the Sun's magnetic field as well as gravitation. The temperature in the corona calculated on this theory is in good agreement with the temperature distribution expected. Comparisons with various experimental data are given. The importance of the magnetic field on the ray structure of the corona is discussed.

3799. Variation during the Solar Cycle of the Time Interval between Chromospheric Eruptions and the Perturbations of the Earth's Magnetic Field.—P. Bernard. (*Comptes Rendus* [Paris], 29th Jan. 1945, Vol. 220, No. 5, pp. 179–181.)

The interval varies widely in individual cases, but its annual mean varies very regularly. It fell from about 45 hours in 1935 to 27 hours in 1938, and remained at about that figure till 1941 (*c.f.* 3053 of 1939). The time lag for the bigger eruptions is usually smaller than for minor eruptions.

3800. On the Motion of a Charged Particle in a Magnetic Field.—H. Alfvén. (*Arkiv för Mat., Astron. och Fysik* [Stockholm], 10th Feb. 1941, Vol. 27, Part 3, Section A, No. 22, 20 pp. In English.)

The motion in an inhomogeneous magnetic field under the influence of electric forces, gravitation etc. is treated as a perturbation of the simple motion in a homogeneous magnetic field. The charged particle, which to a first approximation moves in a circle, is replaced by an equivalent magnet at the centre of the circle. The moment of this magnet is always constant, and its motion is governed by equations that are derived. The method is applicable to almost all problems such as those connected with aurora and magnetic storms.

3801. List of [about 120] Recent Publications [on Terrestrial Magnetism and Electricity and Allied Subjects].—(*Terr. Mag. & Atmos. Elec.*, Sept. 1945, Vol. 50, No. 3, pp. 251–255.)

3802. The Screening Effect of a Cylindrical Tube Placed in a Magnetic Field Perpendicular to its Axis.—Laplume. (*See* 3987.)

3803. "Transmission Lines, Antennas, and Wave Guides" [Book Review].—R. W. P. King, H. R. Minno & A. H. Wing. (*Communications*, Aug. 1945, Vol. 25, No. 8, pp. 88–89, and *Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, p. 727.)

". . . the outgrowth, with some additions, of preradar training lecture material presented at Cruft Laboratory, Harvard University."

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

3804. Measurements by Frame Aerials of Current Variations in Lightning Discharges.—H. Norinder & O. Dahle. (*Arkiv för Mat., Astron. och Fysik* [Stockholm], 24th Aug. 1945, Vol. 32, Part 2, Section A, No. 5, 70 pp. In English.)

The current wave form and amplitude of multiple lightning flashes were measured by determination of the magnetic field variations produced in the vicinity of the flash. For this purpose a loop aerial was developed with electric screening to avoid influences due to variations in the electric field.

The wave form was recorded by means of specially constructed cathode-ray oscillographs, and outside observers measured the distance and the direction to the lightning path, its angular height and its inclination to the earth's surface.

"A close theoretical analysis was undertaken in order to examine the possible methods of calculating the current values from the magnetic field as caused by vertical lightning flashes. Original and typical oscillograms of magnetic field variations obtained at some selected distances from vertical lightning paths were analysed in detail with regard to four possible and different calculation methods. In oscillograms obtained at greater distances from a lightning flash, the calculations took into consideration the influence of the radiation term of the impulses which are emitted from the lightning path.

"A set of typical current variation curves from individual and sometimes consecutive vertical lightning strokes were reproduced and discussed." It was shown that the first stroke in a multiple flash is usually of greater amplitude than the following strokes, which are more or less attenuated.

"Statistical distribution curves of calculated current values, duration of lightning strokes, their time sequence and the transported charges in the separate strokes were examined. The results were in full agreement with corresponding values obtained from observations in the United States where a quite different method of measurement was applied.

"An individual and typical vertical lightning stroke emanating from a limited and typical thunderstorm cloud above an open field region was oscillographed in detail under very favourable conditions. The effects of the lightning were discussed in detail with regard to the oscillograms and the current variation structure of the flash."

3805. ELECTRIC POTENTIAL OF THE EARTH'S SURFACE.—A. B. Arlick. (*Current Science* [Bangalore], June 1945, Vol. 14, No. 6, p. 151.)

It is inferred from geophysical data that the electric potential of the earth's surface with respect to its core of hot liquid metallic mass, must be of a very high order of magnitude and not zero as has been commonly assumed. It is estimated that the electric field at the surface of the core is of the order of 10^6 volts per cm, whilst the atmospheric electric field is of the order 500 volts per metre.

3806. THE INFLUENCE OF WAVELENGTH ON THE GENERAL LEVEL OF ATMOSPHERICS.—R. Bureau. (*Génie Civil*, 1st July 1945, Vol. 122, No. 13, p. 104.)

Abstract of a paper in *Comptes Rendus*, 9th October 1944.

3807. A NEW METHOD TO MEASURE CREST VALUES OF IMPULSE CURRENTS.—Norinder. (*See* 3980.)

3808. LIST OF [about 120] RECENT PUBLICATIONS [on Terrestrial Magnetism and Electricity and Allied Subjects].—(*Terr. Mag. & Atmos. Elec.*, Sept. 1945, Vol. 50, No. 3, pp. 251–255.)

3809. [Underground] COAX CABLE PROTECTION [against Lightning].—L. S. Inskip. (*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 95, 158, 162, 166.) *See* 3657 of November.

PROPERTIES OF CIRCUITS

3810. ON MAXIMUM GAIN-BAND WIDTH PRODUCT IN AMPLIFIERS.—W. W. Hansen. (*Journ. Applied Phys.*, Sept. 1945, Vol. 16, No. 9, pp. 528–534.)

Author's summary :—" By introducing an electrostatic problem analogous to the impedance function problem it is found possible to prove that, under simple and quite broad assumptions, the maximum possible gain-band width products for two-terminal coupling, four-terminal low-pass coupling and four-terminal band-pass coupling are, respectively, 1, 2.47, and 2.53 times $g/\pi C$. . . ."

3811. CATHODE-COUPLED WIDE-BAND AMPLIFIERS.—G. C. Sziklai & A. C. Schroeder. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, pp. 701–709.)

Authors' summary :—" A general analysis indicates that in wide-band amplifiers, stable operation is possible with triodes in circuits using the cathode as a signal terminal. The amplification, however, is approximately equal only to the square root of that available with grounded-cathode amplifier, and therefore twice as many tube units are required to obtain the same amplification. In certain applications, however, the utility of such circuits outweighs the loss of gain.

"A simple radio-frequency amplifier was designed for television receivers, using a cathode-input circuit. By combining a cathode-output and a cathode-input stage using one single twin-triode tube, a circuit was devised which compares favourably with pentode stages with respect to gain stability, and economy, while it has far superior noise characteristics. The new circuit called the 'cathode-coupled twin-triode' amplifier, provides greater flexibility than conventional amplifier circuits, and can be used for radio-frequency, intermediate-frequency, video, converter, or detector services. Since the same tube type can also be used for synchronising and deflection circuits, the number of tube types can be materially reduced, and greater standardisation with further economical advantages may be obtained. An interesting application of the new circuit is a novel bidirectional amplifier."

3812. AERIAL-SPLITTING AMPLIFIERS. — C. N. Jeffery. (*A.W.A. Tech. Review* [Australia], July 1945, Vol. 6, No. 7, pp. 413–422.)

In order to feed several independent receivers from the same aerial without mutual interference and with optimum signal/noise performance the R.F. signals are amplified well above noise level before distributing through parallel cathode-follower circuits. Narrow-band amplifiers with tuning ranges 7–12 Mc/s and 11.5–20 Mc/s are described. They are used for amplifying signals in a band about 1–2 Mc/s wide. A wide-band model covering the range 5–20 Mc/s without tuning is also described.

3813. PHASE SHIFT EFFECT IN AMPLIFIERS.—G. Schaffstein. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 98–100, 138.)

Formulæ and curves are presented for the evaluation of phase shift as a function of frequency. (Abstract of 1253 of 1944.)

3814. FEATURES OF CATHODE FOLLOWER AMPLIFIERS.—H. J. Reich. (*Electronic Industries*, July 1945, Vol. 4, No. 7, pp. 74–78, 170 . . 178.)

Applications are described. Expressions are given for calculating the voltage amplification, input admittance, and output impedance, and the conditions of operation of the device are discussed.

3815. LOW-FREQUENCY COMPENSATION OF VIDEO-FREQUENCY AMPLIFIERS.—M. J. Larsen. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, pp. 666–671.)

Author's summary :—" The low-frequency response of a conventional multi-stage plate-compensated video amplifier is analysed in terms of the distortion of a square wave as measured by a rounding of the wave form. Design criteria are derived to give control of the amount of rounding in the initial design of the amplifier.

"Amplifier compensation effected by inclusion of a discrete impedance in the screen-grid circuit is discussed, and design formulæ are derived. Comparisons of this type of compensation with that where compensation is effected exclusively in the plate circuit are made. The comparisons show that it is difficult to make a strong case favouring the adoption of screen compensation, except when direct coupling is utilised."

3816. A 60-Kilowatt High-Frequency Trans-oceanic - Radiotelephone Amplifier.—Rose. (*See* 3849.)

3817. A D-C Amplifier of High-Current, Low-Impedance Output.—L. Fleming. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 212, 214.)

Maximum output 1.2 A into 3Ω, with input signal 10V d.c. Input impedance 10MΩ. Frequency range 0 to 4000 c/s. A 30 kc/s carrier current system terminating in an output transformer and metal rectifier.

3818. Survey of D-C Amplifiers.—M. Artzt. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 112–118.)

"Analysis of causes of drift in direct-current amplifiers, descriptions of methods used to neutralise or prevent drift, and typical industrial applications."

3819. Band-Pass Bridged-T Network for Television Intermediate-Frequency Amplifiers.—G. C. Sziklai & A. C. Schroeder. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, pp. 709–711.)

Authors' summary :—"Bridged-T networks offer great economy in television intermediate-frequency amplifiers for sharp attenuation of the associated and adjacent sound channels.

"A simple design method was obtained by the use of the equivalent lattice. By the same method, general formulas were obtained for the phase, attenuation, and delay characteristics. Two designs are given to illustrate the convenience of the method."

3820. An Unbalanced Narrow-Band Crystal Filter.—F. J. Lehany & K. G. Dean. (*A.W.A. Tech. Review* [Australia], July 1945, Vol. 6, No. 7, pp. 369–380.)

Authors' summary :—"The paper describes the design and performance characteristics of a T-section crystal filter. In this type of filter the difference between the infinite attenuation frequencies cannot exceed 0.8 per cent of the mid-band frequency when normal X-cut crystals are used. It is shown that the nominal band-width cannot be less than half the separation of frequencies of infinite attenuation if the ratio of crystal thicknesses is limited to six or under."

3821. Resistive Attenuators, Pads and Networks. Parts VI & VII.—P. B. Wright. (*Communications*, July 1945, Vol. 25, No. 7, pp. 50..73, and Aug. 1945, Vol. 25, No. 8, pp. 64..76.)

Part VI. An analysis of purely resistive ladder networks based on hyperbolic functions, and on charts presented in earlier instalments.

Part VII. The problems of multichannel mixer and fader systems are discussed, and solutions are derived in terms of hyperbolic functions.

3822. The Design of Isolating Pads.—J. K. Mackenzie. (*A.W.A. Tech. Review* [Australia], July 1945, Vol. 6, No. 7, pp. 351–368.)

Author's summary :—"One method of supplying a number of independent loads from a single source, so that an open or short circuit load on one or more outlets causes least interference at the other outlets, is to isolate each load from the source by means of a T-pad of resistances, the common ends being paralleled. Given the number of loads to be supplied, the source and load impedances, and the maximum fractional change in output allowable at any outlet, equations are derived which determine the elements of each pad under the conditions (*a*) of least attenuation for the given degree of isolation, and (*b*) of matching each load to its equivalent source impedance when all other outlets are correctly terminated. It is shown that the minimum attenuation is achieved when the pad takes the form of an inverted-L section with the load in parallel with the shunt arm, and that a suitably chosen transformer, placed between the source and the pads, results in a pad with the lowest attenuation and no shunt arm ; different transformers (and a shunt arm) allow either matching at the input or presentation of an optimum load to a triode valve, without appreciable increase in attenuation."

3823. Preferred Numbers and Filter Design.—H. Jefferson. (*Wireless Engineer*, Oct. 1945, Vol. 22, No. 265, pp. 484–488.)

The author shows that the simpler kinds of filter excluding those with close impedance and attenuation specifications can be designed directly to require only components coming within the range of "preferred" standard values with standard tolerances.

The logical basis of the "preferred number" scheme for radio components is explained. The design of low-pass π section, band-pass constant-k π section, and 3-element band-pass filters using preferred number components is detailed.

3824. "Einführung in die Siebschaltungstheorie der elektrischen Nachrichtentechnik" [Book Review].—R. Feldtkeller. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, p. 212.)

"An elementary treatment. . . ."

3825. Forced Oscillations in Oscillator Circuits, and the Synchronization of Oscillators.—D. G. Tucker. (*Journ. I.E.E.*, Part III, Sept. 1945, Vol. 92, No. 19, pp. 226–234.)

Author's summary :—"The behaviour of a feedback oscillator circuit under the influence of an injected tone having a frequency close to the natural frequency of oscillation is considered from the point of view of the steady-state equilibrium of the loop transmission circuit. The conditions for the absence or suppression of the free oscillation and for the stability of the forced oscillation are found. The application of the principles to certain common types of oscillator is discussed, and the effect of impurities in the injected tone is outlined."

It is shown in conclusion that for an oscillator maintained by a cubic type of characteristic the free oscillation is suppressed if the forced-oscillation amplitude exceeds $1/\sqrt{2}$ times that of the free oscillation; also that the range of synchronisation or control is practically proportional to the controlling voltage for small values of the latter, and inversely proportional to the Q-factor of the inductance-capacitance oscillatory circuit.

3826. CRYSTAL OSCILLATORS IN F-M AND TELEVISION.—S. X. Shore. (*Communications*, Aug. 1945, Vol. 25, No. 8, pp. 50–54, 83–86.)

A general discussion of the growing need for oscillator stability and a brief description of a number of circuits so far devised for achieving this. Some of the merits and demerits of crystal oscillators are indicated. To be continued.

3827. A NOTE ON THE DESIGN OF VARIABLE-FREQUENCY RESISTANCE - CAPACITANCE OSCILLATORS.—D. S. Robertson. (*A.W.A. Tech. Review* [Australia], July 1945, Vol. 6, No. 7, pp. 381–392.)

Two resistance-capacitance networks, which can be used in conjunction with an amplifier to provide an oscillator with a frequency range of 3 to 1, are analysed. Variable wire wound resistors and commercial variable capacitors can be used. As an example, at a frequency of 100 c/s a variable resistance of 160 000 ohms and a variable air dielectric capacitor with a maximum capacitance of 1000 $\mu\mu$F are needed.

The frequency scale can be chosen in the same way as with padded L–C circuits.

3828. STABILISATION OF FEEDBACK OSCILLATORS.—D. A. Bell. (*Wireless Engineer*, Oct. 1945, Vol. 22, No. 265, pp. 498–499.)

A letter commenting on 3261 of October, and calling attention to the limited applicability of results deduced from any discussion of oscillation generators in terms of linear circuits. "Probably the best means of securing high stability of oscillator frequency is through automatic control of amplitude."

3829. A VIDEO FREQUENCY [Phase Shift] OSCILLATOR.—C. H. Banthorpe. (*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, p. 694.)

A circuit in which the gain is spread over three valves. Ranges 40 kc/s 500 kc/s and 400 kc/s to 5 Mc/s.

3830. SUPERHETERODYNE TRACKING CHARTS—IV.—A. L. Green. (*A.W.A. Tech. Review* [Australia], July 1945, Vol. 6, No. 7, pp. 423–446.)

These charts are for the design of resistance-capacity oscillators as described in 466 of February. For previous parts *see* 1877 of 1943 and back references.

3831. COMPUTING DOUBLE-STUB LENGTHS FOR LINES.—R. C. Paine. (*Electronic Industries*, July 1945, Vol. 4, No. 7, pp. 94–96, 194.)

The polar form of circle diagram is described and applied to the determination of the requirements for double stub matching.

3832. DESIGN OF SOME COUPLING CIRCUITS FOR AIRCRAFT TRANSMITTING AERIALS.—Honnor. (*See* 3867.)

3833. MATCHING THE ANTENNA FOR TWO-BAND OPERATION.—Marshall. (*See* 3869.)

3834. F-M ANTENNA COUPLER [for feeding an F-M Antenna at the Top of a Base-Insulated Tower used as an A-M Radiator, without Short-Circuiting the Tower].—J. P. Taylor. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 107–109.)

3835. THREE-PHASE POWER FROM SINGLE-PHASE SOURCE [using a 120-Degree Lead-Phase Shifter, a 120-Degree Lag-Phase Shifter, and the Original Unshifted Source].—R. W. Woods. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 284..300.)

A two-page article.

3836. TIME-BASE CONVERTER AND FREQUENCY DIVIDER.—Nagy & Goddard. (*See* 3891.)

3837. OSCILLOGRAPH FOR THE DIRECT MEASUREMENT OF FREQUENCY EMPLOYING A SIGNAL CONVERTER.—P. Nagy & M. J. Goddard. (*Wireless Engineer*, Oct. 1945, Vol. 22, No. 265, pp. 489–496.)

A continuation of 3595 of November. This part deals with the "signal converter" as a time-base generator. It is shown how the following types of time-base can be produced :—(a) a self-generating continuous time base synchronised at the start of the fly-back (b) the same, synchronised at the start of the scan (c) a single sweep (d) a time base equal in frequency to a "standard signal" and with scan period a known fraction of the period of the standard signal. In all cases the synchronising signal may be of positive or negative sign. It is claimed that "almost any type of time base requirements can be satisfied by employing a signal converter".

3838. RIGOROUS METHODS OF SOLVING LONG TRANSMISSION-LINE PROBLEMS.—R. H. Paul. (*Journ. I.E.E.*, Part I, Sept. 1945, Vol. 92, No. 57, p. 366.) Summary of 1746 of June.

3839. A CONTRIBUTION TO THE THEORY OF THE VIBRATION OF COUPLED SYSTEMS.—V. Thorsen. (*Ingen. Vidensk. Skr. B*, 1945, No. 2, 48 pp. In Danish.)

A detailed theoretical paper. The case of forced vibration of coupled systems without damping is first analysed. Equations including damping are then treated by means of analogies and approximations. Finally a general and almost exact solution is found for two coupled systems with different frequencies and dampings. The amplitude and energy resonance curves are discussed. It is shown how the damping can be obtained from the energy resonance curve. An error in a paper by Wien (*Wied. Ann.*, 1897, Vol. 61, p. 151.) is corrected.

3840. NOMOGRAPH FOR Q METER.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 90–91, 198.)

A nomograph is shown for calculating the effective value of the Q of a reactor connected across the capacitance terminals of a Q-meter.

3841. PULSE RESPONSE: A NEW APPROACH TO A.C. ELECTRIC-NETWORK THEORY AND MEASUREMENT.—E. C. Cherry. (*Journ. I.E.E.*, Part III, Sept. 1945, Vol. 92, No. 19, pp. 183–196.)

"The object of this paper is . . . to point out the advantages arising from the use of a pulse type of testing signal—in the ideal case, one of infinitely short duration. The theory of the response of networks to such pulses will be shown to be strikingly similar to the conventional a.c. (steady-state) theory, and time functions in one theory will be found to correspond to frequency functions in the other."

The paper is essentially a study of the reciprocal relationships of Fourier transforms.

3842. Stabilized Negative Impedances, Part II.—E. L. Ginzton. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 138–144, 146, 148.)

The real and imaginary components of the negative impedances produced as described in Part I (3268 of October) are affected by changes of amplifier characteristics with frequency. The effect of variation with frequency of phase-shift in the amplifier is discussed. The power-handling capacity of the amplifier limits the magnitude of negative impedances that can be produced.

3843. Square-Wave Differentiating Circuit Analysis.—G. P. Ohman. (*Electronics* Aug. 1945, Vol. 18, No. 8, pp. 132–135.)

An analysis of the response of a conventional R-C differentiating circuit to a square-wave voltage with an exponential rise. Formulae and generalised design charts are derived giving shape length, and amplitude of the output pulse voltages.

3844. Graphical Symbols for Electronic Diagrams.—(*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 136–137.)

About 100 symbols are given without comment.

3845. Thermistor Technics.—J. C. Johnson. (*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 74–77.)

Thermistors can be used to control the gain of amplifiers of the type used in telephone carrier systems. Three typical circuits are described, corresponding to three possible methods of heating the thermistor, external heating, direct heating, and indirect heating. See also *Electronic Industries*, January 1945, p. 76.

3846. Phase Inverter.—D. L. Drukey. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, p. 722.)

A letter including design formulae, on a triode circuit incorporating equal plate and cathode resistors.

3847. I.F.F. [Identification, Friend or Foe].—(*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, p. 686.)

When a friendly aircraft comes within range of a radar station its I.F.F. unit is triggered by the radar signals and transmits a coded reply.

3848. Skin Effect in Round Conductors.—W. B. Shepperd. (*Communications*, Aug. 1945, Vol. 25, No. 8, pp. 56, 60, 87.)

It is pointed out that whilst skin effect computations at low frequency and high frequency are relatively easy, they are difficult at intermediate frequencies. A method is deduced for finding the values of resistance and inductance at these frequencies by applying a correcting factor to the corresponding d-c values. The correcting factors are plotted as functions of a variable, *K*, which is easily calculated from the frequency and the constants of the conductor.

TRANSMISSION

3849. A 60-Kilowatt High-Frequency Trans-oceanic-Radiotelephone Amplifier.—C. F. P. Rose. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, pp. 657–662.)

Author's summary:—". . . In general, the amplifier is capable of delivering 60 kilowatts of peak envelope power when excited from a 2-kilowatt radio-frequency source. It is designed to operate as a "class B" amplifier for transmitting either single-channel double-sideband or twin-channel single-sideband types of transmission. Features are described which permit rapid frequency-changing technique from any pre-assigned frequency to another lying anywhere within the spectrum of 4.5 to 22 megacycles."

3850. F.M. Power Converter.—F. A. Gunther. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 84–85.)

A description of Armstrong's design for a transmitter converter to permit simultaneous F.M. broadcasting on both the old channel and on the new channel proposed by the F.C.C. during the interim period. Conversion is accomplished at a relatively high amplitude level, the output of a buffer stage at the frequency of the lower channel being combined with the output of a crystal multiplier to give about 150 watts at the sum frequency.

3851. "Tom Thumb" [Transmitter-Receiver].—P. J. Palmer. (*QST*, Sept. 1945, Vol. 29, No. 9, pp. 48–50.)

Constructional details of a combination single-valve transmitter-receiver with a power supply that provides about 6 watts output on 40 or 80 metres wavelength.

3852. Forced Oscillations in Oscillator Circuits, and the Synchronization of Oscillators.—Tucker. (*See* 3825.)

3853. Franklin Type Signal Generator.—S. M. Sugden. (*R.S.G.B. Bull.*, Oct. 1945, Vol. 21, No. 4, p. 56.)

The instrument incorporates a Franklin oscillator circuit and covers the frequency range 65 kc/s–1850 kc/s in four overlapping steps.

3854. Report on the 8th High Frequency Conference of the Swiss Electrotechnical Union held in Berne on 1st Sept. 1944.—(*Bull. Assoc. Suisse des Élec.*, 19th Sept. 1945, Vol. 36, No. 19, pp. 657–661. In German.)

Discussion of three papers:—(1) Facts for Consideration in Transmitter Construction (M. Dick). (2) Selected Subjects connected with Transmitter Measurement Technique (H. Wehrlin). (3) Sensitivity Limits in Receiver Construction (H. Kappeler). The papers have been published in the same journal, 1945, No. 13, pp. 393–400, No. 15, pp. 445–453, and 1944, No. 24, pp. 707–713, respectively.

RECEPTION

3855. Remote Tuning [of Receivers over a Limited Band] with Reactance Tubes.—H. B. Bard, Jr. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 100–101.)

The tubes are connected across the oscillator tank circuit, and controlled by direct voltages applied over telephone lines. 30 kc/s variation at 5 Mc/s can be obtained with 12 V bias variation.

3856. "TOM THUMB" [Transmitter-Receiver].—P. J. Palmer. (*QST*, Sept. 1945, Vol. 29, No. 9, pp. 48–50.)

Constructional details of a combination single-valve transmitter-receiver with power supply that provides about 6 watts output on 40 or 80 metres wavelength.

3857. "THOSE NEW SETS."—G. Keating. (*Wireless World*, Oct. 1945, Vol. 51, No. 10, p. 315.)

A letter proposing that new broadcast receivers should be made to give better performance than was usual before the war, even though more complicated circuits would be needed.

3858. A MOTION PICTURE ARC-LIGHTING GENERATOR FILTER.—B. F. Miller. (*Journ. Soc. Mot. Pict. Eng.*, Nov. 1943, Vol. 41, No. 5, pp. 367–373.)

Author's summary:—"The general means heretofore employed to reduce the commutator noises emitted by arc lamps operated from direct-current generator sets is outlined, and the deficiencies of such equipment are noted. The design of an electrical filter unit, which is extremely compact as compared to previously employed equipment and which is capable of handling the full load output of studio stage-lighting generators, is described. This filter completely suppresses all arc-lamp noises resulting from generator commutator ripple, may be permanently associated with any studio generator set, eliminates the need for repeated installations of large numbers of choke coils on the set, and requires no servicing. The unit is capable of withstanding current overloads in excess of 100 per cent indefinitely."

3859. THE TELEVISION-RECEIVER SOUND CHANNEL. (*Journ. I.E.E.*, Part III, Sept. 1945, Vol. 92, No. 9, pp. 181–182.)

Summary of a discussion meeting of the Radio Section of the I.E.E.

3860. SHIELDING HF INTERFERENCE.—Murray. (*See* 4153.)

3861. INTERFERENCE FROM FLUORESCENT LIGHTING.—Pugh.

Correction to 2959 of September. Instead of (*See* 3253) read (*See* 3442 of October).

3862. REPORT OF THE 8TH HIGH FREQUENCY CONFERENCE OF THE SWISS ELECTROTECHNICAL UNION HELD IN BERNE ON 1ST SEPT. 1944. (*See* 3854.)

3863. SUPERHETERODYNE TRACKING CHARTS—IV.—A. L. Green. (*A.W.A. Tech. Review* [Australia], July 1945, Vol. 6, No. 7, pp. 423–446.)

These charts are for the design of resistance-capacitance oscillators as described in 466 of February. For previous parts *see* 1877 of 1943 and back references.

3864. AERIAL-SPLITTING AMPLIFIERS. — Jeffery. (*See* 3812.)

3865. WIRE-BROADCASTING.—Adorjan. (*See* 4059.)

AERIALS AND AERIAL SYSTEMS

3866. THE DESIGN OF BROAD-BAND AIRCRAFT-ANTENNA SYSTEMS.—F. D. Bennett, P. D. Coleman & A. S. Meier. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, pp. 671–700.)

"A complete technique for the development of broad-band aircraft antennas at frequencies from 10 to 100 Mc/s is described."

Part I. For impedance measurement, a coiled line and probe assembly is described, which gives 5% accuracy providing corrections are made. Standing wave ratios higher than 15 : 1 have been measured. Means of extending the frequency coverage of the equipment to 200 Mc/s are indicated.

Part II. Methods of matching the aerial impedance to that of the feed line are considered. A maximum permissible figure of 2 : 1 for the standing wave ratio is assumed.

Part III. In the frequency range under consideration, expansion of the radiator to large lateral dimensions is not feasible for aircraft use. Multiwire aerials were therefore developed, comprising a fan of coplanar wires joining to a common feed point and having a transverse wire connecting their outer extremities. Fan aerials are described, which, with suitable matching arrangements, yield band-widths in the range 32–45% of the mid-band frequency.

3867. DESIGN OF SOME COUPLING CIRCUITS FOR AIRCRAFT TRANSMITTING AERIALS.—W. W. Honnor. (*A.W.A. Tech. Review* [Australia], July 1945, Vol. 6, No. 7, pp. 393–412.)

Author's summary:—"The electrical constants are given of various aircraft fixed and trailing aerials in the frequency range 140–500 kc and of fixed aerials in the frequency range 2–20 Mc. A design is discussed of circuits for coupling a low impedance line to these aerials over the above ranges of frequency. The design for fixed aerials in the high-frequency band employs the device of a single condenser connected either in series or in parallel with the aerial impedance in order to make the combination always capacitive."

3868. F-M ANTENNA COUPLER [for feeding an F-M Antenna at the Top of a Base-Insulated Tower used as an A-M Radiator, without Short-Circuiting the Tower].—J. P. Taylor. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 107–109.)

3869. MATCHING THE ANTENNA FOR TWO-BAND OPERATION.—J. G. Marshall. (*QST*, Sept. 1945, Vol. 29, No. 9, pp. 23–28.)

Describes the design of networks that enable a single antenna system to be operated on two frequencies without standing waves in the line.

3870. COMPUTING DOUBLE-STUB LENGTHS FOR LINES.—Paine. (*See* 3831.)

3871. SPECIAL TRANSMISSION PROBLEMS IN SOLID DIELECTRIC HIGH FREQUENCY CABLE.—A. G. Kandoian. (*Elec. Communication*, 1945, Vol. 22, No. 3, pp. 198–202.)

". . . the attenuation problem will be primarily considered. Several special cases [e.g., perfect absorption and perfect reflection of energy at the receiving end] important in communication practice, will be analysed to show how the appreciable attenuation of the solid dielectric cable affects the results."

3872. SPECIAL ASPECTS OF HIGH FREQUENCY FLEXIBLE BALANCED CABLES.—N. Marchand. (*Elec. Communication*, 1945, Vol. 22, No. 3, pp. 193–197.)

A description of the causes of unbalance in normally balanced cables and the means which may be adopted to reduce the asymmetry. The paper refers to applications in which a balanced cable is preferable to one of unbalanced type, and concludes with a section describing a method of measuring the unbalance of a cable.

3873. ANTI-FADE ANTENNA SYSTEM.—(*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 272, 276.)

Short account of a system described in 3553 of November on Wire Broadcasting. Two aerials were placed in line with the transmitter, $\lambda/2$ apart, and their outputs combined so that the signals received from the direct ray cancelled. The resultant indirect-ray output was used to cancel the indirect-ray output of a third aerial midway between the first two.

3874. A 14 Mc/s THREE ELEMENT ROTARY BEAM AERIAL.—F. W. R. Robbins. (*R.S.G.B. Bull.*, Oct. 1945, Vol. 21, No. 4, pp. 50–53.)

A detailed description of a 36ft mast, and of a dipole, reflector and director system, rotatable through 360°.

3875. THEORY AND PERFORMANCE OF CORNER REFLECTORS FOR AERIALS.—E. B. Moullin. (*Journ. I.E.E.*, Part I, August 1945, Vol. 72, No. 56, pp. 326–328.)

Long summary of 3291 of October.

3876. THE MEASURED PERFORMANCE OF HORIZONTAL DIPOLE TRANSMITTING ARRAYS.—H. Page. (*Journ. I.E.E.*, Part I, August 1945, Vol. 92, No. 56, pp. 330–331.)

Long summary of 3292 of October.

3877. "TRANSMISSION LINES, ANTENNAS, AND WAVE GUIDES" [Book Review].—King, Mimno & Wing. (*See* 3803.)

VALVES AND THERMIONICS

3878. ON THE POSSIBILITY OF PURELY ELECTROSTATIC FOCUSING IN A VELOCITY MODULATION DRIFT TUBE.—P. Guénard. (*Annales de Radioélectricité*, July 1945, Vol. I, No. 1, pp. 74–77.)

Formulæ are derived giving as functions of focusing voltage, the maximum beam current that can traverse the tube in the cases (*a*) where density modulation is negligible, and (*b*) where density modulation is large at the end of the tube (as in power valves). The electrons are considered to be in a field-free space inside the tube.

3879. CONTRIBUTION TO THE PHYSICS AND TECHNIQUE OF VELOCITY-MODULATED ELECTRONIC TRANSMITTING TUBES.—R. Warnecke. (*Annales de Radioélectricité*, July 1945, Vol. I, No. 1, pp. 6–54.)

A review of the principles, methods of construction and properties of velocity-modulated transmitting tubes. A number of different types are discussed under the headings: klystrons, single-cavity klystrons, tubes with transmission-line circuits, Hahn's cumulative-effect tube, and constructional forms relating to new arrangements and ideas. Technical problems concerning cathodes, focusing systems, cavities, H.F. electrodes, drift electrodes and electron collectors are dealt with. Load matching, modulation, and frequency stabilisation are also discussed. The characteristics and performance of two commercial 100W c.w. klystrons, the K771 (1.2–1.4 kMc/s) and the K781 (1.76–2.2 kMc/s) are given in tables and graphs. A transmitter incorporating a K771 klystron is briefly described. A bibliography of 86 patent and journal references is given.

3880. STUDY OF ULTRA-HIGH-FREQUENCY TUBES BY DIMENSIONAL ANALYSIS.—G. J. Lehmann & A. R. Vallarino. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, pp. 663–666.)

Authors' summary:—"The complete theory of the operation of ultra-high-frequency tubes being extremely difficult, it is shown that dimensional analysis in conjunction with experimental work is a powerful tool in this field.

"If certain general assumptions are fulfilled, the properties of ultra-high-frequency oscillators can be expressed in terms of a dimensionless parameter $\phi = (f \times d)/\sqrt{V}$ [f is the frequency of operation, d the cathode-plate distance, and V the voltage of the source of power].

"The dependence of efficiency on frequency in an ultra-high-frequency oscillator is considered in the first part of this paper.

"In the second part, combining the previous results with the Child-Langmuir equation, the relationship between the voltage, the dimensions of the tube, and the frequency are discussed when the efficiency is maintained constant."

3881. LIGHTHOUSE TUBE USED TO MAKE RADAR EFFECTIVE.—(*Sci. News Letter*, 25th Aug. 1945, Vol. 48, No. 8, p. 120.)

3882. THE PATHS OF IONS AND ELECTRONS IN CROSSED, NON-UNIFORM ELECTRIC AND MAGNETIC FIELDS.—N. D. Coggeshall. (*Phys. Review*, 1st/15th Aug. 1945, Vol. 68, Nos. 3/4, p. 98.)

Abstract only.

3883. ELECTRON TRAJECTORIES IN A PLANE DIODE: A GENERAL RESULT.—L. Brillouin. (*Elec. Communication*, 1945, Vo. 22, No. 3, pp. 212–216.)

The following theorem is developed:—"In a plane diode with hot cathode and space charge, operated under arbitrary voltage variations as a function of time, electron trajectories never cross each other provided the current never becomes negative."

The proof given shows that "if electronic emission is continuous and no crossing occurred before time t, then it will never happen afterwards". The restriction implicit here is discussed, together with that due to the initial assumption of zero velocity of emission for the electrons. It is shown that the theorem holds in the case when the emission velocity is independent of time, providing "the motion of electrons is such as never to bring them back on the emitting electrode". The discussion is extended to cover the overlapping of trajectories occurring in velocity modulated beams. In such circumstances the initial velocity is a function of time, and "crossing of trajectories and overlapping of electron beams become a possibility".

3884. ELECTRON TRANSIT TIME IN TIME-VARYING FIELDS.—A. B. Bronwell. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, pp. 712–716.)

Author's summary:—"The equations of electron acceleration, velocity, and displacement in time-varying fields are derived for the temperature-limited and the space-charge-limited diodes. These are written in a form making it possible to construct universal curves of electron displacement as a function of transit angle. Separate curves represent the direct-current and alternating-current components of electron displacement, the total displacement being obtained by adding the two components. The curves greatly expedite the solution of electron transit-time problems and aid in visualising the physical processes at work."

3885. EMISSION-LIMITED DIODE.—V. M. Brittain. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, pp. 724–725.)

A letter in which is calculated—neglecting the effects of space charge and relativistic change of mass—the transit time for an electron between the electrodes of an emission-limited coaxial-cylinder diode. An approximate expression is included for the transit time between cathode and grid of a similarly constructed emission-limited triode.

3886. MECHANICAL PRODUCTION OF GRIDS.—(*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 104–106, 134, 138.)

A description of the large-scale machine production of special valve grids that had hitherto defied mechanical fabrication.

3887. THE ALIGNMENT OF GRIDS IN THERMIONIC VALVES.—C. S. Bull. (*Journ. I.E.E.*, Part I, August 1945, Vol. 92, No. 56, p. 331.)

Summary of 3301 of October.

3888. THE NEW SERIES OF GLASS-BASED TUBES.—P.-L. Courier. (*La T.S.F. pour Tous*, July 1945, Vol. 21, No. 34, pp. 110–116.)

Description and characteristics of the ECH21, EF22, and EBL21.

3889. AMERICANISED BRITISH RADAR TUBE.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 92, 230, 234.)

Details of changes made in the design of the VR91 valve to enable high-speed production by Sylvania Electric Products Inc. A one-page paper.

3890. SOME TECHNICAL ASPECTS OF VALVE STANDARDISATION.—(*Journ. I.E.E.*, Part III, Sept. 1945, Vol. 92, No. 19, pp. 235–236.)

Discussion opened by A. H. Cooper. "If valve standardisation was to work, it was therefore necessary for valve and circuit engineers to agree not only what valves were needed but also what were reasonable ways of using them; if standardisation was not to act as a brake on progress, this 'code of practice' must be kept alive and ahead of the needs of the users."

3891. TIME-BASE CONVERTER AND FREQUENCY DIVIDER.—P. Nagy and M. J. Goddard. (*Wireless Engineer*, Oct. 1945, Vol. 22, No. 265, pp. 497–498.)

A letter replying to the suggestion (in 3266 of October) that the introduction of a new and specialised type of valve (the "signal converter") is a retrograde step if the same purposes can be served by existing means. It is claimed that a single valve of the new type replaces a number of conventional valves and their associated circuits.

3892. OSCILLOGRAPH FOR THE DIRECT MEASUREMENT OF FREQUENCY EMPLOYING A SIGNAL CONVERTER.—Nagy & Goddard. (*See* 3837.)

3893. A NEW FORM OF DEMOUNTABLE OSCILLATOR TUBE FOR A CYCLOTRON.—S. von Friesen. (*Arkiv för Mat., Astron. och Fysik* [Stockholm], 10th Dec. 1945, Vol. 27, Part 4, Section B, No. 12, 7 pp. In Swedish.)

25 kW output. Similar in many respects to the tube described in 1885 of 1935.

3894. SOME ASPECTS OF SPECIAL ELECTRON TUBES.—F. E. Lane. (*Journ. British I.R.E.*, March/April 1945, Vol. 5, No. 2, pp. 82–102. Discussion pp. 103–104.)

Electrometer triodes, commercial tubes for frequencies up to 1700 Mc/s, power amplifiers, photo-multipliers, klystrons, magnetrons, the iconoscope, and notes on the electron microscope and the cyclotron. A bibliography of 91 items is given.

3895. CALIBRATING INSTRUMENTS FOR USE IN VACUUM-TUBE MANUFACTURE.—E. Goddess. (*Communications*, Aug. 1945, Vol. 25, No. 8, pp. 38, 40.)

Method of using a standard cell, resistors and potentiometer for testing ammeters and voltmeters.

DIRECTIONAL WIRELESS

3896. HIGH-FREQUENCY ERROR CURVES FOR ADCOCK RADIO DIRECTION-FINDER ARRAYS.—J. Holbrook. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, pp. 723–724.)

A letter pointing out that four-aerial systems may be used for direction finding even when the spacing is not small compared with wavelength, providing allowance is made for the appropriate octantal correction.

3897. MULTIPATH INTERFERENCE IN TELEVISION TRANSMISSION.—Lawson. (*See* 3958.)

3898. COMBINATION INSTRUMENT ["The Marconator"] FOR DIRECTION FINDING. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 214 . . . 230.)

The unit comprises the following components: Single-Needle visual indicator, Master cursor, Relative bearing, (True bearing and drift scales), Gyromagnetic distant reading compass repeater motor, Adjustable quadrantal error compensator, and Loop drive mechanism. A one-page descriptive article.

3899. RADIO AND NAVIGATION.—X. Reynes. (*La T.S.F. pour Tous*, July 1945, Vol. 21, No. 34, pp. 117–118.)

An elementary article on navigation by compass or radiogoniometer.

3900. DEVELOPMENT OF AIRCRAFT INSTRUMENT LANDING SYSTEMS.—H. H. Buttner & A. G. Kandoian. (*Elec. Communication*, 1945, Vol. 22, No. 3, pp. 179–192.)

A description of the history of aircraft landing systems and the eventual development at the Federal Telephone and Radio Laboratories of the U.S. Army equipment type SCS-51. A concluding paragraph discusses the possibility of landing aircraft automatically by means of an electronically controlled automatic pilot.

3901. Safe Landings [by the Use of Ground-Control Approach Radar].—A. C. Monahan. (*Sci. News Letter*, 25th Aug. 1945, Vol. 48, No. 8, p. 127.)

3902. The Scientific Principles of Radiolocation.—E. V. Appleton. (*Journ. I.E.E.*, Part I, Sept. 1945, Vol. 92, No. 57, pp. 340–353.)

The thirty-sixth Kelvin Lecture. For summaries see *Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, pp. 679–680, and *Electrician*, 24th Aug. 1945, Vol. 135, No. 3508, pp. 193–194.

3903. Fundamentals of Radar.—(*Wireless World*, Oct. 1945, Vol. 51, No. 10, pp. 299–303.)

A description of the ground stations used for coastal defence by radar, indicating the increase in accuracy obtained during the war by reductions in wavelength. The considerations which determine optimum pulse lengths and repetition frequencies are discussed.

3904. Radar.—(*Elec. Communication*, 1945, Vol. 22, No. 3, pp. 171–178.)

Reprint of Part I of 1487 of May (Smith-Rose), together with a short account of the microwave duplex telephone and telegraph link established in 1931 across the Straits of Dover.

3905. How Radar Works.—(*Telegr. & Teleph. Age*, Sept. 1945, Vol. 63, No. 9, pp. 10, 34.)

A simple description of the basic principles.

3906. Radar—A Report on Science at War.—(*Journ. Applied Phys.*, Sept. 1945, Vol. 16, No. 9, pp. 491–493.)

Summary of U.S. government publication.

3907. Radar Secrets given to Public by U.S. and British Governments.—(*Teleg. & Teleph. Age*, Sept. 1945, Vol. 63, No. 9, pp. 6–10.)

A summary of the general information on radar published by the two governments.

3908. Radar Secrets *and* How Radar Saved England.—(*Sci. News Letter*, 25th Aug. 1945, Vol. 48, No. 8, pp. 115, 117.)

3909. The Pioneers of Radiolocation.—S. Cripps. (*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, p. 680.)

A speech by the Chairman of the Radio Board, 1942-45, at a press conference, which outlined the British developments of Radiolocation.

3910. Radar in Production: The Development of Centimetric [Fire-Control and Search-Light Control] Equipment [by the British Thomson-Houston Company].—(*Electrician*, 14th Sept. 1945, Vol. 135, No. 3511, pp. 265–266.)

3911. Radar Production.—(*Wireless World*, Oct. 1945, Vol. 51, No. 10, pp. 290–295.)

A review of radar production in Britain during the war, introducing the industrial firms which designed and manufactured various types of equipment.

3912. German Views on British Radar.—(*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, p. 686.)

A condensation of a captured German document dealing with the great superiority of "Anglo-Saxon" radar over their own.

3913. Radar in U.S. and Great Britain [Eleven Photographs of Radar Equipment].—(*Communications*, Aug. 1945, Vol. 25, No. 8, pp. 58–59.)

3914. Radio Beacons.—(*Electronic Eng:g*, Oct. 1945, Vol. 17, No. 212, p. 735.)

Transmitters are constructed which, on receipt of a series of pulses in some pre-determined pattern, will transmit pulses in another pattern. By coding the response patterns, beacons can be set up which will enable pilots of friendly aircraft to find their bearings whilst rendering no assistance to hostile aircraft, and aircraft can carry such devices to identify them to friendly radar.

3915. I.F.F. [Identification, Friend or Foe].—(*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, p. 686.)

When a friendly aircraft comes within range of a radar station its I.F.F. unit is triggered by the radar signals and transmits a coded reply.

3916. Gee: A New Method of Radio Navigation.—L. S. Harley. (*Electronic Eng:g*, Oct. 1945, Vol. 17, No. 212, pp. 713–716.)

A simple description of a position-finding system depending on the observation at the moving craft of the time of delay between the reception of pulses transmitted synchronously from three different stations, one master station, and two slave stations triggered by the master. The original British system "Gee" utilises metre waves, so that the range of operation is limited by the radio horizon. The U.S. modification "Loran" uses longer waves subject to ionospheric reflection, and gives longer range, but with reduced accuracy due to uncertainty of the path length of a reflected wave. The article includes an account of the use made of Gee during the war.

3917. Radar Developed Electronic Navigator.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, p. 218.)

A very brief description of the application of radar principles to the design of a navigational aid for detecting above-water obstacles at sea. See also *Sci. News Letter*, 25th Aug. 1945, Vol. 48, No. 8, p. 120.

3918. Peacetime Radar: Application to Civil Aviation.—(*Wireless World*, Oct. 1945, Vol. 51, No. 10, p. 312.)

A short account of some of the proceedings of the third Commonwealth and Empire Conference on Radio for Civil Aviation.

3919. Glossary of [over 100] Common Radar Expressions.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 92, 108, 210..230.)

3920. A Radar Glossary.—(*Electronic Eng:g*, Oct. 1945, Vol. 17, No. 212, p. 719.)

A list of 28 items.

ACOUSTICS AND AUDIO-FREQUENCIES

3921. How Microphones Work.—A. Kahn. (*QST*, Sept. 1945, Vol. 29, No. 9, pp. 34–37.)

Fundamental principles upon which several of the various types of microphone operate are discussed, and suggestions are included for selecting the correct type for a given application.

3922. Frequency Modulation Distortion in Loud Speakers.—G. L. Beers & H. Belar. (*Journ. Soc. Mot. Pict. Eng.*, April 1943, Vol. 40, No. 4, pp. 207–221.)

The form of distortion discussed arises from the simultaneous radiation from a baffle-mounted loudspeaker cone of both high and low frequencies. The source of high-frequency sound can be considered as moving back and forth at the low frequency, so that a Doppler effect is caused. A 12 inch cone radiating one acoustic watt at 100 c/s simultaneously with a 5000 c/s signal will distort the latter by 10 per cent. Methods of reducing the effect include increasing the cone diameter to reduce the amplitude of its motion, and the use of separate loud speakers for high and low frequencies.

3923. Resonant Loudspeaker Enclosure Design.—F. W. Smith, Jr. (*Communications*, Aug. 1945, Vol. 25, No. 8, pp. 35–37, 77–78.)

By the use of equivalent electrical circuits the author deduces graphs and expressions for determining the dimensions of vented or reflex enclosures for a loud speaker of given size.

3924. Phono Head Balance.—N. L. Chalfin. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 102–103, 138, 142.)

Magnetic pick-ups and cutters can be balanced accurately and quickly under operating conditions by a simple dynamic adjustment method using a cathode-ray oscilloscope.

3925. Phonograph Dynamics.—W. S. Bachman. (*Electronic Industries*, July 1945, Vol. 4, No. 7, pp. 86–89, 124, 128, 190.)

A number of factors limit the depth of modulation that can be applied to a disc. The amplitude is limited by the pitch, the velocity by the clearance angle of the cutting stylus, and the acceleration by the diameter of the tracing stylus. In practice the proper limits are often exceeded. The importance of monitoring the acceleration during the recording is stressed.

3926. Some Recent Developments in Record-Reproducing Systems.—G. L. Beers & C. M. Sinnett. (*Journ. Soc. Mot. Pict. Eng.*, April 1943, Vol. 40, No. 4, pp. 222–241.)

A reprint of 2160 of 1943.

3927. Strain-Gage Phono Pickup.—(*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, p. 89.)

A brief description of the principles of a phonograph pickup manufactured by the General Electric Co., Schenectady, which resembles a strain gauge, in that the movements of the needle are used to stretch a wire and alter its resistance.

3928. Design for a 24-watt [A.F.] Amplifier for Gramophone, Radio, or Microphone. —(*La T.S.F. pour Tous*, July 1945, Vol. 21, No. 34, p. 124.)

3929. Contrast Expansion.—J. G. White. (*Wireless World*, Oct. 1945, Vol. 51, No. 10, pp. 309–312.)

Further details of design of a negative feedback contrast expander are given showing how the output impedance can be reduced. *See* 3489 of November.

3930. Shipboard Announcer.—L. B. Cooke. (*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 96, 97, 130.)

An account of the system described in 3557 of November.

3931. Electrical Aids to Public Speaking.—(*Journ. I.E.E.*, Part I, Sept. 1945, Vol. 92, No. 57, pp. 357.)

Discussion led by P. A. G. H. Voigt at an informal I.E.E. meeting.

3932. Acoustic Literature of 1941.—K. Patermann. (*Akust. Zeitschr.*, Nov. 1942, Vol. 7, Nos. 5/6, pp. 93–213.)

A list of over 800 items including papers, classified under 23 subject headings, and books.

3933. Extension of the Beam Theory [Stress Analysis] to Tapered Beams and Conical Shells.—L. Beskin. (*Journ. Applied Phys.*, Sept. 1945, Vol. 16, No. 9, pp. 511–528.)

3934. An Acoustic Wall Covering with Increased Absorption for Low Tones.—R. Berg & J. Holtsmark. (*Akust. Zeitschr.*, Nov. 1942, Vol. 7, Nos. 5/6, p. 216.)

Abstract of *Det Kongelige Norske Videnskabers Selskabs Forhandlinger*, Vol. 13, No. 22.

3935. The Sound Absorption Capacity of Composite Wall Coverings.—R. Berg & J. Holtsmark. (*Akust. Zeitschr.*, Nov. 1942, Vol. 7, Nos. 5/6, p. 217.)

Abstract of *Det Kongelige Norske Videnskabers Selskabs Forhandlinger*, Vol. 13, No. 50.

3936. The Sound Absorption Capacity of Walls that can Vibrate.—J. Holtsmark. (*Akust. Zeitschr.*, Nov. 1942, Vol. 7, Nos. 5/6, pp. 217–218.)

Abstract of *Det Kongelige Norske Videnskabers Selskabs Forhandlinger*, Vol. 14, No. 7.

3937. Acoustic Experiments [on Building and Room Acoustics Carried Out during 1935-40 at the Telegraphy and Telephony Laboratory of the Polytechnic Institute of Copenhagen].—P. O. Pedersen. (*Akust. Zeitschr.*, Nov. 1942, Vol. 7, Nos. 5/6, pp. 218–220.)

Long abstract of *Ingeniørvidenskabelige Skrifter*, 1940, No. 5.

3938. Absorption of Sound by Porous Materials. Parts III and IV.—C. Zwikker, J. van den Eijk & C. W. Kosten. (*Akust. Zeitschr.*, Nov. 1942, Vol. 7, Nos. 5/6, pp. 215–216.)

Abstracts of papers in *Physica*, 1941, Vol. 8, p. 1094 and p. 1102. For reference to parts I and II *see* 1445 of 1943.

3939. The Sound Insulation of Wooden Ceilings.—R. Berg & J. Holtsmark. (*Akust.

Zeitschr., Nov. 1942, Vol. 7, Nos. 5/6, pp. 214–215.)

Abstract of *Det Kongelige Norske Videnskabers Selskabs.*, Vol. 10, No. 46, and Vol. 12, No. 41.

3940. RCA Audio Chanalyst: A New Instrument for the Theater Sound Engineer.—A. Goodman & E. Stanko. (*Journ. Soc. Mot. Pict. Eng.*, Dec. 1943, Vol. 41, No. 6, pp. 467–475.)

This instrument comprises two calibrated amplifiers, a P.M. loud-speaker with amplifier, an audio-frequency oscillator and an extremely sensitive electronic voltmeter, the whole being built into a single portable unit. It is used in theatres, etc. for measuring power output, a.f., a.c., and d.c. voltages, gain etc., and for general servicing of sound equipment.

3941. The Variable-Density Film-Recording System used at MGM Studios.—J. K. Hilliard. (*Journ. Soc. Mot. Pict. Eng.*, Mar. 1943, Vol. 40, No. 3, pp. 143–175.)

The paper describes special features of the system rather than the well-known general principles. The cardioid type microphone reduces the pick-up of background noise, and its pattern can be varied at will for special effects. The perforated steel outer case prevents the pick-up of magnetic particles. The improvement in quality resulting from the use of this microphone made over-modulation of the light-valve very noticeable and limiting amplifiers had to be used. Reduction in noise is accomplished by recording high frequencies at a greater amplitude than normal relative to the low frequencies, and they are brought back to normal amplitude by a post-equaliser.

The paper includes paragraphs on film sensitometry, lighting and portable equipment.

3942. The MGM [Sound] Recorder and Reproducer Equipment Units.—W. C. Miller. (*Journ. Soc. Mot. Pict. Eng.*, May 1943, Vol. 40, No. 5, pp. 301–326.)

A description of the mechanical details of the recorder with many close-up photographs. Improvements include constant velocity of film, obtained by the use of a heavy fly-wheel driven by the film, direct coupling of synchronous motors to eliminate noisy gears, and tungsten or mercury-vapour light sources with the illumination of the latter kept constant by air blowers controlled by the source.

3943. A 200-Mil Push-Pull Film Recording System.—L. D. Grignon & J. P. Corcoran. (*Journ. Soc. Mot. Pict. Eng.*, Mar. 1944, Vol. 42, No. 3, pp. 127–144.)

A detailed description of a new truck-mounted acoustic recording equipment for use in film production. The system is Western Electric variable density light-valve providing a 200-mil push-pull track by means of a semi-intensity modulator.

3944. Notes on Operating Experience Using the Direct Positive Push-Pull Method of Recording [on Film].—A. C. Blaney. (*Journ. Soc. Mot. Pict. Eng.*, May 1944, Vol. 42, No. 5, pp. 279–282.)

Advantages claimed for this method of recording are:—reduction of noise level, improved reproduction of steep wave-front sounds, and saving of film. For an account of the method *see* p. 479 of Vol. 33 (1939) of same journal.

3945. Report of the Basic Sound Committee on Pre- and Post-Equilization for Studio Use.—(*Journ. Soc. Mot. Pict. Eng.*, Mar. 1944, Vol. 42, No. 3, pp. 188–192.)

A pre-equalizer, which reduces the amplitude of low-frequency signals, is inserted between the recording microphone and modulator. A complementary "post-equalizer" is inserted between the reproducing photo-cell and loudspeaker. The objective is a more uniform energy spectrum to be recorded, permitting greater intensity range. The report recommends a particular frequency characteristic for the equalizers.

3946. Report of the Committee on Sound.—(*Journ. Soc. Mot. Pict. Eng.*, Oct. 1943, Vol. 41, No. 4, pp. 292–296.)

A brief account of a number of technical improvements made in sound engineering. These include the use of directional microphones mounted on "fish-pole" booms, feedback pre-amplifiers, improved fidelity of variable-density recorders, coated lenses, fine grain films, etc.

3947. Anecdotal History of Sound Recording Technique.—W. A. Mueller & M. Rettinger. (*Journ. Soc. Mot. Pict. Eng.*, July 1945, Vol. 45, No. 1, pp. 48–53.)

The history of microphones and accessory equipment in motion picture production.

3948. Sound Recording at the Signal Corps Photographic Center.—G. C. Misener. (*Journ. Soc. Mot. Pict. Eng.*, Sept. 1943, Vol. 41, No. 3, pp. 226–238.)

Describes field and studio recording equipment, with photographs, for the making of army training films. Both duplex track and class AB push-pull variable area recording are used, but the latter is preferred, as it eliminates the need for bulky ground-noise-reduction equipment, and accommodates more adequately original sound of large volume range.

3949. New Lightweight Recording Equipment Serves in the War Effort.—A. R. Davis. (*Journ. Soc. Mot. Pict. Eng.*, June 1944, Vol. 42, No. 6, pp. 327–348.)

An RCA product, used for production of war-training films. It consists of a 2-channel mixer amplifier, main amplifier cabinet, compressor, noise-reduction amplifier, recording amplifier, high- and low-pass filters, and film recorder. A detailed description with many photographs.

3950. Recent Developments in Sound-Tracks.—E. M. Honan & C. R. Keith. (*Journ. Soc. Mot. Pict. Eng.*, Aug. 1943, Vol. 41, No. 2, pp. 127–135.)

Authors' summary:—"Photographs and dimensions are given for a number of types of sound-tracks, some of which are in general use and some being experimental types."

3951. Comparison of Variable-Area Sound Recording Films.—O'Dea. (*See* 4149.)

3952. Sound and Projection Equipment in War Department Theatres.—G. L. Bub. (*Journ.*

Soc. Mot. Pict. Eng., Jan. 1943, Vol. 40, No. 1, pp. 35–51.)

Describes the engineer's problems in providing theatres and projection equipment for the Services.

3953. Recent Developments in Sound Control for the Legitimate Theater and the Opera *and* Sound Control in the Theater Comes of Age.—H. Burris-Meyer. (*Journ. Soc. Mot. Pict. Eng.*, Dec. 1943, Vol. 41, No. 6, pp. 494–499, 500–504.)

Describes tests in actual theatres of the addition of reverberation to the music or speech, by recording and multiple playback. The technique makes possible the performance of any piece in the manner intended by the composer irrespective of the acoustic properties of the theatre (*see* 128 of 1942). The second paper notes some of the implications of its application to the motion-picture.

3954. Motor Noise Unit for Aircraft Trainer [to simulate Noise and Vibration in an Aeroplane].—B. E. Phelps. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 96–99.)

"A multivibrator produces the fundamental tone, three trigger circuits add subharmonic frequencies, and the resultant tone is amplified."

PHOTOTELEGRAPHY AND TELEVISION

3955. Television Broadcasting Practice in America—1927 to 1944.—D. G. Fink. (*Journ. I.E.E.*, Part III, Sept. 1945, Vol. 92, No. 19, pp. 145–160. Discussion, pp. 160–164.)

Author's summary:—"This paper reviews the history of television broadcasting in America from 1927 to the present, with particular emphasis on current practice. Section 1, the historical survey, traces the evolution of standards of transmission, frequency allocations, and broadcasting practice. Noteworthy programmes are recalled. Section 2, on present practice, gives a detailed account of the standards of transmission governing public broadcasting under the current regulations of the Federal Communications Commission. The stations currently operating are listed. Typical equipment used in these stations is described in four categories: studio equipment, transmitters, radiators, and mobile pick-up equipment. The design of current (i.e. immediately pre-war) receiving equipment is described. The paper concludes with a digest of post-war prospects."

The introduction contains a list of definitions of American television terms. "A major difference between British and American television practice lies in the method of modulation employed for the sound transmission. The American standard specifies frequency modulation. . . ." The principal advantage claimed for frequency modulation in this application is mitigation of impulse interference such as arises from the ignition systems of motor cars. Some account is given of experimental work in colour television. "Presumably . . . colour television will not be a factor in the immediate post-war period, although its eventual importance cannot be doubted." The article includes six pages of photographs.

3956. Television in France.—P. Hémardinquer. (*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, pp. 692–693.)

Some television transmissions on German standards were made during the war. Reconversion to the pre-war standards is now taking place; frequencies are 46 Mc/s for vision and 42 Mc/s for sound, and the definition is between 440 and 455 lines, interlaced, at 50 frames per second. The use of 1000 line definition is under consideration.

3957. Proposals for Television and Broadcasting Transmission Systems.—W. A. Beatty. (*Journ. British I.R.E.*, March/April 1945, Vol. 5, No. 2, pp. 54–73. Discussion pp. 73–78.)

The following proposals are made:—

(*a*) Vertically polarised vision-signals and horizontally polarised sound-signals sharing a common frequency spectrum.

(*b*) Introduction of pulse transmission to combat interference.

(*c*) Three-way interlacing to give 640 lines per picture with provision for doubling this.

(*d*) Two methods of frame synchronising to be available which will assist the introduction of colour.

(*e*) Sound transmission pulse to retain up to the 9th harmonic of the pulse repetition frequency. Improvement of signal to noise ratio, over amplitude modulation, of 29 db for random noise and 34 db for car ignition noise is claimed.

It is further claimed that one television transmission, with stereophonic sound, and 21 broadcast sound transmissions can be provided in any one locality.

It is shown that an increase in carrier frequency from 42 Mc/s to 250 Mc/s will reduce the number of required channels from seven to five. The possible advantages of using a large number of low-power transmitting stations in preference to a smaller number of high-power stations are also discussed.

3958. Multipath Interference in Television Transmission.—D. I. Lawson. (*Journ. I.E.E.*, Part III, Sept. 1945, Vol. 92, No. 19, pp. 125–140. Discussion, pp. 140–144.)

The paper is theoretical and is concerned with that kind of television interference which manifests itself as a ghost image or blurring of the main image. It is due to multipath propagation caused by reflections from buildings. Expressions are derived for the elliptical loci of equi-delay reflection points. "The field-strength of reflections from idealized buildings is calculated for various wavelengths of transmission and various distances between the transmitter and receiver. It is concluded that, although the interference increases with frequency, most of it could be eliminated by a simple directive antenna." "It would be an understatement to say that much remains to be done on this problem." Appendices contain calculations of the fields due to reflection in free space and over a reflecting earth, based on Kirchhoff's statement of Huygens' principle.

3959. The Television-Receiver Sound Channel. (*Journ. I.E.E.*, Part III, Sept. 1945, Vol. 92, No. 19, pp. 181–182.)

Summary of a discussion meeting of the Radio Section of the I.E.E.

3960. FM-Tele Standards.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 94–95, 238, 242.)

FCC proposals provide for four classes of television stations to serve districts classified mainly in terms of population. Engineering standards for both television and FM transmissions are given. A two-page paper.

3961. STUDIO TECHNIQUE IN TELEVISION.—D. C. Birkinshaw & D. R. Campbell. (*Journ. I.E.E.*, Part III, Sept. 1945, Vol. 92, No. 19, pp. 165–179, Discussion, pp. 179–181.)

The paper describes the methods used by a production engineer in handling a studio production, illustrated by the application of the technique to a particular play; i.e. the handling of light distribution, composition, background, colour, costume, and so on, so as to make the best use of the characteristics of the sound and vision receiving equipment. It is illustrated by a number of photographs of televised scenes and diagrams of corresponding lighting plots and studio "lay-out". "In the television studio the successful production engineer, while being fundamentally versed in scientific principles, must be capable of escaping from the rigidity of thought which such training engenders, and must possess a flair for appreciating and promoting entertainment value in the picture."

3962. TELEVISION RECEIVER SYMPOSIUM [of the New York Section I.R.E.].—(*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 252..272. Also *Electronic Industries*, July 1945, Vol. 4, No. 7, pp. 80–81.)

A two-page summary of the proceedings under the headings: television frequencies, reflective optics, refractive optics, direct viewing, television receivers, colour television.

3963. BAND-PASS BRIDGED-T NETWORK FOR TELEVISION INTERMEDIATE-FREQUENCY AMPLIFIERS.—Sziklai & Schroeder. (*See* 3819.)

3964. THE GENERAL ELECTRIC TELEVISION FILM PROJECTOR.—E. D. Cook. (*Journ. Soc. Mot. Pict. Eng.*, Oct. 1943, Vol. 41, No. 4, pp. 273–291.)

It is thought that much of the subject material for commercial television programmes will be obtained from current motion picture films. As a frame frequency of 30 per second has been used for television, and 24 per second for sound motion pictures it is necessary to employ a varying frequency of projection, so that the average may remain at 24 frames per second so that standard 35 mm motion picture films can be used. The mechanism used for this purpose is described with the aid of photographs and diagrams.

3965. PROJECTION C.R.O. TUBE.—R. Feldt. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 113, 172..180.)

A description of a new DuMont tube for high-speed photographic recording and projection, that incorporates a modified intensifier principle.

3966. TELEVISION OPTICS.—K. Pestrecov. (*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 80–82, 146, 150.)

A discussion of two methods whereby the image on a television cathode-ray tube may be projected on to a screen. The first uses a refractive lens system. The second consists of a spherical mirror with a correcting lens. *See also* 3587 of November.

3967. COLOUR TELEVISION: PART II.—P. Hémardinquer. (*La T.S.F. pour Tous*, July 1945, Vol. 21, No. 34, pp. 123–124.)

An elementary description of the Scophony and Bell Laboratories' systems. For Part I see *La T.S.F. pour Tous*, June 1945, Vol. 21, No. 33, pp. 92–97.

3968. IMAGE CONTRAST IN TELEVISION.—C. H. Bachman. (*Gen. Elec. Review*, Sept. 1945 Vol. 48, No. 9, pp. 13–19.)

Picture quality is limited mainly by factors in the cathode-ray receiving tube, such as halation, reflection of light from various surfaces, scattered and stray electrons, the finite cross-section of the beam, and spot-size modulation. Image contrast can be improved by careful design of the glass envelope and the use of thin metal screens, translucent to electron beams but opaque to light.

3969. VISUAL DARK ADAPTATION: A MATHEMATICAL FORMULATION.—P. Moon & D. E. Spencer. (*Journ. of Math. & Phys.* [of M.I.T.], May 1945, Vol. 24, No. 2, pp. 65–105.)

3970. WESTINGHOUSE PROPOSES FLYING TELE-FM STATIONS.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 94–95, 234, 238.)

Fourteen planes flying over selected centres would serve 78% of population with four television and five FM programmes simultaneously. A one-page article. (See also *Sci. News Letter*, 25th Aug. 1945, Vol. 48, No. 8, p. 121.)

3971. TELEVISION "MONOPOLY."—W. A. Beatty. (*Wireless World*, Oct. 1945, Vol. 51, No. 10, p. 314.)

A letter suggesting that the production of television equipment should not be limited to firms capable of making a complete system a suggested by the wording of the Report of the Hankey Television Committee. *See* 3002 of September.

MEASUREMENTS AND STANDARDS

3972. TUNED-CIRCUIT, PARALLEL-RESISTANCE SUBSTITUTION APPARATUS FOR MEASUREMENTS ON BALANCED-PAIR CABLES AT FREQUENCIES UP TO 10 Mc/s.—J. C. Simmonds. (*Journ. I.E.E.*, Part I, August 1945, Vol. 92, No. 56, p. 332.)

Summary of 3322 of October.

3973. DISCUSSION ON "THE MEASUREMENT OF BALANCED AND UNBALANCED IMPEDANCES AT FREQUENCIES NEAR 500 Mc/s, AND ITS APPLICATION TO THE DETERMINATION OF THE PROPAGATION CONSTANTS OF CABLES".—(*Journ. I.E.E.*, Part III, Sept. 1945, Vol. 92, No. 19, pp. 218–225.)

See 1113 of April for abstract of original paper.

3974. A MODIFIED INVERTED TRIODE-VALVE VOLTMETER.—H. G. Foster. (*Electronic Eng:g*, Oct. 1945, Vol. 17, No. 212, pp. 731–735.)

A short criticism of existing valve-voltmeter circuits including the slide-back diode, the inverted triode, thermocouple milliammeter and potentiometric methods, followed by a description of a modified inverted triode meter. In this instrument there is no d.c. anode supply, automatic bias is supplied instead of fixed bias, the signal is applied between grid and anode, and a milliammeter is connected in the cathode circuit. Used in this manner the triode acts as a half-wave rectifier in which the anode current is proportional to the applied voltage. A mathematical analysis of the circuit is included. The input impedance is not as high as those of anode-bend or slide-back instruments. The instrument is useful for measuring voltages in the range 125–500 V.

3975. FREQUENCY MEASUREMENT AT U.H.F.—G. A. Hay. (*Electronic Eng:g*, Oct. 1945, Vol. 17, No. 212, pp. 720–721.)

The use of an ordinary communication receiver for measuring frequencies up to 250 Mc/s with an accuracy of about ±0.5%. A beat is obtained between the signal to be measured and a harmonic of the local oscillator of the receiver. Observation of the difference between the two tuning points and knowledge of the intermediate frequency indicates the harmonic order used. The reading of frequency depends on the calibration of the frequency dial of the receiver.

3976. A NEW CALIBRATED OSCILLOGRAPH [for Direct Measurement of Frequency].—P. Nagy. (*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, pp. 688–690.)

See 3595 of November and 3837.

3977. NOMOGRAPH FOR Q METER.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 90–91, 198.)

A nomograph is shown for calculating the effective value of the Q of a reactor connected across the capacitance terminals of a Q-meter.

3978. "ELEKTRISCHE MESSGERÄTE, GENAUIGKEIT UND EINFLUSSGRÖSSEN" [Book Notice].—R. Langbein & G. Werkmeister. (*Zeitschr. f. Instr:kunde*, Oct. 1943, Vol. 63, No. 10, p. 368.)

3979. CUBE-SURFACE COIL FOR PRODUCING A UNIFORM MAGNETIC FIELD.—S. M. Rubens. (*Review Scient. Instr.*, Sept. 1945, Vol. 16, No. 9, pp. 243–245.)

Author's summary :—" A system of five, equally-spaced, square coils which provides a uniform magnetic field over a considerable volume is described. The region of uniformity is easily accessible from outside the coils. The method used to design the system is discussed."

3980. A NEW METHOD TO MEASURE CREST VALUES OF IMPULSE CURRENTS. — H. Norinder. (*Arkiv för Mat., Astron. och Fysik* [Stockholm], 30th Dec. 1944, Vol. 31, Part 2, Section A, No. 13, 16 pp. In English.)

Use is made of a small magnetic link consisting of a permanent-magnetic steel alloy wire 1 cm long and 0.25 mm in diameter. It is magnetized by the field created by the current impulse, and is then used to create a magnetic field in which a system of small coils rotates. The e.m.f. induced in the coils is amplified and used as a measure of the current impulse.

3981. MERCURY JET MAGNETOMETER.—A. Kolin. (*Review Scient. Instr.*, Aug. 1945, Vol. 16, No. 8, pp. 209–214.)

Author's summary :—" Mercury is allowed to flow through a narrow non-conducting pipe provided with two pick-up electrodes at the ends of a diameter. In the presence of a magnetic field an e.m.f. is induced in the moving mercury. The potential difference detected between the electrodes is due to the component of the local magnetic field perpendicular to the pipe axis and to the diameter along which the electrodes are located. The device permits the establishment of the direction of the local field without introduction of a ferromagnetic body which might distort it. The magnetic field intensity in a sharply localized region can be determined. The instrument gives a direct reading proportional to the magnetic field intensity and lends itself to the study of rapidly varying transient fields as well as of constant ones. Fields of less than one oersted can still be easily detected. The magnetic field can be measured absolutely. Two ways of propelling the mercury are described. One of them utilizes gravity, and in the other method electromagnetic forces exerted upon a liquid conductor in a magnetic field are used."

3982. SURVEY OF D-C AMPLIFIERS.—M. Artzt. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 112–118.)

" Analysis of causes of drift in direct-current amplifiers, descriptions of methods used to neutralize or prevent drift, and typical industrial applications."

3983. THE TIME/DEFLECTION CHARACTERISTICS OF MOVING-COIL INSTRUMENTS.—G. F. Tagg. (*Journ. I.E.E.*, Part I, Sept. 1945, Vol. 92, No. 57, pp. 362–365.)

Long summary of 3339 of October.

3984. TEMPERATURE COMPENSATION IN INDICATING AND RECORDING INSTRUMENTS.—G. F. Tagg. (*Journ. I.E.E.*, Part II, Aug. 1945, Vol. 92, No. 28, pp. 334–341. Discussion pp. 341–344.)

An account of the more common methods applied to ammeters, voltmeters, millivoltmeters, wattmeters, and rectifier-operated and thermocouple instruments.

3985. RECTIFIER METERS.—A. H. B. Walker : W. H. Cazaly. (*Wireless World*, Oct. 1945, Vol. 51, No. 10, pp. 314–315.)

Letters on the precautions to be observed in adapting D.C. meters for A.C. operations by the use of external rectifiers. *See also* 2732 of August.

3986. CALIBRATING INSTRUMENTS FOR USE IN VACUUM-TUBE MANUFACTURE.—E. Goddess. (*Communications*, Aug. 1945, Vol. 25, No. 8, pp. 38, 40.)

Method of using a standard cell, resistors and potentiometer for testing ammeters and voltmeters.

SUBSIDIARY APPARATUS AND MATERIALS

3987. THE SCREENING EFFECT OF A CYLINDRICAL TUBE PLACED IN A MAGNETIC FIELD PERPENDICULAR TO ITS AXIS.—J. Laplume. (*Annales de Radioélectricité*, July 1945, Vol. 1, No. 1, pp. 65–73.)

A theoretical paper based on the work of King (1933 Abstracts p. 206) and Gustafson (4414 of 1938). Formulae are derived for the screening against both constant and sinusoidal fields, and numerical examples are worked out. The applications in view are the protection of the electron beam in an electron microscope from the effect of external magnetic fields, and the weakening of the deflecting magnetic field in an oscillograph with metal casing and external deflecting coils.

3988. CATHODE-RAY TUBE TRACES. PART III. —H. Moss. (*Electronic Eng:g*, Oct. 1945, Vol. 17, No. 212, pp. 723–729.)

Circular time bases have uniform speed, no blind spot in the cycle due to fly-back, and require no fly-back mechanism. An account of electrostatic methods of production is given, with a note on the advantages of semi-magnetic methods. Methods of obtaining radial modulation are described. For previous parts *see* 3946 of 1944 *and* 1896 of June.

3989. PROJECTION C.R.O. TUBE.—R. Feldt. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 113, 172..180.)

A description of a new DuMont tube for high-speed photographic recording and projection, that incorporates a modified intensifier principle.

3990. CATHODE RAY TUBE PLOTS OWN CURVES.—(*Electronic Industries*, July 1945, Vol. 4, No. 7, p. 110.)

The characteristic curves of electron tubes are obtained on the screen of a cathode-ray tube equipment developed by Sylvania Electric Products Inc.

3991. ELECTROSTATIC DEPOSITION OF PHOSPHOR POWDERS [gives Greater Uniformity].—(*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 184, 188.)

3992. ELECTRON-MICROPHOTOGRAPHY OF ATOMS.—(*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 276, 280, 284.)

Gold is evaporated on to the sample from an oblique angle. The thickness of the deposit varies with the inclinations of the parts of the specimen. Electron photomicrographs then show surface relief as if the specimen were illuminated from the side. A one-page summary of a lecture by R. C. Williams and R. W. G. Wyckoff. *See also* 887 of March.

3993. AN IONIZATION GAUGE OF SIMPLE CONSTRUCTION.—C. Fogel. (*Phys. Review*, 1st/15th Aug. 1945, Vol. 68, Nos. 3/4, p. 101.)

For measuring pressures 10^{-4} to 10^{-8} mm of Hg. Abstract only.

3994. A VACUUM-METER COMBINATION FOR MEASURING PRESSURES 1 TO 10^{-6} MM HG.—S. von Friesen. (*Arkiv för Mat., Astron. och Fysik* [Stockholm], 10th Dec. 1941, Vol. 27, Part 4, Section B, No. 11, 7 pp. In Swedish.)

A complete instrument containing an ionisation gauge and a Pirani gauge.

3995. SOME MEASUREMENTS OF ULTIMATE VACUUM AND PUMP SPEED OF MOLECULAR PUMPS, PARTS I AND II.—S. Ecklund. (*Arkiv för Mat., Astron. och Fysik* [Stockholm], 10th Feb. 1941, Vol. 27, Part 3, Section A, No. 21, and 13th April 1943, Vol. 29, Part 1, Section A, No. 4. In English.)

3996. "HIGH VACUUM TECHNIQUE" [Book Review].—J. Yarwood. (*Journ. of Scient. Instr.*, Oct. 1945, Vol. 22, No. 10, p. 199.)

3997. A HIGH VACUUM CUT-OFF.—E. J. Serfass & R. F. Muraca. (*Review Scient. Instr.*, Aug. 1945, Vol. 16, No. 8, p. 225.)

3998. MAKING VERY THIN VACUUM-TIGHT GLASS WINDOWS.—S. Rosenblum & R. Walen. (*Journ. of Scient. Instr.*, Oct. 1945, Vol. 22, No. 10, pp. 196–197.)

The process is to blow a bubble thin enough to show interference fringes, on one end of a glass tube. Another tube, 1 to 2 mm. diameter, is brought near the bubble while still hot, and slight suction applied. A window 2 mm. diameter capable of withstanding more than an atmosphere pressure difference is thus formed.

3999. LEAKAGE OF WATER THROUGH TUNGSTEN SEALS.—A. L. Chilcot. (*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, p. 693.)

Water leakage can take place through small tungsten seals in hard borosilicate glass when immersed in steam or water. The exact mechanism is unknown. From *Science Forum*, March 1945, p. 10.

4000. GLASS-METAL COLLABORATION [Metal Films on Glass, Other Examples of Glass-Metal Bonding and Their Applications].—K. Rose. (*Scient. American*, Sept. 1945, Vol. 173, No. 3, p. 168.)

4001. CASCADE H.T. GENERATOR.—R. G. Mitchell. (*Wireless Engineer*, Oct. 1945, Vol. 22, No. 265, pp. 474–483.)

A sequel to 3329 of 1943. The operation of the cascade H.T. generator, built up out of rectifier valves and capacitors, is described and analysed for design purposes. The advantages claimed are that no single component has to withstand the full output voltage and that a range of different voltages can be obtained simultaneously, all with good regulation.

4002. VOLTAGE STABILIZERS.—J. A. Uttal. (*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 90–94, 150.)

A description of a voltage stabiliser of inductor-capacitor type accepting a supply voltage of 95 to 130 volts and delivering a voltage of 115 volts, which is constant to better than $\pm$ 1%.

4003. HARMONIC SUPPRESSION FOR AIRCRAFT GENERATORS.—F. W. Jaksha. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 124–125.)

A procedure for designing a series-resonant filter to reduce the harmonic content of the output from 400 c/s and higher-frequency aircraft and marine generators. The third harmonic requires maximum suppression.

4004. ALTERNATING-CURRENT EQUIPMENT FOR AIRCRAFT.—(*Engineering*, 3rd Aug. 1945, Vol. 160, No. 4151, p. 92.)

United States tentative specification suggests three-phase 208 volts and 400 c/s. A discussion of the advantages and disadvantages.

4005. "THE ELECTROLYTIC CAPACITOR" [Book Review].—A. M. Georgiev. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, p. 727, and *Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 210, 212.)

". . . a very practical up-to-date treatment of the subject."

4006. CERAMIC DIELECTRIC AND INSULATOR MATERIALS FOR RADIO AND RADAR INSTRUMENTS.—R. L. Stone. (*North Carolina State College Record*, May 1943, Vol. 42, No. 3, 63 pp.)

A general survey is given of the information available relating to ceramic materials used for dielectrics and insulators. Many different types of ceramics are considered, with details of their mechanical, physical and electrical properties, together with an outline of the occurrence of the natural materials, their mining, manufacture, and the effects of processing methods on their electrical properties. An appendix gives the American War Standard for Ceramic Radio Dielectric Materials Class H and the American War Standard for Ceramic Radio Insulating Materials Class L.

4007. HIGH CAPACITY PORTABLE INSULATION TESTER.—(*Review Scient. Instr.*, Aug. 1945, Vol. 16, No. 8, pp. 227–228.)

The tester has a capacity of 750 VA, and will stand one-minute loads of 1500 VA, at test voltages up to 2500.

4008. RESISTANCE OF GLASS TO THERMAL SHOCK.—C. D. Oughton. (*Journ. Soc. Mot. Pict. Eng.*, Oct. 1943, Vol. 41, No. 4, pp. 351–357.)

Resistance of glass to thermal shock may be increased by the controlled introduction of strain, as for example in projection lenses, in which the surfaces are placed under compression.

4009. SOLARIZATION [Deterioration of Glass in Ultra-Violet Lamps: Vicor Glass transmits Ultra-Violet but does not solarize].—H. C. Rentschler. (*Scient. American*, Sept. 1945, Vol. 173, No. 3, p. 174, 176–177.)

4010. " PLASTICS IN PRACTICE " [Book Review].—J. Sasso & M. A. Brown. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, p. 212.)

" A large list of sources of information is included . . . "

4011. PROPERTIES OF PLASTICS [in Tropical Conditions].—S. Rogerson: W. J. Tucker: P. I. Smith. (*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, p. 698.) Correspondence arising from 3044 of September and 3359 of October.

4012. TROPIC-PROOF COMPONENTS: A READER'S EXPERIENCE [in Malaya].—R. C. Joyce. (*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, p. 698.)

4013. PLASTIC SANDWICHES [using Resin-Impregnated Glass Cloth Laminated with Other Materials: Properties and Tests].—(*Scient. American*, Sept. 1945, Vol. 173, No. 3, pp. 155–158.)

4014. BATTERY SEPARATORS [made of Fiberglas Mats].—(*Scient. American*, Sept. 1945, Vol. 173, No. 3, p. 158.)

Short note only.

4015. CUBE-SURFACE COIL FOR PRODUCING A UNIFORM MAGNETIC FIELD.—Rubens. (*See* 3979.)

4016. NOMOGRAPH FOR COILS [for determining the Length of Wire to fill a Given Spool].—(*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 78–79.)

4017. HIGH-Q IRON-CORED INDUCTOR CALCULATIONS.—S. L. Javna. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 119–123.)

Equations are derived for the condition of maximum Q, and are used to calculate core and coil dimensions for maximum Q, given required inductance, maximum overall dimensions and operating voltage and frequency. The effect of varying the inductor parameters is discussed, and numerical examples are worked out.

4018. THE DESIGN OF IRON-CORED TRANSFORMERS WITH SPECIFIED SELF AND MUTUAL INDUCTANCES.—J. O. G. Barrett. (*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, pp. 676–678.)

If two coils are wound, one on each of the two side limbs of an iron core composed of E and I stampings, the mutual inductance between them is approximately independent of the air gap in the iron circuit, but the self-inductances vary with the gap.

If two coils L_1 and L_2 are wound on one limb, and one coil L_3 on the other, by adjusting the relative magnitudes of L_1, L_2 and L_3, and choosing the right direction of winding, it can be arranged that the series combination of L_1 and L_3 and the single coil L_2 shall have any desired values, while the coupling factor can be controlled over practically the whole range from zero to unity.

4019. MAGNETIC POWDERS.—H. G. Shea. (*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 86–89, 186..202.)

A general description of the nature and uses of iron powder cores for radio-frequency coils.

4020. EFFECT OF SMALL STRESSES ON MAGNETIC PROPERTIES [of Ferromagnetic Materials].—Bozorth & Williams. (*See* 4077.)

4021. FERROMAGNETIC IMPURITIES IN METALS.—Constant. (*See* 4076.)

4022. SCHOTTKY'S THEORIES OF DRY SOLID RECTIFIERS.—J. Joffe. (*Elec. Communication*, 1945, Vol. 22, No. 3, pp. 217–225.)

An account of Schottky's views as expounded in papers published in the years 1939–42. *See* 2092 of 1942 and back references.

4023. SELENIUM RECTIFIERS FOR AIRCRAFT.—(*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, p. 77.)

A brief account of a paper by A. L. Embry for the A.I.E.E. spring programme.

4024. COPPER-CUPROUS OXIDE RECTIFIER.—K. R. Dixit.—(*Current Science* [Bangalore], June 1945, Vol. 14, No. 6, pp. 143–144.)

The method of making rectifier elements is described in detail, and some factors determining the performance are mentioned. Pure copper blanks are oxidised in air at 1020° C, and allowed to cool slowly. The black cupric oxide layer is removed chemically, and an electrical contact made on to the thicker red cuprous-oxide layer by rubbing in powdered graphite and sputtering on a metal film.

4025. HIGH-SPEED [up to 1200 wpm] CODE RECORDING.—(*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 230, 234, 238.)

An inked-tape recorder that can be connected to the output of any communication receiver. A one-page article.

4026. UNITED AIR LINES' REPERFORATOR SWITCHING SYSTEM.—R. E. Hanford. (*Elec. Communication*, 1945, Vol. 22, No. 3, pp. 203–211.)

A description of a system providing "exceptionally expeditious handling of point-to-point telegraph traffic". Each message is transmitted manually only once. All retransmission is automatic, and requires only a switching operation.

4027. SYNCHRO CONTROLS FOR METERS AND SERVOS —R. Goertz. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 78–83, 180..194.)

The basic principles of synchro data systems, in which angular shaft position information may be transmitted electrically, are described. Circuit arrangements are given showing the use of the control transformer that delivers a signal based on armature position, and of the synchro differential generator whereby the sum or difference of two angular rotations may be transmitted. Two-speed systems using "fine" and "coarse" synchros are explained and some notes on demodulators are added. A seven-page paper.

4028. ELECTRONIC COUNTER.—(*Review Scient. Instr.* Aug. 1945, Vol. 16, No. 8, p. 227.)

"A new two-decade counter, designed for industrial and laboratory uses, is actuated by a closing contact, sine wave, or pulse input (as from a photocell) at rates up to 1000 cps . . ."

4029. QUARTZ CRYSTAL IMPROVEMENTS [Advance of Manufacturing Techniques due to Wartime Needs].—C. W. Franklin. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 130–131.)

4030. ANALYSERS FOR USE IN ENGINEERING AND SCIENTIFIC PROBLEMS.—H. A. Peterson & C. Concordia. (*Gen. Elec. Review*, Sept. 1945, Vol. 48, No. 9, pp. 29–35.)

Four types are reviewed. Three are based respectively on d.c., a.c., and transient electrical networks, and the fourth is the differential analyser. The uses of the analysers are discussed with special reference to power system and electrical machinery problems and the special properties of the various types and the differences between them are stressed. An extensive bibliography is provided.

4031. ADHESIVE FOR STICKING RUBBER TO METAL. —A. Jarrijon & P. Louïa. (*Génie Civil*, 1st July 1945, Vol. 122, No. 13, p. 104.)

Summary of a paper in *Revue générale du Caoutchouc*, January 1945.

4032. THERMISTOR TECHNICS. — Johnson. (*See* 3845.)

4033. THE CALCULATIONS OF [the Deflection, the Maximum Internal Stresses, and the Capacity for Work with Changes in Temperature of] BIMETALS.—W. Wuest. (*Zeitschr. f. Instr: kunde*, Oct. 1943, Vol. 63, No. 10, pp. 365–366.)

Abstract of *Messtechnik*, 1942, Vol. 19, pp. 185–188.

4034. THE INVESTIGATION OF OSCILLATION PHENOMENA WITH A PROJECTION PERIODOGRAPH. —W. Meyer-Eppler. (*Zeitschr. f. Instr: kunde*, Oct. 1943, Vol. 63, No. 10, pp. 341–355.)

Description of the theory, construction and operation of an instrument very similar to that described in 2854 of 1942.

4035. SCRATCH ADHESION AND MAR TESTING OF ORGANIC FINISHES.—R. J. Phair. (*Bell Lab. Record*, Aug. 1945, Vol. 23, No. 8, pp. 284–286.)

A simple method of measuring the adhesion and mar resistance of an organic finish is described. A loaded stylus mounted on a pivoted beam is brought into contact with the specimen, and the specimen is then moved by means of a carriage. The load is increased until rupture of the film is observed microscopically.

STATIONS, DESIGN AND OPERATION

4036. "INTERNATIONAL CONTROL OF RADIO COMMUNICATIONS" [Book Review].—J. D. Tomlinson. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, p. 210.)

A history of the subject especially in relation to social science.

4037. FREQUENCY ALLOCATION FOR LONG-DISTANCE COMMUNICATION CHANNELS [Over 1000 Miles].—(*Journ. I.E.E.*, Part III, Sept. 1945, Vol. 92, No. 19, pp. 234–235.)

Discussion, chiefly on 10–300 kc/s and 3–30 Mc/s, opened by R. L. Smith-Rose, whose chief contention was that only in very exceptional cases should frequencies in the 3–30 Mc/s range be allocated for purposes other than long distance communication, for which they were the only usable high frequencies.

4038. FREQUENCY ALLOCATIONS FOR THEATER TELEVISION.—(*Journ. Soc. Mot. Pict. Eng.*, July 1945, Vol. 45, No. 1, pp. 16–19.)

The Federal Communications Commission granted allocations of frequencies for experimentation of theatre television on a "parity of opportunity" basis with television broadcasting. A tabulation of allocations is given.

4039. 44–108 Mc ALLOCATIONS.—(*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 84–85.)

A discussion of the new F.C.C. frequency allocations.

4040. A PLAN FOR BETTER RADIO LISTENING: NEW WAVELENGTH SCHEME PROPOSED BY THE RADIO INDUSTRY.—(*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, p. 690.)

Short summary of 3667 of November. See also *Electrician*, 10th Aug. 1945, Vol. 135, No. 3506, pp. 137–138.

4041. PLAN FOR AN INTERNATIONAL RADIO SERVICE FOR EUROPE.—(*Tech. Mitteilungen*, 1st Aug. 1945, Vol. 23, No. 4, p. 191. In German.)

Note on a plan proposed by Hubert, Eckersley and Tenenbaum. *See* 3645 of 1944.

4042. THE MÜNCHENBUCHSEE RADIOTELEGRAPH STATION IN 1945 [Descriptive Details of the 11 Transmitters Used in the European and North American Services].—(*Bull. Assoc. Suisse des Élec.*, 19th Sept. 1945, Vol. 36, No. 19, pp. 656–657. In French.)

4043. Technical Development of Broadcasting in Switzerland.—E. Metzler. (*Tech. Metteilungen*, 1st Aug. 1945, Vol. 23, No. 4, pp. 169–179. In both German and French.)

An historical discussion dealing particularly with the allocation of frequencies and the special reception difficulties encountered due to the screening effect of mountains between transmitter and receiver.

4044. The Swiss Broadcasting Service.—(*Bulletin Assoc. Suisse des Élec.*, 3rd Oct. 1945, Vol. 36, No. 20, pp. 682–683.)

Extracts from the fourteenth annual report: number of listeners: past and future programmes.

4045. Radio-Suisse.—(*Tech. Mitteilungen*, 1st Aug. 1945, Vol. 23, No. 4, pp. 190–191. In French.)

The maintainance of international communications during 1944 resulting from Switzerland's neutral status.

4046. G.P.O. Developments: Progress during the War.—(*Elec. Review*, 19th October 1945, Vol. 137, No. 3543, p. 557.)

A summary of the inaugural address given by A. H. Mumford, as chairman of the Radio Section, I.E.E. The erection of an auxiliary 16 kc/s high-power transmitter. The design of equipment for simulating the signals received over long transmission paths, and its use in the study of fading phenomena and in the design of receiving equipment. The development of U.H.F. radio links for multichannel communications.

4047. Frequency Modulation.—K. R. Sturley. (*Journ. I.E.E.*, Part III, Sept. 1945, Vol. 92, No. 19, pp. 197–213, Discussion, pp. 213–218.)

The paper gives a comprehensive historical and technical survey of the present position of frequency modulation, and its relation to amplitude modulation, with a bibliography of sixty-two items and a list of thirty-one patents. The author concludes that " frequency modulation is likely to find application in four fields, namely, point-to-point and mobile telephonic communication, high-fidelity audio broadcasting, television and duplex transmission ". The latter is referred particularly to combined telephony and telegraphy or facsimile, the former modulating the amplitude and the latter the frequency of a supersonic frequency which is in turn used to modulate the carrier frequency.

4048. FM–Tele Standards.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 94–95, 238, 242.)

FCC proposals provide for four classes of television stations to serve districts classified mainly in terms of population. Engineering standards for both television and FM transmissions are given. A two-page paper.

4049. F.M. Power Converter.—Gunther. (*See* 3850.)

4050. Measurement Technic.—H. D. Evans. (*Electronic Industries*, July 1945, Vol. 4, No. 7, pp. 90–93, 194, 198.)

A three months' programme of monitoring a selected group of broadcasting stations was launched in June to determine the amount of interference that will be encountered in future FM broadcasting. The effects to be investigated are ground radiation, shadows, sporadic E, and tropospheric effects. The programme is designed to determine which of three alternative allocations in the 44-108 Mc/s region will best serve the public.

4051. Westinghouse Proposes Flying Tele-FM Stations.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 94–95, 234, 238.)

Fourteen planes flying over selected centres would serve 78% of population with four television and five FM programmes simultaneously. A one-page article. (See also *Sci. News Letter*, 25th Aug. 1945, Vol. 48, No. 8, p. 121.)

4052. Extra-Terrestrial Relays.—A. C. Clarke. (*Wireless World*, Oct. 1945, Vol. 51, No. 10, pp. 305–309.)

The possibilities are discussed of providing rocket stations in outer space to serve as broadcast relay stations with world-wide coverage. A scheme is visualised in which three such stations are used, each fixed relative to the earth and rotating with it.

4053. Army FM Mobile Unit.—(*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, p. 111.)

A brief description of the U.S. Army radio set SCR-619, an FM voice communication set.

4054. Signal Corps Radio Relay in North Africa: the First Application of a V.H.F. Radio Relay System to Military Operation.—Perkins & Middleton. (*See* 3781.)

4055. Sigcircus—P-563.—(*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 107, 138, 142.)

A description of the largest mobile radio station yet built. It is rated at 60 kW and was built for the Communications Division of the U.S. Army.

4056. Multi-Channel High-Speed Communications with Standard Radio Equipment. W. M. Ross. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 238..250.)

A one-page article.

4057. Developments in Carrier Telegraph Transmission in Australia.—R. E. Page & J. L. Skerrett. (*Elec. Communication*, 1945, Vol. 22, No. 3, pp. 226–245.)

Reprint of a paper in *The Telecommunication Journal of Australia*, June 1944. An historical introduction followed by a description of the " Type B " carrier telegraph system, and a discussion of voice-frequency systems, frequency allocation, and multi-channel voice-frequency systems.

4058. 8-Channel Carrier Systems for Unloaded Cables [Part II].—S. Janson. (*Ericsson Review*, 1945, No. 2, pp. 43–58.)

Methods and apparatus are described for resplicing the cable and for balancing crosstalk. Details of the characteristics and design of the carrier equipment are given. *See* 3684 of November for Part I.

4059. Wire-Broadcasting.—P. Adorjan. (*Journ. Roy. Soc. Arts*, 31st Aug. 1945, Vol. 93, No. 4699, pp. 511–522.

A general account is given of the history of wire-broadcasting, and its development in various countries, with a comparison between audio-frequency and radio-frequency methods of distribution. It is claimed that wire-broadcasting gives better reproduction, more freedom from interference and greater reliability of service than is obtained by radio reception. *See also* 3553 of November.

4060. STUDIO AND CONTROL-ROOM DESIGN [for Student-Operated College Broadcast Systems].—W. R. Hutchins. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 126–129.)

4061. MORE ABOUT POSTWAR STATION CALLS: REVISION OF PROPOSED CALL AREAS ADOPTED BY [ARRL] BOARD AND SENT TO FCC.—C. A. Service, Jr. (*QST*, Sept. 1945, Vol. 29, No. 9, pp. 20, 82.)

4062. AMATEUR TRANSMISSION.—"Etheris." (*Wireless World*, Oct. 1945, Vol. 51, No. 10, pp. 296–298.)

The pre-war frequency bands used by amateurs are at present used by the services for various purposes, some of which will be useful in peacetime. The prospects for the restoration of their pre-war frequency bands to amateurs are discused, together with the best ways of making full use of such bands.

4063. A FRESHMAN'S GUIDE TO AMATEUR RADIO: PART VI—CALL SIGNS, QSL CARDS AND CERTIFICATES.—A. O. Milne. (*R.S.G.B. Bull.*, Oct. 1945, Vol. 21, No. 4, pp. 54–55.)

4064. RAILROAD RADIO LAB. [Photographs of Radio Test Gear installed in a Pullman Car].—(*Electronic Industries*, July 1945, Vol. 4, No. 7, p. 105.).

4065. NEW [British] RAILWAY RADIO STATIONS.—(*Tech. Mitteilungen*, 1st Aug. 1945, Vol. 23, No. 4, p. 191. In French.)

4066. RADIO FOR EMERGENCY USE IN MINING OPERATION [Incorporating a 60 W F-M Transmitter on 35–46 Mc/s].—(*Electronics*, Aug. 1945, Vol. 18, No. 8, p. 152.)

GENERAL PHYSICAL ARTICLES

4067. PHYSICS AND RADIO.—E. N. da C. Andrade. (*Journ. British I.R.E.*, March/April 1945, Vol. 5, No. 2, pp. 47–53.)

An account of the physical bases of radio, and the history of some relevant discoveries. Particular attention is paid to the physics of the ionosphere and many parallels are drawn between radio and optics.

4068. A GENERALIZATION OF THE DIELECTRIC ELLIPSOID PROBLEM.—R. Clark Jones. (*Phys. Review*, 1st/15th Aug. 1945, Vol. 68, Nos. 3/4, pp. 93–96.)

Author's summary:—"The classical problem of the dielectric ellipsoid involves the determination of the field within a homogeneous, isotropic, dielectric ellipsoid when it is placed in a uniform electric field. In the present generalization, both the ellipsoid and the medium in which it is placed, although still homogeneous, are anisotropic and also possess conductivities which are anisotropic. The principal axes of the ellipsoid, of the two dielectric tensors, and of the two conductivity tensors, may all be differently orientated. The external field, although uniform in space, varies sinusoidally with time. The condition specified in the last sentence is consistent with the electromagnetic field equations only in a region whose maximum dimension is small compared with $\lambda/2\pi$ where λ is the wavelength which corresponds to the frequency in question. Thus the solution given here is restricted by the condition that the maximum dimension of the ellipsoid must be small compared with $\lambda/2\pi$."

4069. AN INTERESTING ELECTRODYNAMICAL PROBLEM.—G.W.O.H. (*Wireless Engineer*, Oct. 1945, Vol. 22, No. 265, pp. 469–473.)

A further contribution to the discussion of the "paradox" of the Biot-Savart Law referred to in 2826 of August. It is shown that the apparent paradox is due to postulating an isolated current element—"seeing that isolated elements are contrary to nature, they cannot be expected to conform to natural laws". The anomaly disappears when the element formula is integrated round a complete circuit. Two other apparently paradoxical experimental results are examined, and it is concluded that "if properly applied, the ordinary laws of electrodynamics explain all the phenomena here considered without any trace of paradox".

4070. TRIDIMENSIONAL EQUIVALENT CIRCUITS.—G. M. Krijanovsky. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, p. 723.)

A letter referring to the work of Kron and others (2123, 2124 and 2838 of 1944) on the approximate solution of Maxwell's equations, and giving a bibliography of Russian work on the subject.

4071. SCHOTTKY'S THEORIES OF DRY SOLID RECTIFIERS.—J. Joffe. (*Elec. Communication*, 1945, Vol. 22, No. 3, pp. 217–225.)

An account of Schottky's views as expounded in papers published in the years 1939–42. *See* 2092 of 1942 and back references.

4072. ACCELERATIONAL - VELOCITAL MAGNETIC FORCES.—F. W. Warburton. (*Phys. Review*, 1st/15th Aug. 1945, Vol. 68, Nos. 3/4, p. 100.)

Expressions for the mutual force of one charge on another containing the product of the velocity of one charge and the acceleration of the other.

4073. THE STATISTICAL PROPERTIES OF UNPOLARIZED LIGHT.—H. Hurwitz, Jr. (*Journ. Opt. Soc. Am.*, Aug. 1945, Vol. 35, No. 8, pp. 525–531.)

Author's summary:—"In a beam of monochromatic unpolarized light the electric field vector at a point traces out an ellipse whose size, eccentricity, and orientation are slowly varying functions of time. The statistical properties of the parameters of this ellipse are investigated. It is shown that the quantity S which is defined as twice the product of the principal axes of the ellipse divided by the sum of the squares is uniformly distributed between zero and one. It therefore has median value $\frac{1}{2}$ which corresponds to a ratio of minor to major axis equal to .268. Hence fairly thin ellipses predominate. The square root of the sum of the squares of the semi-major and semi-minor axes, R, is statistically independent of S and has the distribution function $(r^3/2p^4) \exp(-r^2/2p^2)$ where $2p^2$ is the average value of R^2."

4074. Virtues and Weaknesses of the Domain Concept [in Ferromagnetic Theory].—W. F. Brown, Jr. (*Reviews of Mod. Phys.*, Jan. 1945, Vol. 17, No. 1, pp. 15–19.)

The "domain" or "regional" concept of the magnetisation process has no satisfactory theoretical basis, being postulated to reconcile with theory four different sets of experimental phenomena which, in themselves, are not clearly related to each other. This gives rise to four separate domain concepts, the standard domain is then based on a suitable combination of the properties of the other four in a way convenient for calculation. The usefulness of the domain concept is thus limited and detailed analyses based on it are of doubtful value. The author recommends that more effort be directed to the understanding of the factors determining the microscopic distribution of magnetisation.

4075. A Survey of the Theory of Ferromagnetism.—J. H. Van Vleck. (*Reviews of Mod. Phys.*, Jan. 1945, Vol. 17, No. 1, pp. 27–47.)

The development of the theory of ferromagnetism is outlined, beginning with the Weiss Theory of the molecular field, its modification by the introduction of quantum mechanics and the concept of electron spin. A comparison is made between the theory of Heisenberg based on an atom in which the electrons responsible for the ferromagnetism always remain on the same atom, taking no part in electrical conduction, and the theory as developed by Stoner in which the electrons circulate independently and freely from one atom to another. Both theories give reasonable explanations of various phenomena, for example the behaviour of saturation below the Curie point, and the results in the limiting cases do not differ much from each other.

4076. Ferromagnetic Impurities in Metals.—F. W. Constant. (*Reviews of Mod. Phys.*, Jan. 1945, Vol. 17, No. 1, pp. 81–86.)

The magnetic properties of a metal containing small amounts of a ferromagnetic impurity will depend upon the heat treatment, the mechanical treatment, and whether the impurity is wholly or partially in solution with, or exists as inclusions between the crystals of, the metal. Measurements of these magnetic properties after various forms of heat and mechanical treatment give a better understanding of the solid state and ferromagnetism.

4077. Effect of Small Stresses on Magnetic Properties [of Ferromagnetic Materials].—R. M. Bozorth & H. J. Williams. (*Reviews of Mod. Phys.*, Jan. 1945, Vol. 17, No. 1, pp. 72–80.)

A small cyclic stress applied to a magnetic material causes a cyclic change in induction proportional to the stress and to the value of the polarising induction. From a consideration of the domain theory, the strain sensitivity, defined as $(dB/d\sigma)_{\sigma=0}$, in which B is the change in induction caused by a change stress $d\sigma$, is shown to be dependent upon the more fundamental constants of saturation magnetostriction, saturation magnetisation and crystal anistropy. This is verified by experiments on 45 Permalloy and on the iron-nickel series of alloys.

4078. Magnetization of Gold-Iron and Gold-Nickel Solid Solutions.—A. R. Kaufmann, S. T. Pan & J. R. Clark. (*Reviews of Mod. Phys.*, Jan. 1945, Vol. 17, No. 1, pp. 87–92.)

Measurements made at high and low temperatures and with high magnetic fields show a marked difference in the behaviour of iron and nickel when dissolved in gold. The iron atoms in dilute alloys have a large magnetic moment and a susceptibility that varies rapidly with temperature. Nickel atoms appear to lose their magnetic moment, and the susceptibility varies less with temperature but in a more complex manner. The iron alloys become ferromagnetic with only 8 atomic per cent iron, while the nickel alloys require 40 atomic per cent nickel to become ferromagnetic. It is also shown that gold and copper are approximately equivalent when alloyed with iron or nickel.

4079. Effect of Excitation Frequency on Spectrum of Gaseous Discharges.—K. J. Hayes, J. G. Winans & W. Culp. (*Phys. Review*, 1st/15th Aug. 1945, Vol. 68, Nos. 3/4, p. 98.)

Abstract only.

4080. The Light-Effect under Electric Discharge: The Probability of Recombination.—B. K. Sahay. (*Current Science* [Bangalore], May 1945, Vol. 14, No. 5, pp. 122–123.)

The light effect is in the nature of a negative photo-electric effect. The conductivity of gases like chlorine, when subjected to ionisation by collision under alternating electric fields, diminishes immediately on irradiation.

4081. On the Cathode Dark-Space of a Glow Discharge in Gases at Low Pressures.—R. M. Chaudhuri & S. H. Zuberi. (*Indian Journ. of Phys.*, Dec. 1944, Vol. 18, No. 6, pp. 333–340.)

Authors' summary:—"Experiments have been performed with a movable anode in a discharge tube. It is observed that the tube voltage and current show no variation as the anode is brought closer to the cathode till the former cuts out a certain length of the negative glow. If the anode is pushed further the current decreases while the voltage to maintain a smaller current rises continuously. The drop in the current is linear with the displacement of the anode till it reaches a point near the edge of the cathode dark-space.

"It is concluded from the experimental curves that there is always a supply of the positive ions to the cathode dark-space from the negative glow which is not consistent with Thomson's assumptions." A summary in the form of a letter is in *Current Science* [Bangalore], June 1945, Vol. 14, No. 6, p. 149.

4082. Rotation of Electrolyte between Insulated Poles of Magnet.—(*Science*, 13th July 1945, Vol. 102, No. 2637, pp. 45–46.)

Demonstration that the observed rotation (as reported by Ehrenhaft) is due to convection currents in the liquid, and is not dependent on the presence of a magnetic field. *See* 3655 of 1944 and back references.

4083. Rotating Action on Matter in a Beam of Light.—F. Ehrenhaft. (*Science*, 29th June 1945, Vol. 101, No. 2635, pp. 676–677.)

4084. The History of Atomic Disintegration.—N. Feather. (*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, pp. 668–670.)

4085. Surfaces of Solids in Science and Industry.—W. D. Harkins. (*Science*, 14th Sept. 1945, Vol. 102, No. 2646, pp. 263–268.)

The surface areas of finely divided solids can be determined by measurement of the surface energy of a thin film of liquid adsorbed by the solid. The energy is measured by a calorimetry method and surface areas of fine crystalline solids have been measured in this way, using water or nitrogen as the adsorbed material.

MISCELLANEOUS

4086. Three-Dimensional Fourier Transforms and Their Application to Maxwell's Equations.—F. T. Adler. (*Journ. Applied Phys.*, Sept. 1945, Vol. 16, No. 9, pp. 545–550.)

Author's summary:—"Boundary value problems in regions with rectangular symmetry can be treated by means of the finite Fourier Transform. Transforms of vector point functions and their divergence and curl are obtained. The transforms of Maxwell's equations take a particularly simple form; the resonator problem is discussed as an example."

4087. "Introduction à l'Étude des Champs physiques" [Book Review].—J. Granier. (*Proc. Phys. Soc.*, 1st Sept. 1945, Vol. 57, Part 5, No. 323, p. 445.)

". . . a general treatment of steady-state boundary problems where the differential equation is that of Laplace or of Poisson. . . . The treatment is relatively elementary, and is confined in the main to problems in two dimensions, or those with spherical symmetry . . ."

4088. On the Spherical and Spheroidal Wave Functions.—O. E. H. Rydbeck. (*Chalmers Tekniska Högskolas Handlingar* [Gotenburg], 1945, No. 43, 33 pp. In English.)

This is a mathematical treatise developing in a systematic way some of the main types of solution of the n-dimensional Laplacian $\Delta_n{}^2 V = 0$, in the form of hyper-spherical (n-dimensional), spherical (3-dimensional), and circular (2-dimensional) functions, and a similar range of spheroidal functions. It is a very generalised treatment, embodying a number of results obtained by Gegenbauer, Van der Pol, Nielsen and others as special cases. In an application to wave-guides it is stated that if a circular wave-guide is deformed to an elliptical section the cylindrical wave splits into even and odd elliptic waves having different phase velocities and capable of producing axial interference effects. Therefore, as originally pointed out by Chu (4208 of 1938), waves in circular pipes tend to be unstable under slight deformation.

4089. The Driving-Point Impedance of an Infinite Solid Plate.—R. Clark Jones. (*Journ. Acous. Soc. Am.*, July 1945, Vol. 17, No. 1, p. 100.)

Short abstract.

4090. "Formulaire pour le Calcul Symbolique" [Book Review].—N. W. McLachlan & P. Humbert. (*Wireless Engineer*, Oct. 1945, Vol. 22, No. 265, p. 499.)

". . . a book of reference for those who are skilled in the use of operational calculus and wish to know the operational forms for the various functions."

4091. "Die Mathematik des Naturforschers und Ingenieurs. Bd. I. Differential- und Integralrechnung" [Book Review].—B. Baule. (*Zeitschr. f. Instr:kunde*, Oct. 1943, Vol. 63, No. 10, p. 368.)

The first of seven comprehensive volumes.

4092. Fundamental Scientific Research.—E. V. Appleton. (*Journ. Council for Scientific & Industrial Research* [Australia], Aug. 1944, Vol. 17, No. 3, pp. 208–210.)

Extracts from an address given to the Chamber of Commerce, Manchester. *See also* 2372 of 1944.

4093. British Radio Research.—(*Elec. Review*, 26th Oct. 1945, Vol. 137, No. 3544, p. 591.)

A short account of a lecture by Sir Edward Appleton before the French Society of Radio Electricians.

4094. Research.—(*Science*, 14th Sept. 1945, Vol. 102, No. 2646, pp. 282–283.)

A quotation from an address to Congress by President Truman in which he stressed the need for a large centralised research establishment financed by the Government.

4095. Science, the Endless Frontier.—(*Journ. Applied Phys.*, Sept. 1945, Vol. 16, No. 9, pp. 487–490.)

Summary of Vannevar Bush's reply to President Roosevelt's four questions. For other summaries see *Review Scient. Instr.*, Aug. 1945, Vol. 16, No. 8, pp. 231–237, and 3738 of November.

4096. A Permanent Standards Organisation.—(*Science*, 24th Aug. 1945, Vol. 102, No. 2643, pp. 191–192.)

The Executive Committee of the United Nations Standards Co-ordinating Committee have invited the standardising bodies of a number of countries to a meeting to establish closer relations.

4097. Postwar Engineering.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 74–76.)

The probable effect on communications and electronics of the technological advances brought about by the war.

4098. Technical Education.—(*Elec. Review*, 5th Oct. 1945, Vol. 137, No. 3541, p. 481.)

Some domestic and practical aspects are discussed, including the need to leave ample room for expansion when equipping a laboratory. The importance of mastering the English language, both written and spoken, is emphasised, and it is pointed out that films should amplify but never replace laboratory work.

4099. Technical Education Plus the Humanities Makes a Better Engineer.—A. R. Stevenson, Jr. (*Gen. Elec. Review*, Sept. 1945, Vol. 48, No. 9, pp. 7–9.)

The practising engineer should broaden his outlook by post-graduate study of cultural subjects. Most senior engineers deal more with human than with technical problems, and overspecialization in study is the wrong approach to this type of work. Security, prestige and wealth should be the by-products, not the aims, of a vigorous life.

4100. SELECTION OF STAFF BY MEANS OF INTELLIGENCE AND APTITUDE TESTS: DISCUSSION. —R. C. Woods & A. S. MacDonald. (*Journ. I.E.E.*, Part I, Sept. 1945, Vol. 92, No. 57, pp. 354–357.)

See also 3161 of September.

4101. I.R.E. SPECIAL COMMITTEE ON OBTAINING MEMBERSHIP TALENTS AND VOLUNTEER SERVICE.—E. F. Carter. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, pp. 639–640.)

Report of a committee set up by I.R.E. "for the purpose of obtaining membership talents and volunteer service to aid in broadening participation in various Institution activities".

4102. RESPONSIBILITY OF THE RADIO ENGINEER TO THE ENGINEERING PROFESSION.—H. W. Sundius. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, p. 637.)

Editorial. The radio engineer *is* an engineer: much benefit to the whole profession would accrue if he took part in organizations such as local "combined engineering councils" existing in America.

4103. DESIGN AND MAINTENANCE.—J. H. M. Sykes. (*Elec. Review*, 5th Oct. 1945, Vol. 137, No. 3541, pp. 482–483.)

Closer contact between designers and users would obviate a good deal of maintenance work. Designers should consider maintenance expenses as well as initial cost.

4104. ELECTRICAL SAFEGUARDS.—(*Elec. Review*, 7th Sept. 1945, Vol. 137, No. 3536, pp. 335–337.)

A summary of "Electrical Accidents", the annual report of the Senior Electrical Inspector of Factories, which analyses the causes of electrical accidents and suggests safety measures.

4105. "MANUAL OF SPECIAL LIBRARY TECHNIQUE" [Book Review].—J. E. Wright. (*BEAMA* Journal, Sept. 1945, Vol. 52, No. 99, p. 301.)

". . . a thoroughly sound little book . . ."

4106. "ANNALES DE RADIOÉLECTRICITÉ."—(July 1945, Vol. 1, No. 1.)

A new periodical published on behalf of the companies associated with Compagnie Générale de T.S.F. It is not on sale through commercial channels.

4107. "ELECTROMAGNETIC ENGINEERING (VOL. 1, FUNDAMENTALS)" [Book Review].—R. W. P. King. (*Communications*, Aug. 1945, Vol. 25, No. 8, pp. 89, 91.)

The first of three volumes on Electromagnetic Engineering. "This book should become a reference work on the shelf of every engineer who is either engaged in or who expects to follow the field of electromagnetic engineering."

4108. "UHF RADIO SIMPLIFIED" [Book Review]. —M. S. Kiver. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, p. 210.)

4109. ELEMENTARY PHYSICS OF ULTRA SHORT WAVES.—P. Grivet. (*Génie Civil*, 15th June 1945, Vol. 122, No. 12, p. 95.)

Abstract of a paper in *Comptes Rendus*, 28th April 1945.

4110. "PRINCIPLES OF RADIO" [Book Review].—K. Henney. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, p. 727.)

"The fifth edition of a well-known text-book of elementary radio."

4111. "A SHORTER HISTORY OF SCIENCE" [Book Review].—W. C. Dampier. (*Journ. Applied Phys.*, Sept. 1945, Vol. 16, No. 9, p. 550.)

". . . particularly helpful for those who are anxious for a quick review of the history of science."

4112. TELEPATHY OR RADIO TELEPATHY?—"Radiophare." (*Wireless World*, Oct. 1945, Vol. 51, No. 10, p. 314.)

A letter suggesting there is no real evidence that telepathy is not associated with high-frequency electromagnetic fields.

4113. SHORT-WAVE RADIO IS KEY TO POSTWAR PROGRESS.—(*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, p. 721.)

Report of an account given by a vice-president of Westinghouse Electric Corporation of the way in which radio and electronic developments—benefiting from the impetus given by the necessities of war—may be expected to find post-war application.

4114. AMERICAN WAR STANDARD SPECIFICATION AND DESCRIPTION OF COLOR.—(*Journ. Soc. Mot. Pict. Eng.*, May 1943, Vol. 40, No. 5, pp. 277–280.)

Correlates the technical system and the readily comprehensible system of coloured samples embodied in the 1929 Munsell Book of Color.

4115. THE COLORIMETRY OF TURBID MEDIA [using the "Diffuso-Absorptiometer," incorporating Barrier-Layer Photocells].—A. Dognon. (*Zeitschr. f. Instr:kunde*, Oct. 1943, Vol. 63, No. 10, pp. 363–364.)

Abstract of *Revue d'Optique*, 1940, Vol. 19, pp. 205–212.

4116. AN AUTOMATIC HIGH-PRESSURE MERCURY ARC LAMP CONTROL CIRCUIT.—L. F. Bird. (*Journ. Soc. Mot. Pict. Eng.*, July 1945, Vol. 45, No. 1, pp. 38–47.)

Optical inverse feedback provides a lamp of highly stable intensity, adjustable over a range of 11 to 1. The light operates from 60 c/s supply and can be modulated at any audio frequency.

4117. AN ULTRAVIOLET INTENSITY METER FOR FIELD USE.—H. L. Andrews. (*Review Scient. Instr.*, Sept. 1945, Vol. 16, No. 9, pp. 253–254.)

The instrument incorporates a photocell and a double triode used as a balanced valve-voltmeter.

4118. MOLTEN METAL: POURING CONTROLLED BY PHOTOTUBE.—(*Scient. American*, Sept. 1945, Vol. 173, No. 3, p. 167.) Short note only.

4119. ELECTRONIC CONTROL OF AUTOMATIC RIVETER.—T. A. Dickinson. (*Electronic Industries*, July 1945, Vol. 4, No. 7, pp. 112–113, 190, 194.)

The proper sequence of action of the parts of an automatic riveter is ensured by electronic switching in place of the operation of pedals.

4120. MILLING MACHINE WITH BUILT-IN ELECTRONIC CONTROL [of the Various Motions and Feed Rates].—(*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 150, 152.)

4121. SELF-FORGING WELDER.—C. H. Strange. (*Electronic Industries*, July 1945, Vol. 4, No. 7, pp. 109, 166, 170.)

Residual magnetism in the core of the transformer causes erratic changes in the welds. This is overcome in the model described by the use of an air-core transformer.

4122. A VERY-HIGH-FREQUENCY [50 Mc/s] WELDER FOR JOINING LAMINATED PLASTIC MATERIALS [by Dielectric Heating].—(*Génie Civil*, 1st June, 1945, Vol. 122, No. 11, p. 88.)

Short note on an Arc Manufacturing Co. device. *See also* article in *Aircraft Production*, January 1945.

4123. "MEDICAL PHYSICS" [Book Review].—O. Glasser (Editor). (*Journ. Applied Phys.*, Aug. 1945, Vol. 16, No. 8, p. 486.)

This 1744-page volume surveys the whole field of related subjects in physics, biology and medicine, with full bibliography for each separate article.

4124. VACUUM-TUBE [Thermocouple] ANTICIPATOR CONTROLS [Electric] FURNACE TEMPERATURES.—(*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 188, 192, 196.)

A one-page article. A low-heat-capacity device connected to the power supply of an electric furnace reacts to changing temperature, and operates correcting relays before the furnace, with its large heat capacity, changes in temperature sufficiently to perform the same operation. When the temperature of the anticipator is not changing, a thermocouple in the furnace itself has complete control. A ten-to-one reduction of temperature fluctuation is quoted.

4125. PRECISION RECORDING INSTRUMENT FOR MEASURING FILM WIDTH.—S. C. Coroniti & H. S. Baldwin. (*Journ. Soc. Mot. Pict. Eng.*, Nov. 1943, Vol. 41, No. 5, pp. 395–408.)

Variations in the width of 35, 16, and 8 mm film are made to vary the capacity of a small air condenser that changes the frequency of a quartz oscillator. Film width can be measured continuously to an accuracy of 0.002 mm.

4126. THE RECORDING OF STRAIN BY THE "PARALLEL RESONANCE" METHOD.—H. J. Beach. (*Electronic Eng:g*, Oct. 1945, Vol. 17, No. 212, p. 737.)

The strain gauge consists of a parallel-plate condenser, of which the distance between the plates is controlled by the strain. The condenser forms part of a resonant tuned circuit. The voltage across the circuit is applied to an oscilloscope, and a depression of one condenser plate by 0.002 in. gives a C.R.O. deflection of 2.5 cm.

4127. THE USE OF FREQUENCY MODULATION IN A SENSITIVE MICROMETER. — G. M. Foley. (*Phys. Review*, 1st/15th Aug. 1945, Vol. 68, Nos. 3/4, p. 101.)

Abstract only.

4128. TESTING LATHE SPINDLES FOR ACCURACY [with an Electronic Micrometer].—(*Electronics*, Aug. 1945, Vol. 18, No. 8, p. 150.)

Variations of the capacitance between an electrode and the part examined are used to vary an oscillator frequency. Motions of the order of 10^{-7} inch are measured. "The micrometer has also been used to make a high-speed dilatometer to follow the crystalline changes in steels during rapid heating . . ."

4129. ELECTRONIC CONTROL FOR MAGNETIC CLUTCHES.—R. L. Jaeschke. (*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 102–106.)

"By exciting a magnetic clutch with a grid-controlled gaseous rectifier that is controlled by a governor generator through a bridge circuit having a vacuum tube in one leg, the output speed of a motor can be varied over a 100-to-1 range or a preset speed automatically maintained within 0.1 per cent from no load to full load.

4130. [Cause of] VIBRATION [in Precision Machinery] LOCATED BY ELECTRONIC PICK-UP.—(*Scient. American*, Sept. 1945, Vol. 173, No. 3, p. 167.)

Short note only.

4131. PIPE FINDER [The "Gradientometer", an Instrument for locating Magnetic Gradients, and so detecting Ferromagnetic Objects.]—(*Scient. American*, Sept. 1945, Vol. 173, No. 3, p. 167.)

Short note only.

4132. "DIE ELEKTRONENRÖHRE ALS PHYSIKALISCHES MESSGERÄT" [Book Review].—J. Schintlmeister. (*Akust. Zeitschr.*, Nov. 1942, Vol. 7, Nos. 5/6, p. 213.)

A book written to popularise the use of valves in physical and chemical research.

4133. STREET LIGHT CONTROL.—J. L. Haley. (*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 98–100, 130, 134.)

A 3000 c/s signal is applied to the mains and is used to switch street lights off and on.

4134. A NEW APPARATUS FOR DETECTING AND REPORTING FIRES.—A. Langenberger. (*Tech. Mitteilungen*, 1st June 1945, Vol. 23, No. 3, pp. 114–124. In both French and German.)

The electrical conductivity of air irradiated with α-particles falls when the air is mixed with gases of combustion. The fire detector incorporates two ionisation chambers with their inner surfaces coated with a radioactive material, one of them open to the surrounding air, and one filled with air and sealed. The ionisation currents in the two cells are compared, and the change that takes place when gases of combustion enter the open cell is used to operate an alarm relay. The device does not react to heat, moisture, draughts, dust or steam.

4135. RADIO EQUIPMENT IN THE V2.—A. G. Pither. (*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, p. 675.)

A 30 Mc/s transmitter on the ground gave a signal of lower frequency at a receiver in the rocket, owing to Doppler effect. A transmitter in the rocket returned the signal to the ground at double frequency (about 60 Mc/s). When the change in frequency received at the ground indicated that the rocket had acquired the desired speed, signals from a second ground transmitter to a second rocket receiver cut off the fuel supply. The system was liable to jamming, and was abandoned in favour of an integrating accelerometer. Summary of a lecture before the Australian I.R.E.

4136. AN IMPROVED ELECTRONIC STIMULATOR.—R. K. McCombs & F. C. Walz. (*Review Scient. Instr.*, Sept. 1945, Vol. 16, No. 9, pp. 249–252.)

The circuit, which is used for biological purposes, supplies a unidirectional, rectangular current pulse, the frequency, amplitude and pulse length being independently variable. The frequency range extends from 1 cycle in several minutes to 20 000 cycles per second. A current amplitude up to 2 mA can be obtained for loads up to 200 000 ohms.

4137. RADIO DOOR ACTUATOR.—R. G. Rowe. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 96–97, 130..138.)

A simple modification of a standard automobile receiver permits remote control through an induction relay circuit, of such objects as a gate or a garage door. A 3-page paper.

4138. PHONO HEAD BALANCE. — Chalfin. (*See* 3924.)

4139. GAGING BY THE BLIND.—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 104, 142, 146.)

Upper and lower limit switches on dial-type gauges causing a change of frequency of a loud speaker note enable blind people to use precision gauges.

4140. REMOTE RECORDER [for transmitting Liquid-Level Information].—(*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, pp. 108–109.)

Four paragraphs only.

4141. MODERN MEASUREMENT OF PROJECTILE SPEEDS.—T. H. Johnson. (*Electronic Industries*, July 1945, Vol. 4, No. 7, pp. 82–85, 178..190.)

A brief account of older methods of measuring the speeds of projectiles is followed by a description of the modern method in which two electromagnetic or electrostatic screens are used to give signals as the projectile passes through them, and the time interval between the two signals is measured by an electronic counter chronoscope.

4142. PRESET INTERVAL TIMER.—(*Electronic Industries*, July 1945, Vol. 4, No. 7, pp. 97–99, 130..146.)

The oscillations of a quartz oscillator operate a six-decade electronic counter. With suitable switching arrangements the combination can be used to measure intervals of time or can be preset to give definite time intervals.

4143. PRESSUREGRAPH. — (*Review Scient. Instr.*, Sept. 1945, Vol. 16, No. 9, p. 256.)

A brief description of an electronic device, which indicates on a cathode ray oscillograph the pressure-time curve of any internal combustion engine or other enclosed pressure system.

4144. DETONATION INDICATOR FOR AIRPLANE ENGINES.—(*Electronic Industries*, July 1945, Vol. 4, No. 7, pp. 100–104.)

A magnetostriction pick-up fixed to the wall of each cylinder. The voltages produced in the pick-up are amplified and operate a lamp on the dashboard.

4145. "METROLUX" FLUORESCENT CRACK-DETECTION EQUIPMENT.—(*Engineering*, 3rd Aug. 1945, Vol. 160, No. 4151, p. 97.)

Articles are impregnated with a solution of fluorescent material, dried, and then subjected to ultra-violet rays from a mercury-vapour discharge lamp. Flaws show up vividly because fluorescent material clings to the imperfections.

4146. A DIRECT-READING *pH* METER. — R. H. Thorp. (*Electronic Eng:g*, Sept. 1945, Vol. 17, No. 211, pp. 671–675.)

The presence of stray voltages, when measuring *pH* values by a glass electrode system and a valve voltmeter, is of no importance provided the magnitudes are constant. It is therefore unnecessary to obtain negligible grid current in the first valve of the electrometer circuit, provided that it can be made constant over the range of potential the electrodes will give. An instrument based on this principle is described.

4147. ELECTRIC HYGROMETER (BROWN BOVERI MANUFACTURE) [Depending on the Difference in Thermal Conductivity of Dry and Moist Air].—E. Kobel. (*Schweizer Arch. f. Angew. Wiss. u. Tech.*, Aug. 1945, Vol. 11, No. 8, pp. 238–241.)

Four heater wires form the arms of a Wheatstone bridge. The damp air is passed over two opposite arms, and is then dried and passed over the other two. The displacement of the balance of the bridge is a measure of the moisture of the damp air.

4148. "ELECTRONICS LABORATORY MANUAL" [Book Review].—R. R. Wright. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, p. 210.)

For engineering students.

4149. COMPARISON OF VARIABLE-AREA SOUND RECORDING FILMS.—D. O'Dea. (*Journ. Soc. Mot. Pict. Eng.*, July 1945, Vol. 45, No. 1, pp. 1–9.)

Author's summary :—" This paper describes the the test results obtained by comparing the new Eastman 1372 film with those in current use. Our tests indicate that this film has characteristics superior to the Eastman films now in use for variable-area sound recording, particularly with respect to density speed, processing tolerances, and requirements for direct positive."

4150. MAPS ON MICROFILM : SOME FACTORS AFFECTING RESOLUTION.—M. Bruno. (*Journ. Soc. Mot. Pict. Eng.*, Nov. 1943, Vol. 41, No. 5, pp. 412–425.)

Author's summary : — " . . . The conclusions drawn from this research are :—(1) The reproduction of colored maps in color on 35-mm film is impossible because of the low resolving power of present color emulsions. (2) Reproduction of colored maps in monochrome on 35-mm is not satisfactory because of grain clumping in magnification above 20 ×. (3) The resolution of an image is a composite function depending on the degree of correction in the optical system producing it, the resolving power of the material reproducing it, and the processing it undergoes."

4151. "PHOTOGRAPHY IN ENGINEERING" [Book REVIEW].—C. H. S. Tupholme. (*Journ. of Scient. Instr.*, Oct. 1945, Vol. 22, No. 10, p. 199.)

4152. THE CLOSURE AND PARTIAL SEPARATION OF A METALLIC CONTACT.—A. Fairweather. (*Journ. I.E.E.*, Part I, August 1945, Vol. 92, No. 56, pp. 301-321.)

A study of the contact between nominally clean platinum-iridium surfaces approaching and separating normally, without continuous sliding, for both static contact and for separating contact up to the instant of final interruption of the metallic conducting path. All observed changes of resistance with variation of current and pressure are predictable in terms of contact spots. The extents of resistance changes are directly related to the mechanical pressure. A technique is described for assigning a lower limit to the number of contact spots. The influence of the rate of current loading is examined.

The ranges of pressure and voltage used in the experiments were greater than those encountered in ordinary practice. They were bounded by the effects of surface films at very low pressures and voltages, and by the onset of glowing and fusing at high voltages.

The unequa wear of the members of a contact pair is studied. In severe cases a pip grows on one member, and a corresponding crater appears on the other, and the members may then lock together. It is suggested that in general the phenomenon may be caused by the molten metallic bridge joining the partly separated members, and by the arc. The sense of arc erosion is independent of the metal, but bridge erosion depends on the sign of the Thomson coefficient of the metal near its boiling point. The advantage of using a metal with zero Thomson coefficient is suggested.

4153. SHIELDING HF INTERFERENCE. — A. F. Murray. (*Electronic Industries*, Aug. 1945, Vol. 4, No. 8, pp. 108–110, 142, 146.)

Radio interference from high-frequency devices used in diathermy can be largely avoided by the use of screened rooms. Experimental results are given for a number of such rooms. A double screen is many times better than a single screen, and a large room is better than a small one. The intensity of the unwanted field may be reduced by as much as 140 db by a well-designed screened room.

4154. VACUUM-TUBE RADIO-FREQUENCY-GENERATOR CHARACTERISTICS AND APPLICATION TO INDUCTION-HEATING PROBLEMS. — T. P. Kinn. (*Proc. I.R.E.*, Oct. 1945, Vol. 33, No. 10, pp. 640–657.)

Author's summary :—" . . . The fundamentals of the vacuum-tube self-excited oscillator and design considerations which determine the characteristics of the radio-frequency generator are reviewed and illustrated. In general, the characteristics show a high-impedence, constant-current, variable-voltage generator which requires manipulation of load circuits to load the generator properly. Methods are illustrated for accomplishing proper loading, and numerical examples are given illustrating the formulas and procedures necessary to any induction-heating problems." Practical examples of the application of the technique—such as to case hardening—are discussed in detail.

4155. INDUCTION AND DIELECTRIC HEATING EQUIPMENT.—(*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 110–111.)

" Tabular comparison of technical characteristics and initial cost per kilowatt of output power for commercially available induction and dielectric heating equipment, as reported to *Electronics* by manufacturers. Both electronic and non-electronic types are covered."

4156. MOULDING SPONGE RUBBER WITH DIELECTRIC HEATING.—(*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 196..208.)

A one-page article.

4157. DIELECTRIC DEFROSTING OF FROZEN PRODUCE.—(*Electronic Industries*, July 1945, Vol. 4, No. 7, pp. 111, 124.)

Dielectric heating methods are to be used for defrosting large quantities of stored produce. This method will reduce the time required from days to minutes.

4158. HIGH-FREQUENCY HEATING.—(*Elec. Review*, 28th Sept. 1945, Vol. 137, No. 3540, pp. 437-438.)

Rediffusion Ltd. exhibited a wide range of dielectric heaters, and some of induction type. One dielectric heater for moulding powders has an output of $\frac{1}{4}$ kW at 30 Mc/s, another continuous conveyor dryer for thick fabrics or paper has an output of 2 kW, and the largest model intended for bulk drying of baled wool or refracting bricks has an output of 25 kW.

4159. GLASS AND ELECTRONICS [the Use of High-Frequency Heating in the Working of Glass]. — (*Scient. American*, Sept. 1945, Vol. 173, No. 3, pp. 165–167.)

4160. THE CONCENTRATION [by Evaporation] OF RUBBER LATEX BY THE USE OF HIGH-FREQUENCY CURRENTS.—H. Leduc & R. Dufour. (*Génie Civil*, 15th June 1945, Vol. 122, No. 12, p. 96.)

Summary of an article in *Revue générale du Caoutchouc*, December, 1944.

4161. GRAPHICAL SYMBOLS FOR ELECTRONIC DIAGRAMS.—(*Electronics*, Aug. 1945, Vol. 18, No. 8, pp. 136–137.)

About 100 symbols are given without comment.

4162. "ELECTRICAL DRAFTING APPLIED TO CIRCUITS AND WIRING" [Book Review].—D. W. Van Gieson. (*Electronic Industries*, Sept. 1945, Vol. 4, No. 9, p. 212.)

ABSTRACTS AND REFERENCES INDEX

The Index to the Abstracts and References published throughout the year is in course of preparation and will, it is hoped, be available in February, price 2s. 8d. (including postage). As supplies will be limited our Publishers ask us to stress the need for early application of copies.

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