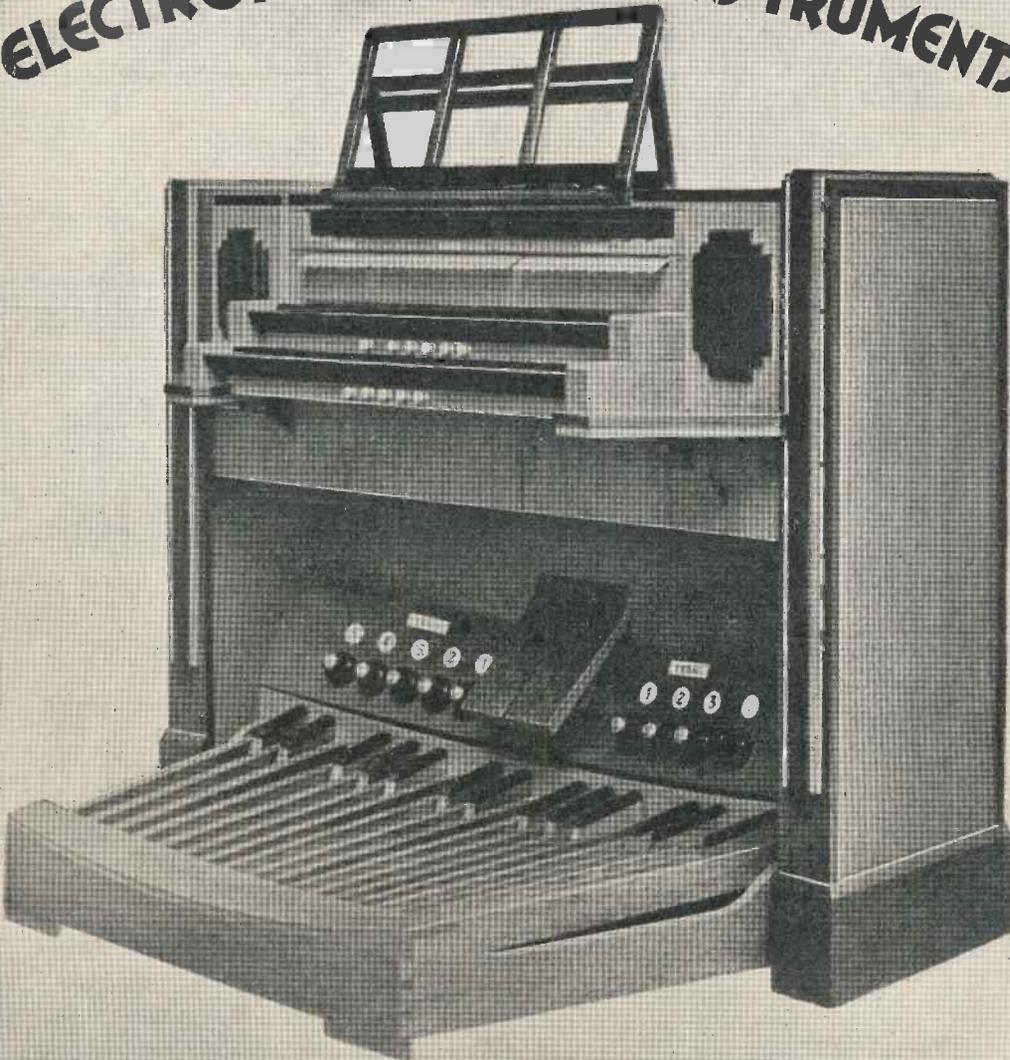


ELECTRONICS AND TELEVISION & SHORT-WAVE WORLD

AUGUST, 1940

1/6

ELECTRONIC MUSICAL INSTRUMENTS



THE FIRST
TELEVISION
JOURNAL
IN THE
WORLD

HULTON
PRESS LTD.,
43, SHOE LANE
LONDON, E.C.

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AUGUST, 1940

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EDITORIAL, ADVERTISING AND PUBLISHING OFFICES
43, SHOE LANE, LONDON, E.C.4

Editor : H. CORBISHLEY

Telephone : CENTRAL 7400

Subscription Rates; Post Paid to any part of the world—3 months, 5/-; 6 months, 10/-; 12 months, 20/-.

Monthly (published 25th of preceding

month) 1/6 net, Registered for Transmission by Canadian Magazine Post.

News and Views

ON other pages of this issue we present an important paper on the development and present possibilities of electronic musical instruments. Investigation of these devices has not received the attention in this country commensurate with their probable future importance, but it is evident that a field is open which will well repay attention; it is a line of investigation that directly concerns the electronic engineer.

A considerable amount of prejudice against the introduction of new types of musical instruments is bound to exist, particularly if they are intended to rival those which have taken centuries to develop, but even if we admit that in some respects the new types possibly fall short of those they are intended to simulate, few will deny that under certain conditions they are likely to prove most valuable. As the authors said in reply to some criticisms of the production of music by electronic methods, although in the present stage of development of electronic organs it may appear that they could not be built to compete with very large pipe organs, it must be remembered that electronic forms of organ have only been contemplated since the beginning of this century and that large scale development only commenced about ten years ago. In view of the fact that the pipe organ is the product of many centuries development, a similar degree of finality and perfection is hardly to be expected in what must therefore be considered to be the comparatively early stages of the development of electronic organs.

One surprising fact which emerges from a study of the review presented is the large variety of methods that may be employed for the production of electronic music and the authors make it clear that the possibilities of both methods and principles are by no means exhausted.

From time to time discussions have taken place in the Press regarding the apparently unnecessarily stringent specifications for Service apparatus, and the delays and increased costs which result therefrom. The increasing use of radio communication in modern warfare has caused receiver manufacturers to view their production from a different viewpoint, and no doubt many are surprised to note how far their opinion on

what constitutes reliability and workmanship differs from that of the Service authorities.

While it is not proposed to enter into a discussion on what constitutes reliability from Service considerations, it is to be hoped that Mr. Morrison's advice on omitting the "spit and polish" from certain components and thereby increasing production is being followed in the radio industry as well as in the armament trade. Some time ago a well-known manufacturer abandoned the usual cobalt plating in favour of sprayed finish—a small point which did not affect the performance of the receiver, but which saved an appreciable amount in production costs.

In an American broadcast talk in June, Ray Giles said that "thinking wild" solved many problems after systematic thinking had failed. He quoted the case of Singer, the sewing machine inventor, who was obsessed with the idea of a needle with an eye in the blunt end, as had been the practice for centuries. As soon as his imagination suggested the apparent absurdity of an eye in the point the problem of the sewing machine was solved.

In a paper presented to the Institution of Electrical Engineers, Mr. W. T. O'Dea puts forward an argument for the revision of standards at present drawn up for performance of electrical apparatus and components. He claims that it is impossible to discriminate between batches of a manufactured product by applying a criterion in the form of a "factor of safety," and states that it is quite possible that a batch with poorer characteristics has a better chance of being accepted under such circumstances. It is suggested that the existing factors of safety be replaced by a new set of empirical standards based on a guaranteed minimum performance.

It is also pointed out that in some cases the present test samples are inadequate in size and number, and it is recommended that samples of 50 items in some products should be accepted as reasonable. While Mr. O'Dea's arguments are intended to apply in the main to electrical materials they may well be taken as a basis on which to revise the acceptance tests for components such as condensers and other items in radio construction.



Electronic organ with case removed.

ELECTRONIC MUSICAL INSTRUMENTS

The Development of the Pipeless Organ

By

G. T. WINCH & H. M. MIDGLEY

GR EAT skill and ingenuity have contributed to the present standard of perfection of the traditional forms of musical instruments. However, it must not be overlooked that such instruments are dependent on the limitations of mechanical resonators, and this automatically determines their size, loudness, cost, degree of flexibility of control and the tone colours which they can produce.

Possibilities of Electronic Methods

The attraction of electronic methods of producing (as apart from reproducing) music is that, at least theoretically, it should be possible to generate electric current of any desired fundamental frequency and harmonic content. Such currents when amplified and converted

Very many systems have been proposed for producing musical tones of different timbre by electronic methods. The table indicates the various branches of electronic musical instrument

This article is an abstract from a paper read before The Institution of Electrical Engineers (Tees-side sub-centre) and is published here by kind permission of the Institution. This portion is a survey of the practical design of electronic instruments which simulate the pipe organ and reviews very comprehensively the several types developed.

development. It will be noted that these developments may be considered in three main groups, namely, melodic or single-note instruments, harmonic or multi-note instruments of the percussion type essentially developed from the

instrument. In fact, only one serious attempt was made to construct an electronic form of musical instrument prior to the advent of the thermionic valve, namely, that by Cahill in 1897.

In 1915 Lee de Forest lodged the first patent application for a musical instrument utilising thermionic valves for producing musical tones. His instrument consisted of a valve oscillator, the frequency of which was controlled by adjustable capacitance. The amplified audio frequency was then fed to a loudspeaker which produced the musical notes.

This was followed at a later date by a number of inventions in which various forms of oscillatory circuits were proposed, with the object of facilitating playing technique, and to some extent controlling the harmonic content or timbre of the notes produced by the super-position of formant frequencies.

By separately generating these form-

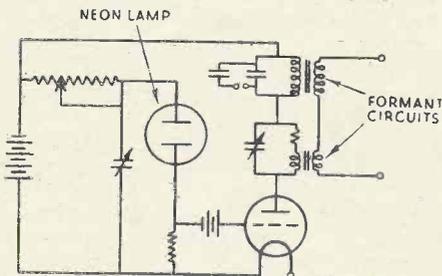
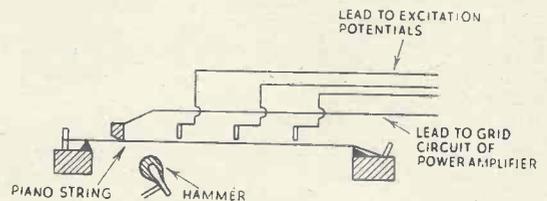


Fig. 1 (left). Neon lamp oscillator circuit.

Fig. 2 (right). Struck string as generator, with electrostatic pick-up.



to sound-pressure waves by means of loudspeakers should enable sound waves to be generated of any frequency and harmonic form, over an almost infinite loudness range. The flexibility of control of such methods of sound production should exceed that of any of the traditional forms of musical instrument, and there seems every reason to expect that the bulk and cost should be only a fraction of that of large and elaborate instruments such as pipe organs.

piano, and harmonic instruments simulating the pipe organ both in playing technique and musical effect.

Melodic or Single-note Instruments

The Duddell singing arc was probably the first melodic electronic musical instrument, although obviously its form and potentialities were not such as to attract interest in it as a serious musical

ant frequencies and superposing them on the note frequencies, the electronic instrument is made to produce a limited range of tone colours. In another variation of the circuit for producing these effects, neon lamps are incorporated in conjunction with condensers and discharging resistances to produce audio-frequency oscillations. One example of the form of circuit used in this type of instrument is shown diagrammatically in Fig. 1.

Classification of Electronic Musical Instruments

Two instruments of this melodic type have attracted considerable attention as solo instruments and may be quoted as examples. In the instrument invented by Theremin, two supersonic valve oscillators produce beat frequencies in the audio range, the desired frequency or pitch of the note being controlled by the hand capacitance of the player. This is accomplished by moving the hand to different positions in space with respect to an electrode in the form of a vertical rod projecting from the oscillator

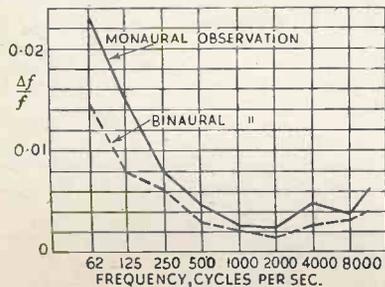


Fig. 3. Relation between pitch discrimination and frequency of pure note at sensation level 40 db. above threshold.

cabinet. Starting and stopping of the notes is accomplished by means of a switch held in the other hand of the performer.

The Trautonium, invented by Trautwein, has a measure of timbre control which is realised by superposing formant frequencies on those generated by means of neon tubes. The pitch of the notes is in this case controlled by means of a variable resistance in the form of a spun-wire cord stretched over a steel band, the wire being pressed on to the band at the desired point by the performer.

Multi-note Instruments

A type of instrument which has been developed mainly by Vierling and

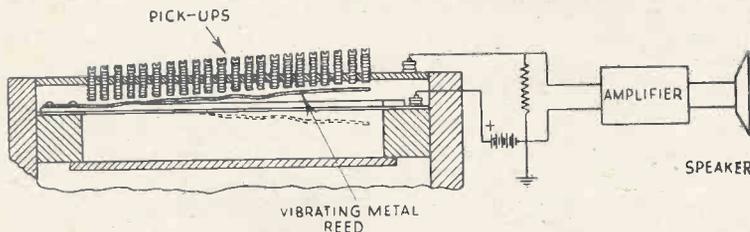


Fig. 4. Wind-maintained reed generator.

Miessner consists essentially of piano-type action and strings mounted on a frame in the conventional manner, but with no soundboard. The general form

respective audio frequencies can be used to produce musical notes. The harmonic content of the notes will depend on the proportionate excitation of the

TABLE

Group. (1)	Sub-group. (2)	Division. (3)
(A) Single-note form	(a) Electric arc	—
	(b) Oscillating valve circuits	—
	(c) Oscillating neon-lamp circuits	—
(B) Multi-note key-board percussion form	(a) Struck string or tuned rod as generator	(i) Electromagnetic pick-up (ii) Electrostatic pick-up
	(C) Multi-note key-board organ form	(a) Maintained tuning form or vibrator as generator
	(b) Maintained strings as generators	(i) Electromagnetic pick-up (ii) Electrostatic pick-up
	(c) Cathode-ray generator	—
	(d) Multiple oscillator circuits utilising valves and neon lamps	(i) Thermionic-valve oscillator circuits (ii) Neon-tube osc. circuits
	(e) Wind - maintained reeds as generators	(i) Electrostatic pick-up (ii) Electromagnetic pick-up
	(f) Rotary forms of generator	(i) Photo-electric (ii) Electromagnetic (iii) Electrostatic

Note:—There are two distinct methods which may be adopted with any of the above forms of instruments:—

(a) To generate directly complex waveforms of the required shape to produce the various tone colours.

(b) To generate series of sinusoidal waveforms of the required fundamental and harmonic frequencies, and by mixing circuits combine these to form the required complex waveforms and tone colours by synthesis.

of arrangement adopted in such instruments is shown diagrammatically in Fig. 2, from which it is clear that if different excitation voltages are applied to the respective pick-up bars and the strings connected to the grid circuit of an amplifier, when the strings are vibrated by the hammer blow, the resulting variations in capacitance at the

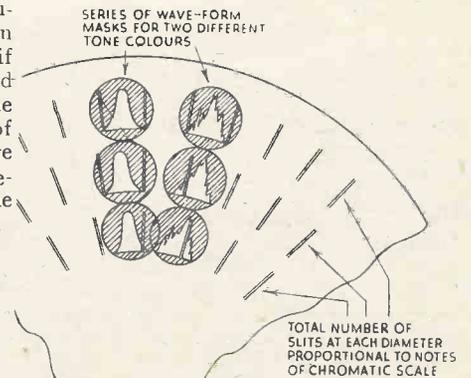


Fig. 5. Sketch showing arrangement of stationary waveform masks and slits on portion of rotating scanning disc of photo-electric organ.

various pick-up bars and their positions along the strings.

Various methods have been proposed for controlling the extent to which the

Design Considerations of The Augetron Secondary- emission Multiplier

By the Technical Staff of Vacuum Science Products, Ltd.

In recent articles in this journal, the Augetron characteristics have been published, giving readers an accurate idea of Vacuum Science Products thermionic electron multiplier. This article explains how a particular type of construction was arrived at.

IN secondary emission tubes, the primary electron stream emitted by a thermionic cathode may be directed on its successive targets by magnetic or even by correctly adjusted electrostatic fields.

secondary emitters round the central cathode, as adopted by Zeiss in Germany.

- (3) The disposition of the secondary cathodes behind each other and

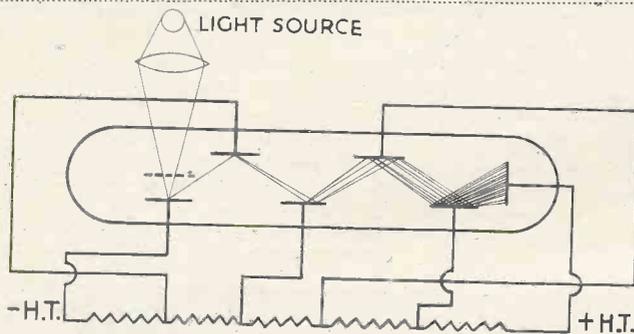


Fig. 1. The Slepian type secondary-emission multiplier.

In designing commercial electron multipliers, which have to be made to a fixed standard with definite characteristics, all the problems of alternative construction of secondary emitting cathodes have been studied including investigation of the Slepian type and the Zworykin type, of which schematic representations are given in Figs. 1 and 2, in which electron paths are shown. Several variations of either type have been evolved with relative claims to higher efficiency.

The electron beams have to be guided and directed by magnetic fields, and although improvements have been made in designs of magnets to create these magnetic fields, it constitutes, nevertheless, a serious handicap, and we have, therefore, to abandon a higher possible efficiency with a high specific secondary emission co-efficient, for a more simple and reliable, but slightly less efficient method. It should be borne in mind that for commercial purposes, replacement should be made easy, while it should at the same time, offer to the user the greatest possible simplicity, and the use of magnetic fields is definitely a handicap in this direction.

Three other methods are possible:—

- (1) The electrostatic direction of the electron stream, such as is applied by Philips and Mullard in their single-stage secondary emission valve.
- (2) The concentric arrangement of

made pervious to the electron stream, as adopted by Weiss, and Baird Television in this country.

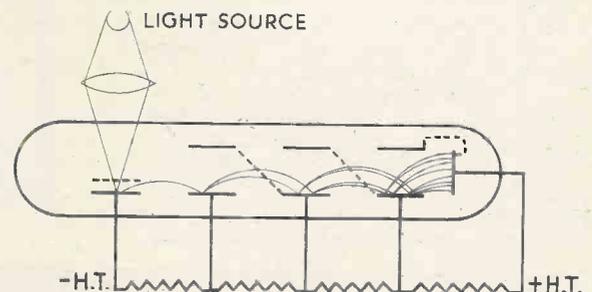
- (1) In this case, the complication of the electrostatic fields required, limit the number of stages, besides which, extra care has to be taken to prevent poisoning of the secondary emitter by

to discuss the merits of secondary-emission co-efficients, input impedance, slope, etc., of this particular valve as they are outside the scope of this present article.

(2) Various people have been working on the idea of putting the secondary cathodes concentrically round the cathode and making the secondary cathodes out of grids, thus pervious to the electron stream. The Germans first applied for patents for this form, which has many disadvantages, such as evaporation of the coating material of the primary cathode. In the case of barium oxide coated cathodes, the secondary emitters are poisoned. In the case of other oxides, such as caesium oxide, the life of the cathode is very short. Recently, however, the Germans improved this construction and placed a double series of louvres between the control grid and the first secondary emitter. This has the advantage of shielding the primary cathode from the secondary emitter and of allowing electrons to pass which have a definite velocity. However, the first series of louvres lose their efficiency rather quickly because here again they get coated and the efficiency of the tube drops rather abruptly when the first louvres become secondary emitters. Also there are other limitations such as frequency response, etc., which make research in that direction not worth while.

- (3) The disposition of the secondary cathodes behind each other, such as in the Weiss and Baird types, we found to be the most practicable, because it allowed us to build a secondary emitter structure which was independent of the primary emitter, and we could thus concentrate on building thermionic guns with a high slope, which, with the addi-

Fig. 2. The Zworykin-type multiplier.



the primary cathode. In the case discussed here, the electrostatic direction of the primary electron stream was arrived at after it was found that, experimentally, a secondary emission cathode, built concentrically round the cathode could be covered entirely with a monomolecular layer of barium oxide in forty hours, thus making it impossible from the commercial aspect, where a much longer life is anticipated from a thermionic valve. It is not proposed

tion of the secondary emitter, results in the output slope, given in preceding articles. Many details, such as frequency response in relation to structure have been discussed in the past.

One advantage claimed for Vacuum Science secondary emitters over the grid system adopted by Weiss is that the anode current can be of the order of 10 milliamperes without injuring in the slightest either the secondary emitters,

(Continued in 1st col. of next page)

News Brevities—

Commercial and Technical

A STATEMENT has now been issued by the Post Office regarding the use of radio equipment in dealers' vans. This is as follows:—

"Apparatus which can be used only for the purpose of amplifying speech and music and comprises a microphone, low-frequency amplifier, record player and loudspeaker(s) is not considered to be 'wireless receiving apparatus.' Consequently, the Postmaster-General, as at present advised, would not regard such public address apparatus as covered by the provisions of the Defence Regulation provided that the vehicle carrying it does not, at the same time, carry apparatus which could be readily used to convert it into wireless receiving apparatus.

"The use of a wireless receiving set in a road vehicle in association with public address apparatus for the purpose of amplifying broadcast programmes would clearly contravene the regulation."

Another order requires that any person who had high frequency apparatus in his possession on June 28 that generates or uses a maximum output exceeding 10W at a frequency exceeding 10,000 C/S, or who acquires any after that date, must notify the police. The types of apparatus covered are:—Diathermy and electro-therapy apparatus using either valves or spark coils (fre-

quently known as ultra-short wave, or short or long wave diathermy, surgical diathermy or therapy apparatus); high frequency furnaces; eddy current heating apparatus such as is used by valve and electric lamp manufacturers; testing oscillators with a high frequency output exceeding 10W.

The Electric Construction Co., Ltd., have recently issued a catalogue which gives comprehensive details of their range of metal rectifiers.

The E.C.C. metal rectifier is made in three distinct types, each with its own applications. The first group comprises metal rectifier battery chargers for electric vehicles, the second battery-chargers for A.C. mains operation only, and the third oil-immersed rectifiers for plating and electrolytic work of all kinds.

The catalogue gives much valuable information, and readers who are interested should get in touch with The Electric Construction Co., Ltd., at their temporary address: Lamport Hall, Northampton.

Georg Wilhelm Alexander Hans Count von Arco, who founded the well-known German radio corporation Telefunken Gesellschaft in 1903, has died at the age of 71.

Count von Arco originated the idea for the German radio station at Nauen, near Berlin, and the credit for popularising radio broadcasting in Germany is largely due to him. Subsequently, his work resulted in the establishment of radio telephonic transmission between Germany and the rest of the world.

The Federal Communications Commission recently announced that in future frequency modulation stations will be licensed on the basis of coverage, rather than power; stations serving the same centre of population will be licensed to cover the same area, their power being adjusted to give the desired coverage.

When the National Republican Convention at Philadelphia was televised last month, American television entered the political arena for the first time. Two complete mobile television units were used for the transmission, which were described as the most elaborate television coverage ever given to a single event, and the programmes were relayed by coaxial cable to New York for broadcast over the N.B.C. transmitter in Manhattan.

It is estimated that a maximum audience of nearly 40,000 persons saw the transmissions, based on the belief that

there were eight to ten persons to every television receiver.

Details of a direct-reading photo-electric densitometer appeared in a recent issue of the Journal of the Society of Motion Picture Engineers. The film to be measured is placed between the photo-cell and a circular neutral scale rotated at 20 c.p.s. to which a wedge is attached. The photo-cell output is fed to an amplifier which distorts it into a square wave, in which the times of current or voltage change mark, one, the change from maximum to minimum transmission of the wedge; and the second the time in the cycle when the light received by the cell equals a fixed value. At the moment of this second change a stroboscopic lamp is flashed, illuminating a reading on the rotating scale corresponding to the density of the test strip.

The applications of the photo-cell in the foodstuffs industries was the subject of a paper by A. Seymour in a recent issue of the *Electrical Times*.

In commerce the difference between one quality of rice and another consists mainly in the proportion of discoloured grains present, but as Mr. Seymour points out, since hand-sorting has never been commercially practicable, the mechanical and electrical method of sifting out the discoloured grains by a machine may have far-reaching effects.

The machine described utilises the properties of a photo-cell and by an ingenious mechanical method, the grains emerge from the feeder in a single line at a speed of 5 ft. per second, and pass under the electric "eye." The perfect grains shoot straight forward into a tube leading downwards to a sack. Discoloured grains cause an electrical impulse which brings into action a jet of compressed air, sending them into another receptacle.

Examination of granulated sugars is more elaborate, as it includes a classification of the finished sugars for general appearance and an evaluation of the colour and turbidity of the sugar solutions.

Experiments with photo-electric apparatus have shown that good correlation exists between the appearance of a sample of granulated sugar and its reflectance relative to magnesium oxide. A specially designed optical system in the photo-electric apparatus permits measurements of the transmittancy of sugar solutions as well as of the reflectance of the sugar in granulated form, and numbers obtained from these data enable the expert to compare the relative merits of the samples.

Successful two-way radio contacts with the West base and WGeo in Schenectady, of the U.S. antarctic expedition, have now been established. Relatives and friends of expedition members are being invited to visit the

"The Augetron Secondary-emission Multiplier"

(Continued from preceding page)

the performance, or the life of the tube. The thermionic cathode operating at a maximum current of 10 microamperes, there is little danger of cathode evaporation with the consequent poisoning of the secondary emitters. This has also the advantage of a high signal-to-noise ratio, and coupled with a very low input impedance and low input and output capacity and the high possible anode current, without injury to the secondary emitters, definitely establishes the Augetron as a commercial thermionic secondary emission tube, presenting an advanced technique.

One objection which many users point out is the high voltage employed. This, however, is due to the fact that the tube is run at its maximum efficiency of secondary emission. If the use of a lower voltage was advocated there would result a drop in secondary emission co-efficient and a consequent drop in overall efficiency. We claim to have developed a thermionic electron multiplier commercially available, built to a definite performance and definite characteristics.

studio and actually talk with expedition members. Conversations, of course, depend upon reception of signals from the West base, but the first two have been entirely successful.

* * *

American television programmes have been successfully received 234 miles from New York. The receiver was installed in a liner travelling between New York and Bermuda, and according to N.B.C. engineers who were on board, images were held for a full hour without fading or distortion, in spite of the great distance.

Another record reception is also reported from America. An engineer living in Chicago, nearly a thousand miles from the television transmitter, managed to tune in both vision and sound programmes. Although the images faded after a few minutes, the sound was received for 16 minutes.

* * *

The capabilities of frequency modulation for purposes other than regular broadcasting are being steadily recognised in America, and this is borne out by the fact that two-way frequency modulation communication for emer-

gency service is soon to be put into operation in Douglas County, Nebraska.

The new equipment will make it possible for officials to maintain constant, interference-free communication with mobile units patrolling different sections of the county.

Radio transmission of photographs via frequency modulation has also been successfully achieved in America. The photographs were received on a General Electric frequency-modulation home broadcast receiver after travelling 87 miles from Boston to Paxton and back again, and were almost duplicate reproductions of the originals. Largely eliminating static, frequency modulation cuts out the static distortion that has hitherto attended radio photo transmission.

An Essential for Long-distance Reception

WE are frequently asked what type of headphones we can thoroughly recommend for really good long-distance reception, and yet which are, at the same time,

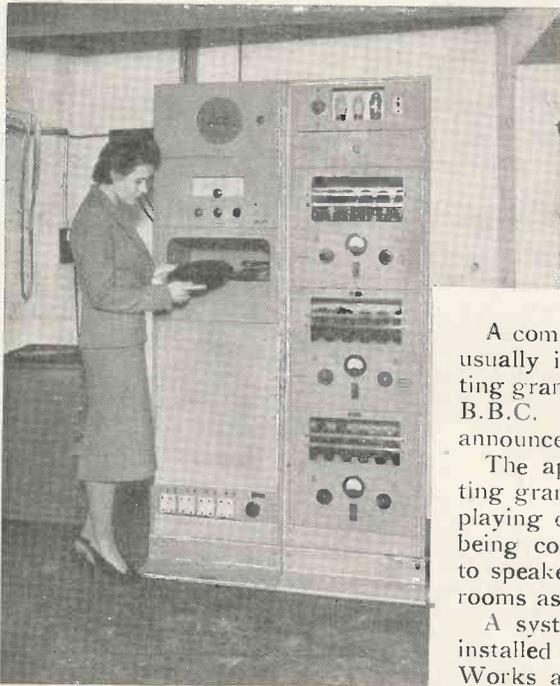
comfortable in wear and very pure in tone.

As is generally known, reception of long-distance short-wave stations is often inconsistent and many stations require very careful tuning before they can be heard with clarity. An efficient receiver is, of course, an important factor, but really sensitive phones are essential, and we have no hesitation in recommending Ericsson Supersensitive Headphones. Our experience with these has shown that they are very reliable and extremely efficient.

Apart from one small increase at the beginning of the war, the price remains unaltered. They are made in three resistances, 120, 2,000 and 4,000 ohms, the price being the same for each type.

* * *

Mr. F. Lewin, of 97 Bryant Road, Kettering, Northants, informs us that he has available back numbers of TELEVISION right from the first issue, which he is prepared to dispose of at a low figure.



Radio, gramophone, amplifying and control equipment for a factory installation.

MANY tests have been made as to the percentage increase in production obtained in works when music is broadcast. According to Report No. 77 entitled "Fatigue and Boredom in Repetitive Work" made by the Medical Research Council Industrial Health Board, the average rise in production is usually not less than 6 per cent.

Broadcast Music To Speed-up Production

Details of a Complete Installation

A complete installation of this kind usually includes provision for radiating gramophone music, broadcasting B.B.C. programmes, and general announcement facilities.

The apparatus required for radiating gramophone music consists of a playing desk and an amplifier, these being connected via a control panel to speakers placed in shops or work-rooms as required.

A system of this nature has been installed at the Osram-G.E.C. Lamp Works at Hammersmith.

The processes in the majority of the production departments of this factory are concerned with the manufacture of radio valves and lamps of several categories. They are of the most pronouncedly repetitive nature, and are typical of the kind encountered in small part mass production.

The installation, besides providing gramophone music, comprises equipment that enables it to be used both for the diffusion of radio broadcasts, and for A.R.P. and other "announce-

ment" purposes. Two microphones, two hundred and twenty speakers, amplifying apparatus, record-playing desk, radio and control panels are included.

Apparatus Used

The amplifying and associated equipment which comprises the system is situated in a control room which is deep in the heart of an underground part of the factory chosen for its invulnerability. At one end of this room, as can be seen from the photograph, the apparatus is mounted in convenient racks.

The amplifier has three 100-watt channels, taking the microphone, gramophone and radio inputs through a remotely controlled relay panel.

The remotely controlled relay panel allows appropriate switching from the telephone exchange or con-

(Continued on 3rd page of cover)

THE PHOTO-ELECTRIC CELL IN INDUSTRY

Photo-electric Control of Paper Registration IN THE PRINTING INDUSTRY

By E. W. Forster, B.Sc., A.M.I.E.E.
British Thomson-Houston Research Laboratory

PHOTO-ELECTRIC equipment may be used to control the rate of feed and the position of a pre-printed web of material with respect to the operating cycle of a machine, using, or working on, this material. Typical applications are provided by packing machines, wrapping machines, paper bag making machines, and web inserters for printing presses.

In most cases draw rolls are used to pull the paper from the pre-printed roll and feed it into the machine where a knife or cutter or some other device performs the necessary operation on the paper web. It is necessary to maintain register between the design on the paper web and the operation being performed by the machine. For instance, on a wrapping machine each wrapper must be cut off in the same position (within limits) with respect to the design on the wrapper.

When the machine is started, the design on the web may be in register with the cutter, but any discrepancies in the gearing, diameter of draw rolls, slip at draw rolls, or stretch in paper will result in an accumulation of errors which will soon throw the web out of register after a few operations of the machine.

An error of only 0.01 in. in the cut-off length becomes a total of 1 in. in 100 operations of the machine unless some means are employed to correct the position of the web, when the error amounts to the maximum which can be tolerated; usually something of the order of $\pm \frac{1}{8}$ in.

Detection of Error and Correction

On high-speed machines it is obviously quite impossible for an operator to make this correction by observation of the web and even at slow speeds it becomes a very tiring business. However, the detection of error and subsequent correction of web can be done automatically by photo-electric register control.

At the time that the design is printed on the web a small register mark about $\frac{1}{2}$ in. by $\frac{1}{8}$ in. is also printed, usually in the margin where it is clear of other printed matter.

When the paper is subsequently passed through the machine which performs the necessary operation on it, the register mark passes through an area scanned by a photo-cell, and by illuminating this area, a change in photo-cell current is produced every time the mark passes the photo-cell. The photo-cell impulse is amplified by a valve amplifier which impresses a voltage impulse on the grid of one thyratron tube when the mark arrives late with respect to the cut, and on another thyratron when the mark arrives early. The

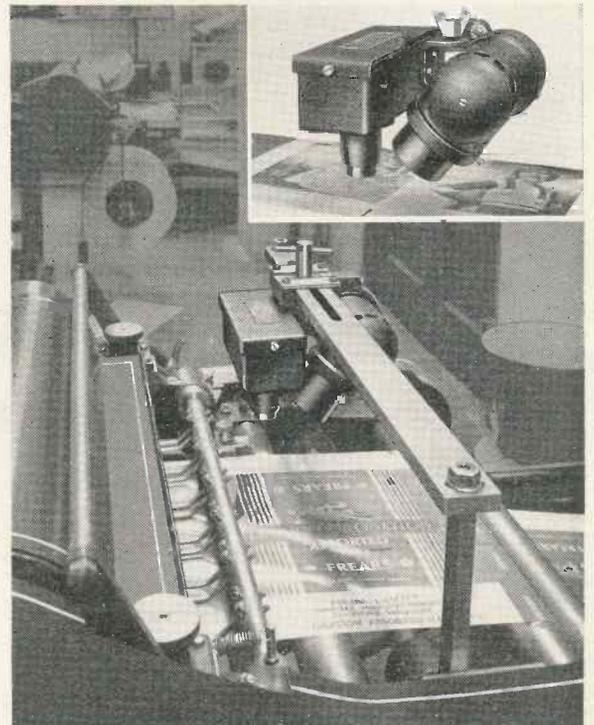


Fig. 1. Biscuit wrapping machine with (insert) photo-electric scanning head.

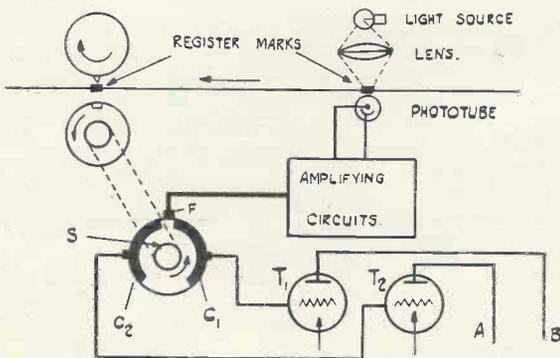


Fig. 2. Web in register. Photo tube impulse occurs when control circuits are broken; neither control circuit is energised.

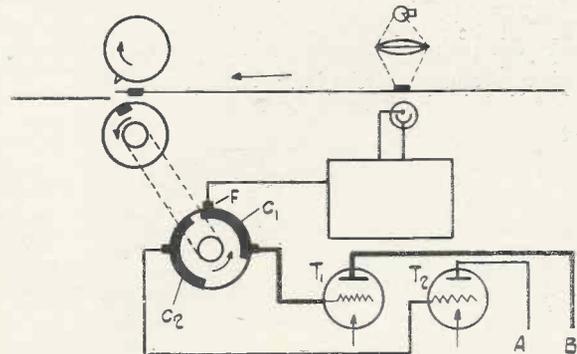


Fig. 3. Web running behind mean register position. Photo tube impulse is transmitted to T1 and circuit B is energised to advance web.

A RECORD OF PATENTS AND PROGRESS

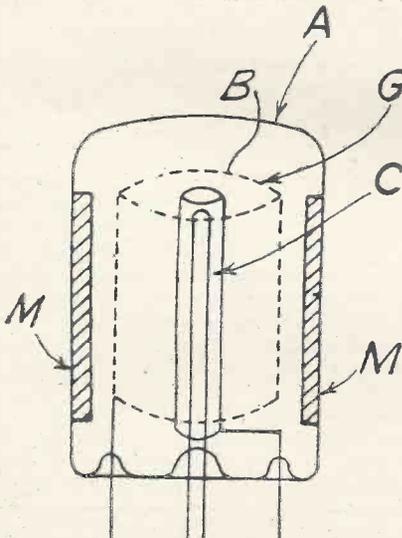
RECENT DEVELOPMENTS

PATENTEES

Telefunken Ges für Drahtlose Telegraphie m.b.h. :: M. von Ardenne and Siemens and Halske Akt. :: A. F. Burgess :: Marconi's Wireless Telegraph Co., Ltd. :: Kolster-Brandes Ltd., and C. N. Smyth :: Belling and Lee Limited and F. R. W. Trafford (Drawing) :: Automatic Signal Corporation.

Short-wave Generators (Patent No. 517,526.)

Very short waves, extending into and beyond the infra-red part of the spectrum, are generated by bombarding selected materials by high-speed electrons. The action is similar to the known process of producing visible waves from a fluorescent screen by electronic bombardment, as in a cathode-ray television



Short-wave generator, Patent No. 517,526.

receiver, except that, in the present case, the waves generated are considerably longer.

As shown in the Figure, the electrons liberated from an indirectly-heated cathode C are accelerated by a grid G towards an anode A which is coated with a special layer M capable of liberating waves of the desired frequency. The layer M is made of a selenide or telluride of zinc, cadmium, or mercury mixed with metallic copper, silver, or cadmium, according to the particular wavelength required. The oscillations so produced may be modulated by inserting a second grid between the cathode and anode. The indirectly-heated cathode C may be replaced by a spark-discharge electrode, in which case the containing

tube is gas-filled.—Telefunken Ges für drahtlose Telegraphie m.b.h.

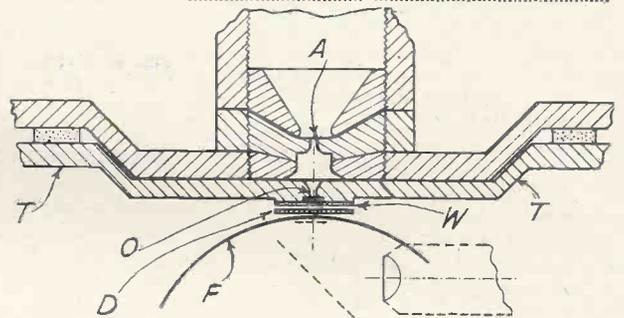
Electron Microscopes (Patent No. 518,951.)

The object to be examined is placed in the track of a scanning beam of electrons having a diameter of less than the thousandth of a millimetre. The electrons passing through the object, or those diffracted, diffused,

using them to cause a change in the brightness of a reflecting surface. The resulting change is indicated by a photo-sensitive cell, so that no undesirable inertia effects are involved at any stage in the process.

In the drawing, the force to be measured is indicated by the arrows F, which are applied to bend or "arch" a small membrane M. A ray of light from a source S is focused

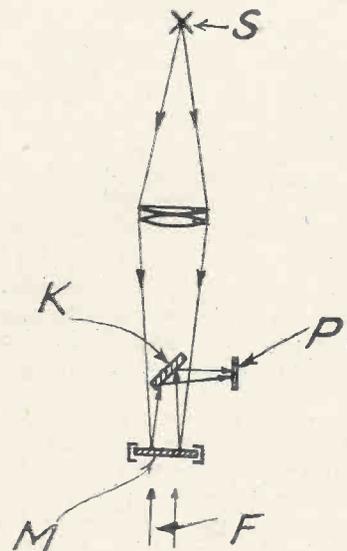
Diagram of magnetic lens for electron microscope. Patent No. 518,951.



or reflected by it, are then re-focused upon a photographic film, so as to form a magnified image of the object, or of its crystalline or other structure.

The drawing shows the construction of the magnetic lens inside the cathode-ray tube which forms the electron microscope, together with the aperture A through which the scanning stream of electrons passes on to the object O. The latter is placed on a thin plate W of collodion, which is cemented to the outer wall T of the cathode-ray tube, and forms a "Lenard window" to allow the passage of the scanning electrons on to a photographic film R, where the image is recorded. A diaphragm D, with an adjustable aperture, is placed between the collodion "window" and the film F. The object O can be mounted on the outside surface of the collodion plate, if it is desired to examine it in free air.—M. von Ardenne and Siemens and Halske Akt.

upon the diaphragm, so that any change in its effective surface due to the arching causes a corresponding change in its surface brightness. This change in brightness is measured by diverting the reflected rays by a mirror K on to a photo-electric cell P.—A. F. Burgess.



Method of measuring electric strains by means of photo-cell. Patent No. 519,417.

Photo-electric meters (Patent No. 519,417.)

Purely mechanical forces, such as stresses and strains, are measured by

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Electron Multipliers

(Patent No. 520,117.)

The secondary-emission electrodes of a multiplier tube are made substantially L-shaped in cross-section, and are arranged in two rows, one above and the other below the main axis of the tube. The limbs of the electrodes overlap each other in such a way that the secondary electrons (emitted when a ray of light strikes against the photo-electric cathode) are "shepherded" between them, and so made to follow a zig-zag path through the tube. In this way, they strike each target electrode in succession, until the amplified stream is collected by the output electrode.

Owing to the shape of the electrodes, this path is followed without the necessity of having to use any auxiliary focusing means. Another advantage is that any positive ions which may be liberated, when the main stream strikes against the targets, are collected by the longer limbs of the L-shaped electrodes, and are so prevented from "choking-up" the tube, or affecting the straight-line response required between input and output.—*Marconi's Wireless Telegraph Co., Ltd.*

Scanning Control

(Patent No. 520,235.)

Provision is made in a television receiver (a) for simultaneously adjusting the horizontal and vertical sweep of the scanning voltages, so that any desired part of the picture can be enlarged, or shown as a close-up, on the screen, and (b) for centring different parts of the picture on the screen.

For magnifying the image, the output from the "framing" amplifier is controlled by a potentiometer in its grid circuit, whilst that from the line amplifier is controlled by a reverse feed-back resistance in its cathode circuit; both these controls are ganged together for simultaneous operation.

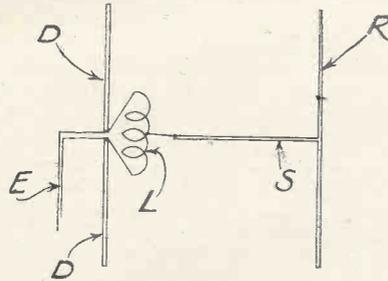
For centring any required part of the picture, two auxiliary deflecting-coils are provided. These are connected in a bridge circuit so that they carry no current during the normal operation of the set. When desired, they can be independently energised, through a single control, for bringing any selected part of the picture to the centre of the fluorescent screen.—*Kolster-Brandes, Ltd., and C. N. Smyth.*

Television Aerials

(Patent No. 520,628.)

An aerial, of the dipole-and-reflector type, is arranged so that it can be used for receiving either television signals, or the medium and long-wave broadcast programmes, at will. In the latter case, the spacing-rod between the dipole and reflector, as well as the reflector itself, both serve as capacity loading, and separate down-leads are used for the two types of signal.

Alternatively, as shown in the Figure, the dipole D, Di and reflector R are coupled together through a



Dipole aerial for reception of television and broadcast programmes. Patent No. 520,628.

coil L having a low impedance to medium and long wavelengths, so that the whole unit, including the spacing rod S and reflector R, serves to pick up the ordinary broadcast programmes and feed them to the set through the down-lead L.

For television frequencies, however, the coil L acts as an effective choke, and the signal pick-up is confined to the dipole D, assisted only by the re-radiation effect of the reflector R. In this arrangement, the same down-lead E is used in both cases.—*Belling and Lee, Ltd., and F. R. W. Stafford.*

Traffic Detectors

(Patent No. 521,339.)

It is well known that when a body containing iron or steel passes through a magnetic field, it provides a better passage for the flux than ordinary air. The field is therefore momentarily strengthened and an electromotive force is generated. This principle is used to detect the passage, say, of a motor-car along a road, and to cause it to operate traffic lights automatically.

A pair of magnetised iron bars are laid down, just below the surface of the roadway, and spaced a few inches apart. The magnetic field spreads above the surface and is momentarily strengthened by the iron in the

wheels and chassis of a passing car, thus producing a voltage "kick." This is used to operate a relay and so record the passage of the vehicle, and, if necessary, to operate signalling lights. By arranging the windings of the magnetised detector unit in series opposition, the device can be arranged to respond only to vehicles travelling in one direction and not in the other. If necessary a thermionic amplifier is used to amplify the initial voltage impulse, induced by the passage of the car.—*Automatic Signal Corporation.*

Summary of Other Electronic Patents

(Patent No. 513,776.)

Cathode-ray dispersion screen made of alkali-halide crystals for projecting a televised picture on to a viewing screen located outside the C.R. tube.—*Scophony, Ltd., and A. H. Rosenthal.*

(Patent No. 513,810.)

Volume control for adjusting the gain of the radio and intermediate-frequency amplifiers in a television receiver.—*The General Electric Co., Ltd., and D. C. Espley.*

(Patent No. 513,984.)

Method of scanning and synchronising in which the line and the frame impulses are distinguished by differences in the "slope" of each leading edge.—*Hazeltine Corp.*

(Patent No. 514,304.)

Four-terminal network for coupling the valves in a wide frequency-band amplifier, suitable for television.—*Marconi's Wireless Telegraph Co., Ltd., and N. M. Rust.*

Rotary Convertors

There is at the present time a steadily increasing demand for small power rotary convertors both of the D.C./A.C. and D.C./D.C. types. The uses of this class of machine are many, particularly for radio, amplifiers and public address systems. A very complete range is manufactured by Chas. F. Ward, of 46 Farringdon Street, with outputs from 60 to 250 watts.

The machines are of particularly sturdy construction and embody modern scientific principles of design. Commutators and slip-ring assemblies are of unusually heavy build, giving long life, and trouble-free commutation.

Both double wound and single wound armatures are available, the former being most suitable for radio applications.

Prices range from £9 to £15 according to output and type, and designs are available for a very full range of input and output voltages.

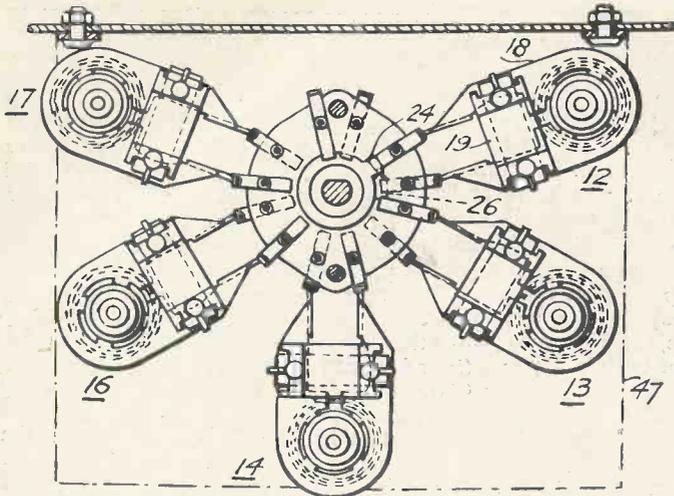


Fig. 3a. Plan of unit.

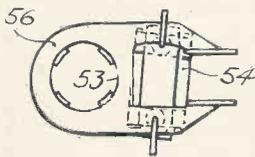
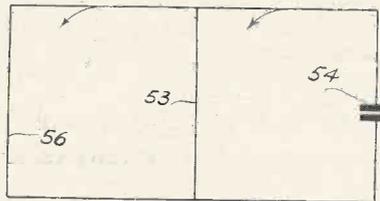


Fig. 4 (left). Primary coil design for use with high frequencies.
Fig. 5 (right). Method of coupling primary and secondary windings.



mission line, one in each conductor of the line, for the purpose of rejecting the sound signal of an adjacent television channel. In this case the con-

denser is adjusted along the legs of the U and soldered at a point where the unit is tuned to the undesired sound signal.

A New Projection System for Large-screen Television Receivers

TELEVISION receivers of the projection type are usually provided with a lens which projects on to a suitable screen a magnified image of the picture reproduced on, for example, the fluorescent screen of a small cathode-ray tube. In such receivers a compromise is usually made in the focus of the lens between providing good illumination of the image as seen from an axial point conjugate with the aperture of the projecting lens, and average illumination, as seen over a wider angle, by providing that the light emerging from the lens is approximately parallel.

The use of the special lens system about to be described enables optimum light distribution to an audience to be achieved and this result is obtained by a lens the components of which are aspherical, as in the case of two cylindrical lenses arranged at right angles. The two lenses are made to be of unequal power, thus resulting in a spherical cylindrical combination having two foci consisting of line images at right angles to one another.

Such a lens combination provides two

images, a primary image near the lens and a secondary image further away, and the primary image is used to satisfy the illumination conditions required by observers placed near the screen, the secondary image being used to satisfy observers further away from the screen.

A lens of the type required to produce the effect referred to may be manufactured by pressing a sheet of plastic transparent material with a wax matrix in which ruled parallel grooves are formed. The angle of the grooves is progressively increased from the central axis in the plane of the lens so as to produce the required configuration of the surface of the sheet and the lens rulings may be formed either both on the same side of the sheet or one on each side.

The lens so formed may be used in conjunction with a diffusing screen of the ground glass or transparent type, or the lens elements or ribs on the surface may be formed to give the required diffusing action. Such a diffusing action of the lens ribs may be produced by cutting the grooves in the wax blank or blanks forming the prototype

of the two component cylindrical lenses with a cutter having a curved edge so that the optically active face of each groove, besides having the appropriate angle required due to the cylindrical lens formation of which it constitutes a part, has such a curvature that it is in fact an elongated cylindrical lens itself.

As the rulings constituting the two cylindrical lenses intersect at right angles, the combined field lens and diffusing screen will consist of a mosaic of elementary sphero-cylindrical lenses, as well as constituting as a whole the main lens, or lens system, with sphero-cylindrical properties. The curvature of each groove is chosen to suit the vertical and horizontal distribution of light demanded by the viewing angle it is desired to preserve or set up.

The action of the screen may be explained as follows:—

A narrow ray of light from the projection lens falls upon the screen and its direction is changed both in horizontal and vertical planes due to the main sphero-cylindrical properties of the screen, so that the light travels towards the audience. In addition, the ray on emerging from the lens will no longer be a narrow pencil, but will be in the form of a divergent cone of somewhat elongated cross-section, the angles of divergence being determined by the required viewing angles.

It is obvious that if the cylindrical components have equal curvature the combination will, in fact, be a spherical lens, but the method described retains the advantage of making it possible to produce the diffusing screen integral with the lens rulings. Also, in the case of a spherical Fresnel lens, the side of the viewing screen is limited by the difficulties in providing suitable presses and engraving apparatus. An additional advantage accrues, therefore, to the type of cylindrical lens combination described, in that it is possible to rule each of the lenses in sections and fit them together, subsequently to form a large field lens such as would be required for demonstration of television in a theatre.

“Magnetostatic Focusing of Electron Beams”

Correction.—In the article with the above title which appeared in the July issue, on pages 297-301 there are two typographical errors which possibly have puzzled readers. These are as follows:—

A few lines below Eq. (14p)—

$$z = v = \sqrt{2qE/m}$$
 should read

$$\frac{dz}{dt} = v = \sqrt{2qE/m}$$

and in Eq. (22p)—

$$(H_z \cdot \sqrt{q/8mE} \cdot z + B)$$
 should read

$$(H_z \cdot \sqrt{q/8mE} \cdot z + B).$$

R.C.A. Tube Data

A Review of American Handbook Information

THE last few years have seen remarkable progress in the development of electronic tubes and other apparatus, as well as their applications to various branches of practice. This development has been so rapid and far reaching that it would be difficult indeed to predict the future trend of events in this sphere. It can safely be assumed, however, that progress will continue, and that we may expect radical future changes resulting from the extending uses of electronic equipment.

A large proportion of contemporary development in this direction has taken place in America, where the use of electronic appliances of all kinds is already extensive, and still increasing rapidly. Evidence of this progress is to be found not only in the numerous items of electronic research which are reported from time to time in America, but also in the vast literature on the subject which has made its appearance there. The number of American textbooks dealing with the industrial applications of electronics provides in itself an indication of the amount of attention devoted to the subject.

In the radio field and related spheres of activity, the Radio Corporation of America, known universally as the R.C.A., occupies a prominent place and has brought to industry the advantages resulting from standardisation and co-ordination on a large scale. R.C.A. publications have supplied a definite need in this direction by giving essential data for a wide range of tubes of different types.

Complete R.C.A. tube data has recently been issued in the form of handbooks with loose-leaf data sheets so as to facilitate the introduction of new or revised material. The sheets are classified under three headings, representing respectively receiving types, transmitting types and miscellaneous types. The data given for each type include the price, intended uses, ratings, physical dimensions, terminal connections and characteristics in the form of curves plotted to scales large enough for the solving of design problems. The loose-leaf binders are of black fabricoid, imprinted in gold, and are made in three forms covering respectively all types (Handbook Series HB-3) with prong or ring binders, and the Receiving-Tube Handbook (HB-1). The foreign subscription prices for these volumes are respectively \$5.25, \$5.75 and \$3.75. These prices include the first year's service of sheets giving new

or revised information, subsequent issues of which cost \$2.00 annually for volumes including all types of tubes and \$1.50 for receiving types only.

Service sheets are sent during the subscription period to the subscriber whose name appears in the R.C.A. records against the serial number of the handbook. In case the handbook is re-sold or transferred within any subscription period, service sheets are sent to the new owner if the change is notified. The sheets measure 6 $\frac{3}{4}$ in. by 3 $\frac{3}{4}$ in. and are photolithographed.

The preface to the handbook of all types states that it is the outgrowth of the increasing demand for a one-volume reference to the characteristics of all R.C.A. tubes. Some idea of the scope covered may be obtained from the fact that the general tube list contains designations of no less than 332 types. This total is made up of 200 receiving types, 78 transmitting types and 54 miscellaneous types.

Basic Information

The prefatory information includes some useful definitions of a basic nature, such as amplification factor, input capacitance, etc., and there are also definitions of the various forms of amplifier: Class A, AB, B, BC and C. Information is given concerning the alternative types of cathodes used in different tubes. In connection with the thoriated-filament type, a procedure is specified for reactivating the filament in the event of reduced emission due to the accidental application of too high filament or plate voltage, provided that the over-voltage has not persisted too long. In some cases it is possible to secure a few hundred extra hours of life in this way, although filaments occasionally burn out during the process, which includes flashing at three times normal voltage for periods up to one minute.

A particularly interesting and useful feature is the index of receiving types according to use and cathode voltage. The index relates to 36 tube types which are shown by experience to meet the needs of design engineers for practically all types of radio sets and the majority of applications where receiving types are used. The advantages of standardising upon a limited number of types in this way may be summarised as follows:

1. Lower initial cost of tubes.
2. Advantage from improved deliveries.

3. Improved quality, resulting from increased skill of operatives working on one type of tube.
4. Reduction in number of stock parts required, such as condensers, resistors, etc., for variety of tube types.

Some of the data sheets bear a star near the index corner, indicating that the maximum rating of the corresponding tube is to be interpreted in accordance with R.M.A. Standard M8-210, which defines operating conditions. The design of the cathode in receiving tubes must be such as to ensure that emission will not fall off unduly with a small drop in voltage and that the life will not be excessively shortened with a small rise in voltage. The tolerance of voltage allowed is usually 5 per cent. above and below the nominal figure.

A note of warning is sounded here against the measurement of cathode voltages at points other than the corresponding socket terminals. It is also pointed out that a high-resistance voltmeter is necessary in order to avoid inaccuracy, especially when the current is small. Practical hints and reminders of this kind are of the greatest help in many cases where operating conditions require investigation.

It is a little difficult to know why the so-called gas triode OA4-G should be included under the classification of receiving types. This tube is described as a cold-cathode starter-anode type, and the starter-anode requires so little energy to initiate the main anode-to-cathode discharge that it becomes possible to obtain remote control of relays, for example, by means of electrical impulses at radio frequencies superimposed on the same power line. Although this application may justify the inclusion of the tube in the receiving section, it would appear more at home under the heading of miscellaneous types along with the conventional gas triodes. In fact it seems rather unfortunate that the term gas triode should be used at all for the OA4-G, especially in view of the fact that the same name is used for the hot-cathode control-grid types 884 and 885, whose operation and principles are essentially different from the OA4-G.

The data given concerning receiving tubes includes in most cases some typical operating curves, such as anode current versus anode volts and anode current versus grid volts for ordinary types. In the case of combined valves, such as double-diode triodes, particulars are given for both units, or alternatively reference is made to curves given under another type designation with the same characteristics. A useful feature of the data is a specification of the mounting

(Continued on page 376)

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"R.C.A. Tube Data"

(Continued from page 374)

position, with supplementary instructions on horizontal mounting where this is permissible.

Transmitter Tubes

The transmitter tube section contains information of a similar kind relating to tubes mainly employed in transmitters and associated equipment. In this case an index has been arranged so as to classify the tubes by (1) use, and (2) power output. This, incidentally, is a feature which would have been very useful in the receiving tube section. As it is, there is a rather imposing array of different types, listed in order of designation, through which one must search patiently in order to discover a tube likely to fulfil the requirements. It would seem quite possible, and very helpful, to include an index guide to specific types.

In the transmitting tube guide the types are listed in relation to plate input, plate volts, plate dissipation and filament volts for the different classes of amplifier. The range in size is from type 841, for example, with an overall length of 8 3/8 in. and a maximum plate dissipation of 12 watts, to the type 898,

over 60 in. long and with a maximum plate dissipation of 100 kilowatts. Tables are given showing the relationship between operating frequency and permissible tube ratings for transmitter types. These show the limiting frequency in megacycles for 100, 75 and 50 per cent. of the maximum rated plate volts and plate input, as well as the resonant frequency of the individual tubes. The data sheets for specific types give electrical particulars, maximum ratings for typical operating conditions, dimensions, bulb particulars and average characteristics.

The miscellaneous tube section is of particular interest from the viewpoint of engineering electronics, as distinct from the radio field. Some idea of the range of apparatus dealt with may be gained from the following list:—

- Cathode-ray tubes.
- Gas triodes and tetrodes.
- Iconoscopes.
- Kinescopes.
- Monoscopes.
- Photocells (gas and vacuum).
- Rectifiers.
- Video beam tubes.
- Voltage and current regulator tubes.

Some of the types seem out of place in this section; for example, types 840 (R.F. pentode) and 954 (detector amplifier pentode).

An interesting item is the type 920

gasfilled twin phototube, having two caesium-coated cathodes, each with a window area of 0.31 sq. in. The reduction of sensitivity with increase of frequency is approximately 20 per cent. between 100 and 10,000 cycles, or from 75 to 60 microamperes per lumen. A figure of not more than 10 is given for the gas amplification factor, defined as the ratio of sensitivity at maximum anode voltage (90 volts D.C. or peak A.C.) to sensitivity at a voltage sufficiently low to eliminate the effects of gas ionisation. This is at about 25 volts.

In many cases the information is amplified by means of typical circuit diagrams, which are very helpful. In fact, one might wish to see more of these, although it would be necessary in most cases to delete other information or reduce the size of the characteristic curves if extra pages were to be avoided.

It is inevitable that in the assemblage of such a vast amount of information, a few errors should occur. Thus under types 2050 2051 (gas tetrodes) the tube voltage drop is given as 8 and 14 milliamperes respectively. Slips of this kind, however, detract but little from the value of the information as a whole, which is of the greatest interest and service to all concerned with applied electronics in its various branches.

G. WINDRED.

RADIOMART

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"IF INVASION COMES. Every radio amateur outside H.M. Services should, unless already engaged on Government work:—

Take steps to ensure that his receiving gear is in first-class working order;
See that sufficient material in the way of aerial wire and accessories is available."

Note.—These brief extracts are taken from a leader article in the July issue of *The T. and R. Bulletin* published by The Radio Society of Great Britain.

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 - T.850Y—350/350v. 150 mA. 4V6A, 4V2.5A ... 15/-
 - T.464919—10V4A, Primary Tapped 110-250v. ... 5/6
 - T2311A—230 to 110v., 100 watt Auto Transformer ... 12/6
- Many others also in stock.

CHOKES

The following chokes are interleaved and impregnated.

- T7007—250 mA., 135 ohms., 20-8 Hy. cadmium shrouded 12/6
- T7007A—150 mA., 250 ohms 30-12 Hy. cadmium shrouded ... 12/6

- 100 mA. 20 Hy. 500 ohms., unshrouded ... 4/11
- 60 mA. 15 Hy. 250 ohms ... 1/11

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for Government use.

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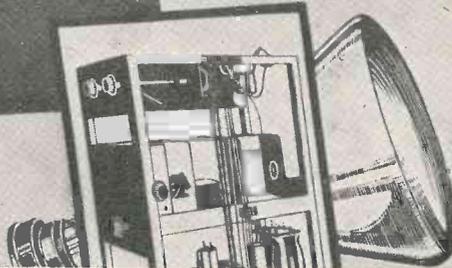
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- DPA.1 complete with 30 ft. down lead ... 12/6
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