ELECTRONICS AND TELEVISION & SHORT-WAVE WORLD

1/6

APRIL, 1940

THE PHOTO-CELL IN THEORY AND PRACTICE

THE FIRST TELEVISION JOURNAL IN THE WORLD

BERNARD JONES PUBLICATIONS LIMITED LONDON

THE

TELEVISION SOCIETY AND THE WAR

Now that the war has put a temporary stop to television developments, it is more than ever necessary that the work of the Society should continue.

At its new headquarters at 17, Featherstone Buildings, Holborn, a reference library of books and data is available to members, and a museum of historic apparatus is in course of assembly.

This will form a valuable record of work done in the television field, and will enable all interested in the science to keep track of the progress made until normal working is resumed.

Television engineers are invited to register with the Society, who will be pleased to put them in touch with fellow workers and keep them informed through the medium of the Journal.

Full particulars of membership qualifications may be had from the Hon. General Secretary:—J. J. Denton, 17, Anerley Station Road, London, S.E.20.

THE TELEVISION SOCIETY

(Founded 1927)

President: Sir AMBROSE FLEMING, M.A., D.Sc., F.R.S.

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News and Views

IT is no secret, of course, that both the Allies and Germany have considered the possibilities of television in war and it was known that during the past two years many developments in Germany were purposely withheld from publication on account of their possible use in this respect. Naturally all information regarding the subject is taboo at the present time but it is interesting to note some recent tests in U.S.A., in which a television transmission was made from an aeroplane flying over New York and the picture was received near Schenectady, a distance of 129 miles. It is stated that the picture was so distinct that work being done on buildings in New York could be seen, and the observers were also able to distinguish waves in the harbour.

The transmitter in the plane was a new light R.C.A. model and its signal was picked up and retransmitted by the N.B.C. transmitter on the Empire State Building. The performance is regarded as one of great scientific importance and possibly forecasting a new era in warfare. The commander of the Schenectady Army Depot, termed the performance as "extremely significant" from a military viewpoint. "It is likely to revolutionise artillery fire," he said.

The Television Service

An interesting matter for reflection on the possibility of a limited television service being instituted during the war is contained in a statement regarding the personnel of the Hollywood television station operated by the Don Lee Broadcasting System.

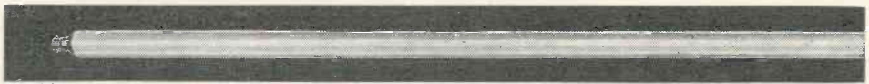
This station is on the air approximately $10\frac{1}{2}$ hours a week and has a permanent production staff of seven technical men and two production men on full time. There are also three part time assistant production men.

A camera is used to film outside broadcasts, and to date viewers have seen two fires, a hurricane, an aquaplane race, a Tournament of Roses parade, and many other items of local interest.

The above staff, of course, is exclusive of artistes but as a considerable amount of film is employed, we assume that expense in this connection is reasonably limited. Cost and the limited number of viewers has been one of the most important factors in the decision recently made not to reintroduce the London service at the present time and our contention is that a solution in this respect could be found with immense benefit to the industry.

CONTENTS FOR APRIL

A New 80-watt Fluorescent Discharge Tube



A NEW fluorescent discharge lamp of the tubular mercury-vapour type capable of producing illumination of daylight quality at a low temperature has been developed by the Ediswan Company.

The commercial applications of a lamp of this description are numerous, particularly at the present time when in many instances artificial illumination is necessary even during daylight hours, and in many cases where correct colour rendering is of importance, as in the printing, dyeing and textile industries, artificial illumination of this type is essential.

A photograph of the lamp is shown above and it will be seen that it consists of a glass tube approximately $1\frac{1}{2}$ in. in diameter, fitted at each end with a standard B.C. cap, the overall length being 5 feet.

The interior surface of the tube is coated with a film of fluorescent medium, the function of which is to convert the short-wave (invisible) U.V. radiation produced by the discharge tube into a visible radiation of longer wavelength. The nature of this film of fluorescent material is such that the composition of the light emitted very closely approaches that of cold daylight.

Enclosed within each end of the tube are the electrodes between which the electric discharge takes place: the tube has a low pressure filling of inert gas for the purpose of initiating the discharge and also a small quantity of mercury.

An accessory unit comprising a choke, thermal switch and suppressor condenser is required for the operation of each lamp; in addition, a condenser of suitable size must be employed for each lamp or group of lamps if power factor correction is desired. The thermal switch and suppressor condenser are combined in the choke unit. The thermal switch is contained in a small bulb and it is, therefore, easily replaceable should it become damaged.

The lamp is connected to the supply mains in series with the tapped choke B, as shown in the diagram. This choke is necessary for current stabilisation. Upon switching on, current flows via the choke, through the electrode coils D and D, the circuit being temporarily completed through a thermal switch A (which is initially closed) for about three seconds, during which time the temperature of the electrodes is raised sufficiently to provide the necessary electronic emission to initiate the discharge between them.

After a period of about three seconds, the thermal switch automatically opens, causing a momentary rise of potential across DD, and the immediate establishment of a discharge between the electrode. C is the condenser for power factor correction if this is desired.

The lamp is for use on A.C. mains 200-250 volts, and the consumption is 80 watts with a light output of 2,800 lumens, with an efficiency of 35 lumens per watt. The surface brightness of the tube is 3 c.p. per sq. in. and the average life 2,000 hours.

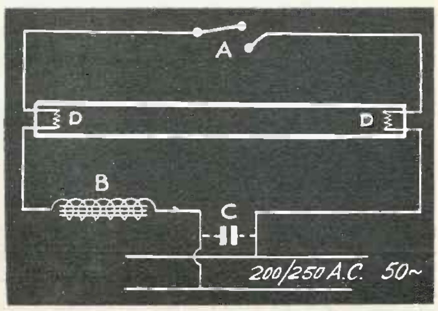


Diagram showing method of connecting discharge to the mains

A trough reflector is available for this lamp with the control gear housed in a sheet metal box. The reflector is fixed to this box by means of angle brackets, which also provide the angular adjustment of the fitting.

"Theoretical and Practical Aspects of Photo-cells"

(Continued from preceding page.)

amplify the initial photo-current a number of times. However, there are certain subsidiary effects which cause complications. In particular, the frequency response of a gasfilled cell; the modulated light is not so good as that of a vacuum cell, and its stability is definitely more variable.

If cells are to be used for sound film work, in which the light is modulated at audio frequency, it will be found that we cannot obtain a gain by ionisation of more than about five or six times, without an appreciable drop in sensitivity at 10,000 cycles per second. The relation between the output current at the working voltage—usually 90 volts—and the pure photo-current, measured at about 20 volts is known as the gas factor and an upper limit of gas factor is usually fixed. The exact reason for the drop in frequency characteristic is rather obscure. It was at first thought to be due to the fact that the passage of heavy positive ions from the point where they were produced back to the cathode was very slow because of their mass; but this delay by no means accounts for all of the falling frequency response.

Another effect is possibly the release of electrons, either thermionic or secondary as a result of bombardment of the cathode by positive ions. There is no doubt that an appreciable quantity of Argon gets trapped in the cathode surface during running, thereby lowering the effective gas pressure, and causing a drop in output sensitivity. On standing in the dark, however, some of this gas comes out again and the cell, when re-illuminated, will be practically as good as before. This may be accelerated by gentle baking of cells at about 130° C. to facilitate the release of the trapped Argon.

It is possible to construct gas-filled cells with improved frequency response by introducing an electrode at cathode potential close to the anode, which serves to shorten the path of the positive ions, and to prevent undesirable cathode bombardment. Improved frequency response may also be obtained by filling with other rare inert gases, such as Krypton or Xenon.

Recent Developments in Electron Engineering

From the annual reports issued by leading manufacturers, 1939 saw many notable developments in radio and electron engineering. The General Electric Co. and The British Thomson-Houston Co. have described some of these developments of which the following will be of interest to readers.

The General Electric Co.

AMONG lamps designed for special purposes the extra high pressure mercury vapour compact source lamp has been developed by the G.E.C. in various sizes. Some of its applications were discussed before the Illuminating Engineering Society of London, in a recent paper* which gave the results achieved by the use of a $2\frac{1}{2}$ kW Osira compact source lamp in a 14 in. diameter mirror. This lamp gave only 30 per cent. less screen illumination than a 55 ampere high intensity arc. The colour of the light from the mercury lamp was found very satisfactory for the projection of black and white films and lantern slides, although for dull red and near-red colours in colour films improvement could be gained by the use of a suitable filter.

Other applications to different forms of projection apparatus are also being thoroughly explored.

Cathode-ray Tubes

The rapid increase in output of cathode-ray tubes to meet the public demand for television brought with it many manufacturing problems requiring chemical and physical research. The solution of these problems has made possible a high speed of production with maximum economy.

The design of a range of magnetically focused and deflected tubes was completed and 9 in. and 7 in. tubes were put into production, with larger sizes following. These tubes, which are of the triode type requiring only the application of heater, modulator and accelerator volts, are designed for a modulation input of 30 volts and for acceleration voltages of 3,500 to 6,000 volts according to size. These tubes are very short, using wide angle deflection and allowing direct viewing of the picture in a cabinet of small back to front depth. The use of the very successful short 12-in. electrostatically controlled tube was continued and the relative merits of the electrostatic and magnetic methods of operation are still somewhat in the balance when the more distant future is considered. Both are capable of excellent performance.

* V. J. Francis and G. H. Wilson, Transactions of Illuminating Engineering Society of London, Vol. IV., No. 4, p. 59.

Radio Sets

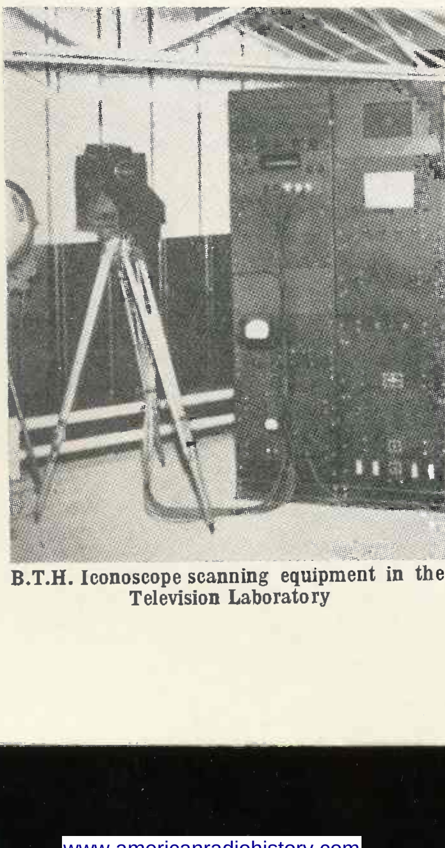
Development had been completed and production commenced of a range of main station and mobile transmitters and receivers operating on the ultra-high frequency bands. The sets are intended primarily for use in connection with police communication systems and the like. Equipments have already been supplied to several of the more important police forces.

Work is proceeding upon crystal controlled transmitters incorporating band switching between multiple frequencies, and a high-grade communication receiver embodying the most advanced technique with reception covering a range of 8.5 to 2,000 metres.

A device which will be found very useful to those who wish to run an A.C.receiver from a D.C. supply, is a D.C./A.C. conversion unit, which is a type of automatic polarity changing switch. When connected to a D.C. source it will operate to give a supply which will be suitable for the operation of a normal A.C. receiver. This unit is capable of supplying sufficient power to drive a 10-valve receiver.

G.E.C. Receiving Valves

The trend towards greater economy in the heater wattage consumption of receiving valves has progressed further by the introduction of the new Uniwatt range of mains valves, the basic types of which incorporate heater cathode systems of 1 watt rating. This achievement has been made possible by many detailed improvements in cathode coating efficiency, mechanical design and glass manipulative technique, resulting in valves not only of low consumption bnt of small physical dimensions.



B.T.H. Iconoscope scanning equipment in the Television Laboratory

The basic heater rating of the range has been so chosen that a wide range of applications can be met. Thus, with a nominal rating of 5.8 volts on the filament and 0.16 amp. filament current, satisfactory working from a 6-volt acumulator is assured and the low basic current rating offers a considerable advantage to the designer of series running A.C./D.C. receivers, where hitherto the dissipation of the power lost in the valve heater limiting resistance has proved a difficulty.

Another manifestation of the same trend towards greater cathode efficiency is found in the new range of 1.4-volt battery valves. A detailed study of the influence of core materials upon the emissive coatings of valve filaments has led to the introduction of battery valves of a nominal 1.4-volt, 0.05-amp. rating, which have such liberal emission reserve that satisfactory performance is maintained when the filament voltage is allowed to fall as low as 1.0-volt.

The diminutive "Acorn" ultra-high-frequency triode and H.F. pentode types, referred to as HA1 and ZA1, have been supplemented by two newcomers, the HA2 and ZA2, of equivalent performance, but with heaters rated at 6.3 volts and pin spacing in conformity with American practice, as distinct from the 4-volt heaters and British Standard pin spacing of their forerunners.

A specialised type of small transmitting valve, the KT8, caters particularly for the lowest wavelength region. This type is a twin pentode incorporating a special form of ring seal mounting and connection scheme, which permits the minimum length of connections to be secured, a factor of supreme importance at the frequencies in the region of 200 mc./sec. where this valve is designed to serve.

Measuring Instruments

A new heterodyne reactance comparator takes the form of a portable mains

B.T.H. Television Research

operated test set and enables coils or condensers to be checked rapidly against standards. Two radio frequency oscillators, one of which is variable, are made to beat against each other. The resultant signal is rectified and heard, a loudspeaker contained within the instrument serving as an aural indicator. The variable oscillator is fitted with a knob and drum drive. An accuracy of ±0.1 per cent. is obtained.

A thermionic test set gives direct readings of A.C. and D.C. voltage and current. The A.C. current range is from .005 microamp. to 5 amperes, the A.C. voltage range from 50 millivolts to 500 volts on frequencies from 25 cycles to 20 megacycles, the D.C. current range from .0005 microamp. to 1 ampere, and the D.C. voltage range from 1 millivolt to 500 volts. A patented feedback circuit of the D.C. amplifier type using negative feedback is employed with a potentiometer input.

The instrument can be supplied either for battery or mains operation. The input impedance of the instrument on D.C. and on radio frequencies, when used as a voltmeter on any range, is 10 megohms so that it can be used for measuring voltages in high resistance circuits with great accuracy, current consumption from the circuit being negligible. The special circuit provides extremely high sensitivity and at the same time prevents the indicating movement from being damaged by heavy overloads.

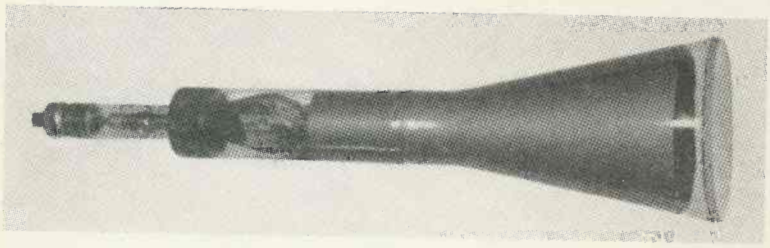
Other instruments which have been introduced include: a new type of "Q" meter for measuring the "Q" of inductances, capacities, etc., at high frequencies; a miniature illumination meter with a range of 0 to 250 foot-candles; and also a slip-on ammeter. The range of valve voltmeters has been extended, and one of the new instruments employs an acorn triode H.F. valve.

British Thomson-Houston Co.

Steady progress in the development of B.T.H. electrical equipment is the result of continued study, calculation, investigation, and experimental work on the part of this firm's large staff of engineers, supplemented by the work of the Research Laboratory which is such an important part of the B.T.H. organisation.

Electrical and Development Section

The development section of the laboratory deals with researches and developments of an electrical, magnetic, or acoustical nature; with measurements of a special character; with cinema projection development, the production of instructional talking films, and illumination schemes and apparatus. It builds in its model room most of the experimental models of new apparatus and looks after the standardisation and calibration of laboratory instruments.



The B.T.H. cathode-ray tube with plane glass screen.

Television

The development of large screen television pictures was being actively pursued until recently. A new projector unit was built during the year, in which the cathode-ray tube with its screen at an angle to the beam co-operated with mirror projection. The experimental projector operates on 40 to 80 kV and the oblique projection is so arranged that the projector may be placed close to the viewing screen without interfering with the line of sight of the audience, and a wide aperture lens of small diameter may be used.

Experience with the original television projector showed the importance of flat screen television tubes for large screen projection, and resulted in the development of a special cathode-ray tube.

Improvements in the projector demanded further improvements in the transmission equipment. The test signal generator and the scanning circuits of the transmitter were reconstructed, and a transmission line was erected between the Television Laboratory and the Acoustical Laboratory where the necessary space is available for large picture projection. The reconstructed camera unit and circuit racks are shown in the photograph.

In parallel with the above work the development of television testing equipment has continued. The study of cinema television in 1938-39 necessitated the construction by the development section of special testing equipment in the form of a signal generator and auxiliary equipment whereby projection type cathode-ray tubes could be tested by means of a stationary pattern derived from the signal generator and applied to the tube under test by wire connection.

A carrier current link was also provided to test the receiving circuits associated with the projection tube and thereby to ensure that the highest possible fidelity was achieved in the absence of B.B.C. television signals.

Many items in this review can only be given the briefest mention, and among these are included photo-electric cells and many forms of radiation devices. Certain work on cathode-ray tubes also comes under this heading. Prior to September considerable research work had been done on high-voltage projection tubes suitable for large scale television, and work had reached an advanced stage showing that pictures could be projected with adequate brilliancy on to screens many square feet in area. To attain a uniform picture on a cathode-ray tube screen a technique has been evolved which enables a glass plane to be sealed to the cathode-ray tube envelope. This end can be of sufficient thickness to give the tube increased rigidity and can be ground optically flat if required. The advantages of a plane fluorescent surface are obvious, and a tube incorporating this feature is shown by the photograph.

A New Valve

Type 257 Gammatron

Heintz & Kaufman, Ltd., San Francisco, Calif., have recently introduced the Type 257 Gammatron, a beam pentode valve in which the elements are constructed entirely of tantalum and are mounted directly on a moulded base without the use of internal insulators of any kind. Thus, it is said to be possible to pump this valve under extreme temperature and to maintain a vacuum under operating conditions without the use of the usual "getter." The elimination of insulators and the unique construction employed reduces feed-back capacity from plate-to-grid to approximately one-third of that found in similar multi-element transmitting valves. Thus, it will operate on higher frequencies without fear of self-oscillation. Another element of design which makes this type of operation practical is the employment of dual screen grid and suppressor grid leaks, which result in very low inductance drop over their short length, and make it comparatively easy to maintain these elements at earth potential.

News Brevities—

Commercial and Technical

NEW studios for the Columbia Broadcasting System are patterned on the fundamental principles of a violin, with panels of hard wood on one side and soft porous wood on the reverse. These panels have something of the appearance of aeroplane wings and are set up about two feet from the actual walls for the purpose of obtaining variable acoustics. They can be turned singly, either wholly or partly, from a central control, according to the wish of the producer.

The "acoustivanes" are the result of a series of experiments for means to facilitate governing of a variety of shading of sound quality.

* * *

Investigation has shown that there are instances where diathermy equipment which has been "keyed" so as to identify it at distant points, can be picked up thousands of miles away. Range, however, which though remarkable, is not the most serious side of the problem. The spread of this interference "all over the dial" is an even greater trouble.

* * *

The first commercial television programme to be transmitted was, it is believed, that of the Roma Wine World's Fair Party on March 2, which was broadcast simultaneously over radio and television from the Don Lee station, W6XAO.

* * *

Valves have the unique property of amplifying small voltages at low frequencies without absorbing power from the input circuit. Electrons leaving the cathode pass the grid so soon after starting out that their time in passage is usually negligible in respect to the length of a cycle. When higher frequencies are considered, however, there comes a point where an electron, leaving the cathode when the grid is at one point in the cycle, arrives when the phase of the grid voltage has changed. This state of affairs is such that the grid acts as though there were a leak from it to the cathode, and power from the input circuit is necessary. Even when the grid is biased beyond the point where grid current flows, this conductance or input admittance appears and damps the input circuit as if a resistor had been placed across it. A type 57 or comparable valve, when hot, is equivalent to 75,000 ohms across the input circuit at 15 mc., 20,000 at 30 mc., and 5,000 at 60 mc. The loading effect increases approximately with the square of the frequency. An R.C.A. 954, using much closer spacing, has an input resistance of about 55,000 ohms at 60 mc., and 15,000 at 112 mc. Large transmitting triodes may have an input resistance of only 3,000 ohms at 15 mc.

* * *

WMAL, owned by the *Washington Star*, of Washington, D.C., has been named the winner of the annual engineering efficiency award given by the General Electric Company to the N.B.C.-operated station with the lowest total of lost time through technical failures. It marks the second consecutive year WMAL has received the award. WMAL was off the air only one minute and two and one-half seconds during its regular operating schedule of more than 6,600 hours during 1939.

* * *

Some time ago we reviewed in this Journal a system of inter-communication developed by the Edison Swan Co. for use in offices. A similar equipment produced in U.S. has the addition of pilot lights, showing whether the point called is engaged and annunciator tabs to show if the station has been called during the absence of the owner. An additional handset enables the called person to cut out the loudspeaker and carry on a conversation in private.

An especially interesting installation is the Bogen communi-phone system which permits communication between elevators in a building. These are units of the "wireless" type and utilise the earthed side of the power line for one side of the circuit and actual earthing (through the car) for the other side. This arrangement eliminates the drawback in many power-line carrier systems of not being able to communicate between different phases of a power system, opposite sides of a three-wire system or between A.C. and D.C. power lines. Such a system as this, operating two-way, can solve many problems involved in the efficient operation of elevators.

* * *

The American Time Products Co., of U.S.A., use an ingenious apparatus for checking the timekeeping qualities of clocks and watches. A two-channel amplifier is used, one portion of which is connected to a standard tuning fork. The output of this is used to drive a drum from a small synchronous motor at a speed of 300 r.p.m. The other amplifier is fed from a microphone and actuates a stylus which marks the drum. When the watch to be regulated is placed on the microphone the tick causes a dot to be marked on the drum, and if the watch is beating at 300 ticks per minute (an average rate), there will be one mark per revolution.

If the watch is neither gaining nor losing the dots made on the drum will be in a straight line across the paper, the stylus being made to travel slowly across the drum as it revolves.

A losing or gaining watch will cause the dots to form a line which slopes across the drum, the inclination of the line showing the rate at which the watch differs from the standard timing.

* * *

A correspondent, Mr. W. I. Flack of Fulham, makes the following suggestion regarding the use of television receivers during the period of the war. He says :—

Now that it is certain that the television service will not be resumed during the war, I would suggest a new field of interest to television enthusiasts.

It has long been known that so-called freak reception of television signals at long distances is possible, amongst them being such occasions as the reception of vision and sound signals from the Alexandra Palace by N.B.C. engineers in New York, the reception of sound signals in South Africa, the continuous reception of sound signals in the Channel Islands, and also vision signals from Rome received there.

More recently there was brought to my notice the reception in England of sound signals of the N.B.C. programmes from New York; doubtless there are other occasions on which long-distance reception has been attained, but the above instances, in my opinion, are sufficient to show great possibilities in this direction.

I would suggest, therefore, that some endeavour be made to receive signals from both America and Italy where regular television programmes are being transmitted.

I do not suggest that regular programme reception is possible, but if sufficient data were to be obtained of signals received and results collated, then it might be a great step to the eventual reception of long distance television, even though at the moment it is considered as freak reception.

Short-wave enthusiasts would also find this a new field of interest.

* * *

The N.B.C. television programmes are transmitted on five days a week as follows :—

English Summer Time.

Wednesday.—8.30-9.30 a.m.
2.30-3.30 p.m.
Thursday.—2.30-4.0 p.m.
Friday.—8.30-9.30 a.m.
2.30-3.30 p.m.
Saturday.—8.30-9.40 a.m.
3.0-5.0 p.m.
Sunday.—8.30-9.46 a.m.
2.30-3.30 p.m.

The vision frequency is 45.25 mc. and the audio frequency 49.75 mc. The programmes are transmitted via New York City, under the call sign W2XBS. The periods in New York are, of course, afternoon and evening.

The Institution of Electronics

Lecture on Wave Mechanics

On April 4, Professor D. R. Hartree, M.A., F.R.S., will give a lecture on "Wave Mechanics" before the Institution of Electronics. The meeting will be held in the lecture hall of the Royal Society of Arts, John Street, Adelphi, London, W.C.2, at 6 p.m., and tickets of invitation can be had on application to Mr. Alex. H. Hayes, the secretary of the Institution, at 27 Fetter Lane, London, E.C.4.

Book Review

Television To-day and Tomorrow, by Sydney A. Moseley and H. J. Barton Chapple (Sir Isaac Pitman and Sons, Ltd., 10s. 6d.).

This book is a fifth edition of a publication which has for its purpose a complete survey of television development in this country. It is, therefore, to a considerable extent historical but it does at the same time provide adequate explanation of each item of progress that has been made. This edition has, of course, been brought up to date and includes such developments as big-screen and colour television. It is very well illustrated with photographs and diagrams.

A Projection Kaleidoscope for Television

A "VISUAL curtain" for television, with changing multiple patterns, is described in "Communications" (New York). The device has been developed by William C. Eddy, video effects engineer of the National Broadcasting Company.

A combination of projectors, mirrors and a lens system constitutes the projection kaleidoscope. The instrument has been used during N.B.C.'s television programmes and has met with enthusiastic audience approval.

The device projects the moving and abstract designs directly on to the plate of the Iconoscope. Eddy describes his device as "a projection kaleidoscope in which pictorial material is multiplied quadrentially by means of mirrors placed at angles to each other.

Although the whole device simulates the general action of the common form of kaleidoscope, new arrangements of mirrors and lenses were necessary to adapt it for television work. Through the use of more than one projector, it is possible to superimpose a second design against the moving kaleidoscopic pattern.

Any design can be reproduced and multiplied in the projection kaleidoscope.

Since the patterns consist, essentially, of shifting light values,

Example of a pattern produced by the projection kaleidoscope.

manual control of light volume is impossible. An automatic gain control is, therefore, incorporated in the unit.

The material to be multiplied in the kaleidoscope is recorded on film, the film being fed continuously through an intricate gate system, thus permitting the constant movement necessary for the formation of this type of abstract design. The rate of feed is less than one foot of film a minute and it has been reduced to as low as the equivalent of three motion picture frames a minute, or five minutes to the foot of finished film. The usual rate of feed is about one one-hundredth the speed of film in motion picture projection.

Nearly a year was spent in perfecting a satisfactory method of recording material for projection on film and synchronising it against a musical score. It is stated that practically any musical device may be given a visual counterpart through the kaleidoscope method.

New Tungsram Frequency Changer

Type 6E8-GM.

A new octal-based triode-hexode has recently been introduced for use in conjunction with the American type octal range valves.

It is very useful for the manufacturer of modern all-wave receivers for either A.C.-A.C./D.C. or vibrator battery supplier, as owing to its 6.3 volt 0.3 amp. heater it can be run either in parallel or in series heated circuits.

The characteristics are as follows :—

Conversion conductance = 0.65 mA/V.
Optimum heterodyne voltage = 10 volts r.m.s.
Hexode anode voltage = 250 volts.
Hexode screen voltage = 100 (or fed through 50,000 ohms from 250 V.).
Signal grid voltage = −2 to −20 volts.
Triode conductance = 2.8 mA/V.
Triode anode voltage = (fed through 30,000 ohms from 250 volts).
Optimum triode grid leak = 50,000 ohms.
Total screen current = 3 mA.
Hexode anode current = 2.3 mA.
Triode anode current = 3.3 mA.

The 6E8-GM has a floating screen voltage characteristic resulting in a conversion conductance curve which is practically pure logarithmic function of the input voltage and hence the valve has considerably reduced cross modulation and lower noise level. Due to the separation of the two systems in the valve the frequency drift on short waves due to A.V.C. or variation of supply voltage is reduced to a negligible quantity.

Transit time effects have been reduced so that at 25 megacycles the kinetic grid current at normal grid bias is only 2-3 uA. The input impedance at this frequency is of the order of 15,000 ohms.

The price of the Tungsram 6E8-GM is 11s. 6d., the same as that of other frequency changer valves.

A RECORD OF PATENTS AND PROGRESS

RECENT DEVELOPMENTS

PATENTEES

The M-O Valve Co., Ltd., and G. W. Warren :: Kodak Ltd. :: Kolster-Brandes Ltd., and C. N. Smyth :: Marconi's Wireless Telegraph Co., Ltd., and G. B. Banks :: Marconi's Wireless Telegraph Co., Ltd., and L. E. Q. Walker :: The British Thomson-Houston Co., Ltd., H. Trencham and F. A. Tuck :: Societa Anonima Fimi.

High-impedance Valves

(Patent No. 508,724.)

RELATES to a valve in which a cathode, a control grid, an auxiliary electrode, an accelerating electrode, and an anode are set in line, and the auxiliary electrode is so biased that it drives the electrons through gaps formed in the accelerating electrode, thus preventing them from striking it. The present improvement consists in so arranging matters that any secondary electrons liberated by impact from the anode are almost wholly prevented from returning to the accelerating electrode, even when the latter is at a relatively-high positive potential.

Such a valve is said to have certain advantages over the ordinary tetrode or pentode type. It may, for instance, be given an anode impedance of over one megohm. At the same time, owing to the very small secondary current from anode to accelerator, the " noise level " of the valve is very low.—*The M-O Valve Co., Ltd., and G. W. Warren.*

Photo-electric Reproducers

(Patent No. 508,950.)

The figure shows a sound reproducer for a talking film in which the frequency-range is automatically expanded in order to secure greater fidelity. The light from a lamp L passes through the film F on to a photo-electric cell C, the output from which, after being amplified at A, is fed to the loudspeaker S.

A part of the output from the cell C is also passed to an amplifier V and a detector D, and the resulting voltage is used to control the power generated by an oscillator valve O.

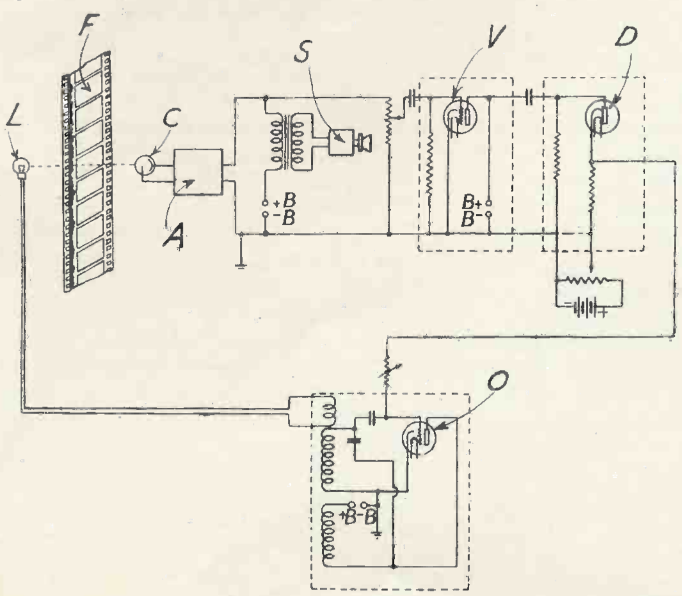
The oscillator O, in turn, controls the amount of light emitted from the lamp L, so that any increase in the amplitude of sound in the loudspeaker thus serves to strengthen the sound still more. In other words the volume is automatically "expanded" in such a way as to offset the contraction which inevitably occurs when the original studio performance is recorded on the sound-track of the film. —*Kodak, Ltd.*

" Contrast " Control

(Patent No. 510,715.)

Contrast control is applied to a television receiver through the negative feed-back developed across a resistance common to the anode and cathode circuits of the vision amplifier. At the same time the D.C. component required to reproduce slow changes of illumination is restored by a diode valve, which is shunted across the anode of the vision amplifier to a point on a potentiometer bridging the feed-back resistance.

The method has the advantage that regulation of the contrast does not noticeably affect the frequency response of the pentode amplifier. Similarly the method of restoring the D.C. component does not result in undesirable changes in the mean brightness of the picture. The latter is controlled by a tapping from the grid of the cathode-ray tube to a potentiometer bridging the H.T. supply.—*Kolster-Brandes, Ltd., and C. N. Smyth.*



Talking-film reproduced with automatic frequency-range expander. Patent No. 508950.

Electron Multipliers

(Patent No. 511,449.)

The invention relates to the use of an electron-multiplier as a means of improving the performance factor or mutual conductance of a thermionic amplifier. An external winding applies a magnetic field which causes the primary electrons to leave the cathode of the valve in two oppositely-curved paths. They then pass through a positively-biased grid, which forces them through an "open" anode on to a target electrode, which is coated with a substance having a high coefficient of secondary emission.

As a result of the impact, each primary electron releases several secondary electrons, and the resulting stream, multiplied several times, is finally collected by the anode. The special arrangement of the electrodes is designed to prevent any barium atoms given off by the indirectly-heated cathode from reaching the sensitised target electrodes and so spoiling their emissivity.—*Marconi's Wireless Telegraph Co., Ltd., and G. B. Banks.*

Television Systems

(Patent No. 512,571.)

It is usual to transmit sound and

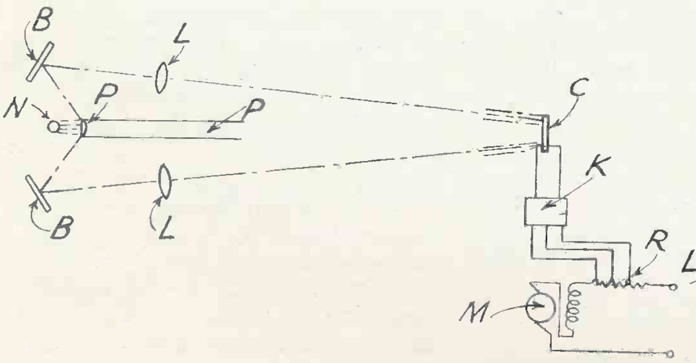
picture signals on separate carrier waves, one of which is modulated with a frequency-band of, say, $1\frac{1}{2}$ megacycles, whilst the other carries a signal-band of only 10,000 cycles. The latter presents no difficulties in amplification, but it is very difficult to design amplifiers capable of dealing faithfully with the wide band-spread of the picture signals.

The problem is solved, according to the invention, by distributing the total band of signal frequencies more equally between the two carrier-waves.

For this purpose, the band of picture signals is first divided into two halves, and the upper half is allotted to the first carrier-wave. The lower half is then heterodyned, and so converted into the same frequency as the first half. A band of frequencies corresponding to 10,000 cycles is then abstracted from this second band —so as to make room for the sound frequencies—and the two are then modulated on to the second carrier-wave. The process is, of course, reversed in reception.—*Marconi's Wireless Telegraph Co., Ltd., and L. E. Q. Walker.*

Below : Photo-electric arc control. Patent No. 513,851.

Right : Photo-electric remote control. Patent No. 517,033.



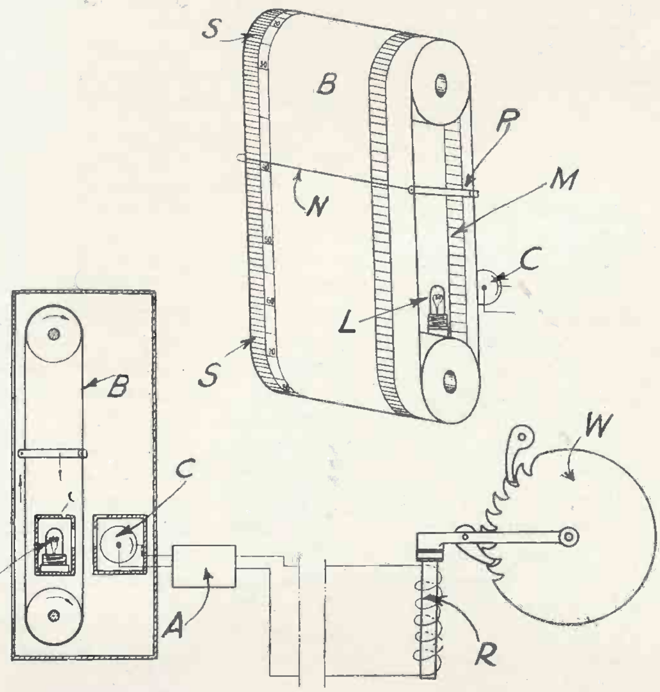


Photo-electric Arc Control

(Patent No. 513,851.)

In a projection arc-lamp the positive carbon must be gradually fed forward towards the negative carbon, so as to compensate for the gradual burning away of the positive carbon by the crater formed in it. It is also desirable to control this movement so that the crater is always accurately positioned with respect to the optical system associated with the arc-lamp.

According to the invention, the feed is automatically controlled by means of a photo-electric cell. As shown in the drawing, the positive carbon P is normally driven forward by a motor M. To regulate the speed of the latter, some of the light from the discharge-gap between the positive and negative electrodes P, N is focused by mirrors B and lenses L on to the opposite edges of a photo-electric cell C. Should any abnormal shift of the crater occur, the effective amount of light falling on the cell C will alter, so that a relay K is operated to cut in or out some of the resistance R in series with the field-winding of the motor M. The use of two mirrors prevents the motor M from responding if the crater merely shifts to one side or other of the centre of the positive carbon.—*The British Thomson-Houston Co., Ltd., H. Trencham, and F. A. Tuck.*

Photo-electric Remote Control

(Patent No. 517,033.)

Relates to an arrangement for controlling movements step by step at a distance by photo-electric means. The scheme can, for insance, be used for the remote tuning control of a wireless set.

The endless band B, Fig. 1, is marked on one side with a tuning scale or station-indicators, and on the opposite side is provided with a number of perforations or slits M. As the pointer F is moved to bring the needle N opposite to a desired station, it causes a certain number of the slits M to pass between a lamp L and a photo-electric cell C.

Each slit produces a current impulse in the photo-electric cell. These are amplified at A, as shown in Fig. 2, and are then applied to operate an electromagnetic relay R, which drives a ratchet wheel through a corresponding number of steps. The spindle of the tuning condenser of the wireless set is thus caused to rotate, step by step, so as to tune the circuits to the selected programme.—*Societá Anonima Fimi.*

Summary of Other Electronic Patents

(Patent No. 507,270.)

Valve cathode formed with a number of straight or curved emitting surfaces each of which is associated with parallel rod-like control grids and anodes.—*Standard Telephones and Cables, Ltd.*

(Patent No. 508,065.)

Piezo-electric oscillator for applying supersonic pressure waves to a light-modulating cell.—*Scophony, Ltd., J. Sieger and F. Okolicsanyi.*

(Patent No. 508,373.)

Rotating disc scanner for film television adapted to be driven from the electric mains.—*Radio-Akt. D. S. Loewe.*

(Patent No. 508,995.)

Preparing the sensitive electrodes used in television transmitters of the Iconoscope type, and in electron multipliers.—*Electrical Research Products Inc.*

(Patent No. 513,157).

Electron-optical arrangement of electrodes for focusing the beam in a cathode-ray tube.—*O. Klemperer.*

Television Transmission over Telephone Wires

By G. L. Weis, Bell Telephone Laboratories

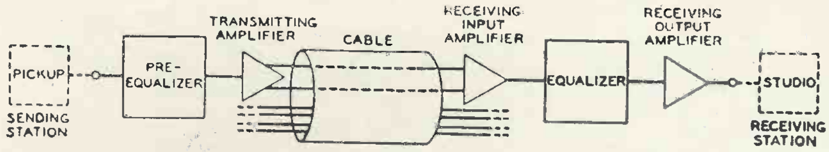


Fig. 2. Block diagram showing arrangement of equalisers.

THE utilisation of ordinary telephone circuits to link remote pick-up points to the television studio is difficult because of the much wider band of frequencies employed and certain exacting requirements for television transmission. Because of the experimental state of television at the present time, no arrangements for transmitting from remote pick-up points have as yet been standardised though experimental circuits of this nature have been provided for by the National Broadcasting Company, and the Columbia Broadcasting System.

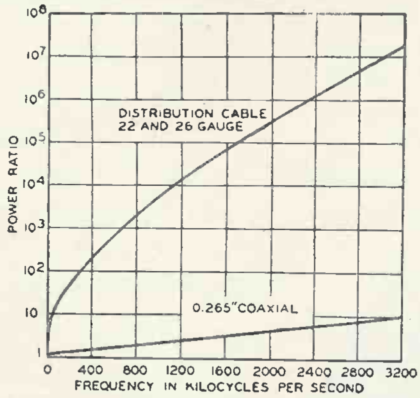


Fig. 1. Curves showing losses in one mile of experimental telephone and coaxial-cable circuit over the television frequency range.

The difficulties encountered in transmitting over telephone circuits are due largely to the very wide frequency band required. For ordinary telephone circuits a frequency band of about 3,000 cycles is sufficient, while for television transmissions the band extends from 45 to over three million cycles—a range of a thousand times greater than the ordinary broadcast band. The effect of the difference in frequency range on loss is indicated in Fig. 1. This shows the energy loss in one mile of local telephone cable made up mostly of 22 and 26 gauge paper-insulated pairs. The loss in a co-axial cable, which is especially suited for television transmission, is shown in the same illustration for comparison.

At three million cycles, a mile of cable pair gives a loss a million times greater than that of a coaxial conductor of similar length. For satisfactory television transmission, equalisers must be provided to make the overall loss essentially the same for all frequencies. The variation in loss over the equalised line is within plus or minus one-half db.

Besides this variation in loss with frequency, there is also a variation in the time of transmission. This variation is too small over the sound range to require correction for ordinary telephone circuits. For television transmission, however, if it is not kept extremely small the detail of the picture will be blurred, and spurious transients and "ghosts" will appear. Before a cable pair can be used for television, therefore, it is necessary to measure the transmission time, and then to provide phase equalisers to correct it. The equalised line maintains the same transmission time to within plus or minus 0.1 microsecond.

In addition to the phase and attenuation equalisers required by such circuits, high-gain amplifiers are needed to overcome the very large losses encountered. These amplifiers provide a flat gain over the entire range of frequencies from 45 cycles to 3,000,000 cycles. Their design is complicated by the fact that the cable pairs are balanced, that is, each wire of the pair has the same impedance to earth, while the television apparatus—in common with most high-frequency apparatus—is earthed on one side.

Relatively large currents are likely to be induced on both conductors of a cable pair from nearby power circuits and other noise sources. These currents flow equally over both conductors of a pair, which with the earth return comprise the longitudinal circuit. If the circuit, including its termination, is balanced throughout, these currents cannot affect the signal currents flowing in the metallic circuit.

With an unbalanced amplifier terminating the circuit, the longitudinal currents would enter the metallic circuit, and appear as bar patterns on the received picture. This difficulty is avoided in this case by applying negative feedback in the amplifier to the longitudinal circuit but not to the metallic circuit currents. This, in conjunction with vacuum-tube balances, results in a reduction of 75 db in these induced currents. This feedback is applied both to the output stage of the transmitting amplifier and to the input stage of the receiving amplifier.

The arrangement of the apparatus for the C.B.S. television experiment is indicated schematically in Fig. 2. Amplification and equalisation were provided at both ends of the circuit. The effect of the equaliser at the transmitting end is to predistort the signals, sending out the high frequencies at a level much higher than if equalisation were not employed. This tends to decrease the effect of any high-frequency noise, since the induced currents become smaller relative to the higher level of the signal currents. At the receiving end, the equaliser is placed between two sections of the receiving amplifier. This results in a higher level at the input to the receiving amplifier and minimises the valve noise, the mains hum, and the microphonic disturbances. The two amplifiers divide the total gain of about 75 db. They operate on power circuits, and with their equalisers and power supply are mounted in small portable cabinets.

"Horizontally Polarised Waves and Wide-band Loop Antennas"

(Continued from page 167)

It is not necessary that the form of the loop should be circular for the principle employed is quite a general one and Figs. 2 and 3 illustrate rectangular arrangements. In Fig. 2 to obtain the cardioid of Fig. 4 it is necessary that the diagonal should be somewhat less than half a wavelength, and in Fig. 3 all the linear conductors from which the loop is formed are about a quarter of a wavelength in length.

The loops may be constructed of tubing of about half an inch in diameter and may therefore be practically self-supporting. A suitable value for the resistance R with this type of conductor is about 700 ohms. An antenna constructed on these lines was found to possess an almost constant diagram for as wide a range of frequencies as from 45 to 100 megacycles per second.

This development is reported from the R.C.A. laboratories.

PHOSPHORESCENT PHOSPHORS

By Leonard Levy, M.A. (Cantab.), D.Sc. (Lond.), F.I.C., and Donald W. West, A.C.G.I., A.I.C.

The following is an abstract from a recent lecture by the authors named above given before the Institution of Electronics at the Royal Society of Arts, Adelphi.

IT was the authors' original intention that the subject matter dealt with should have been concerned with the more recent developments in the uses of luminescent substances for television, lighting, etc., but owing to the outbreak of hostilities it was decided to deal with one class only of luminescent substances, namely, those that are produced primarily for their phosphorescent, as distinct from their luminescent qualities.

When uniform ultra-violet radiation is absorbed by a luminescent substance, the latter generally emits visible radiation. The intensity of this radiation builds up rapidly to a maximum; the time interval elapsing between the incidence of the exciting radiation and the attainment of this maximum is in most cases very short. In the case of the zinc and zinc cadmium sulphide phosphors, a moderate period of time elapses before this maximum is attained. The illumination then remains at a constant value (except in certain circumstances) until the exciting radiation ceases to function.

In the case of luminescent substances which display only fluorescent effects, and are practically devoid of phosphorescence, the illumination falls to zero in an extremely small fraction of time after the source of radiation has ceased to function. In the case of phosphorescent phosphors, energy is stored in the molecule and is emitted slowly over a subsequent period of time. The intensity of the emitted radiation declines exponentially, but the shape of the decay curve varies very greatly with the type of phosphor employed.

The first luminescent substance to be produced artificially was prepared by strongly heating barium sulphate mineral, and as organic matter or some other reducing agent was present, a certain amount of barium sulphide was produced, thus giving the luminescent properties.

The majority of luminescent substances are required for their fluorescent rather than phosphorescent effects, and can be classified as follows: (a) Phosphors which are required for their fluorescent effects, in which the presence of phosphorescence is immaterial; for example, phosphors for radio-active luminous paint, for gas discharge tubes and for illumination by longwave ultra-violet light.

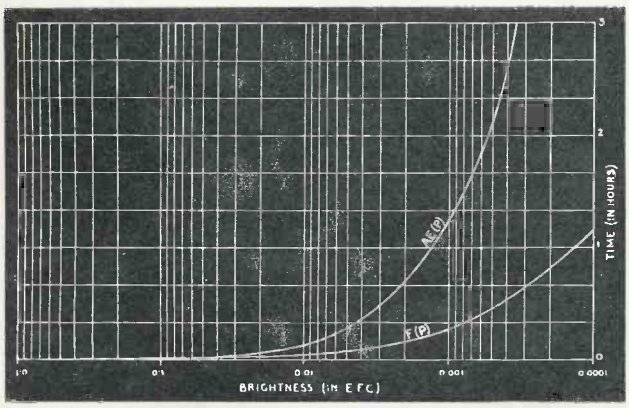


Fig. 1. Decay curves for AE(P) and F(P) type powders excited by standard source described in B.S./A.R.P./18, Dec., 1939.
F(P) coating Density = 0.28 kg. per sq. metre.
AE(P) coating density = 0.2 kg. per sq. metre.

(b) Phosphors required for their fluorescent effects, in which absence of any appreciable phosphorescence is essential; for example phosphors required for the manufacture of X-ray screens and for cathode-ray tube screens for television.

(c) Phosphors required for their fluorescent effects, in which a relatively intense phosphorescence of the same colour as that of the fluorescence and of short duration is desirable. Such phosphors are of utility in gas discharge tubes, as they assist in reducing flicker caused by the use of alternating current.

(d) Phosphors in which the phosphorescence is the main or only requirement. Certain types of cathode-ray tubes employed for electro-cardiographs and other purposes are required to show a visible trace on the screen after the exciting beam has ceased to function. Such screens must be constructed of phosphors showing considerable phosphorescence. The most suitable one is a zinc sulphide phosphor with a copper activator.

The most extended use of phosphorescent phosphors is for the manufacture of luminous paints, plastics and the like, which are now finding extensive application owing to the blackout.

In this instance the fluorescence of the phosphor is of no importance; the main factor required is an ability to store as much energy as possible and to emit it slowly in the form of luminous radiation over a period of at least 12 to 14 hours. It is furthermore essential that the luminosity at the end of the 12 to 14 hours period is still sufficient to enable the paint or plastic to be perceived readily by a sensitive eye. Two different types of phosphor are employed for the production of phosphorescent paints and plastics:—Zinc and zinc cadmium sulphide phosphors and alkaline earth sulphide phosphors. These two types differ very considerably in their properties.

Zinc and Zinc Cadmium Sulphide Phosphors

Zinc and zinc cadmium sulphide phosphors display the following characteristics: they are relatively stable and can be used in a variety of paint media. They display a very intense fluorescence followed by a strong initial phosphorescence which, however, declines from that of the fluorescence and is always of greater wavelength. The most intense phosphorescent effects are displayed by phosphors fluorescing from orange to green. The phosphorescent effects displayed by red and blue fluorescing phosphors are very slight.

Fig. 1 shows the decay curve of the phosphorescence of copper-activated zinc sulphide phosphor known as F (P). The initial brightness of this material after irradiation by an Osira black glass ultra-violet mercury vapour lamp of 125 watts at a distance of 3 feet is about 5 equivalent foot candles.

Alkaline Earth Sulphide Phosphors

Alkaline earth sulphide phosphors constitute the oldest types of luminescent materials known. Their chemical stability is very low. They are readily attacked by moist air with the evolution of sulphuretted hydrogen and gradual loss of luminescent properties. The fluorescence is not particularly good, even the highest is not equal to

Excitation

that displayed by the best zinc and zinc cadmium sulphide phosphors.

The initial intensity of the phosphorescence of the best preparations is not quite so great as that of the zinc and zinc cadmium sulphides, but the intensity curves cross in a very short space of time, after which the intensity of the phosphorescence of the alkaline earth sulphide phosphors is much greater than that of the zinc and zinc cadmium sulphide types. (See Fig. 1). The intensity of the phosphorescence is high enough to be of utility for as long as 12 to 14 hours after final exposure to light.

The slow rate of decline of the phosphorescence of the alkaline earth sulphide phosphors is a very valuable property, but the intensity after a few hours after excitation has, until recently, been too low to render these substances of much practical value.

Considerable advances have recently been made in the preparation of phosphors of this type and the best of them has proved to be strontium sulphide phosphor, which displays a slightly greenish-blue fluorescence and phosphorescence of similar colour.

The best barium sulphide phosphors so far prepared do not exhibit phosphorescent properties of practical interest. The phosphorescence is reddish orange, but is of lowish intensity and persistence.

The phosphorescence displayed by strontium sulphide phosphors is much greater. It is intensely luminescent for some time after exposure, and even after 12 hours is brighter than calcium sulphide phosphor after a comparatively short period.

The barium and calcium sulphide prosphors are now of little or no practical importance, and the remainder of this paper is confined entirely to the consideration of certain characteristics of the most modern type of strontium sulphide phosphors.

Strontium sulphide phosphors can be excited by various light sources, the spectral composition of which is naturally very different. For example, daylight, light from gas-filled tungsten filament lamps, gas discharge tubes containing carbon dioxide or the ultra-violet radiation transmitted through nickel oxide glass (the so-called "black lamp") can all be employed as exciting sources. The shape of the decay curves (Fig. 2) of the phosphorescence excited by these various types of radiation differs, but this difference is not believed to be due to any actual difference in the shape of the curve, but rather to the initiation of the illumination commencing on different parts of the first portion of the same curve.

The most intense initial phosphorescence is obtained by daylight excitation, on account of the much greater amount of energy incident on the surface, the illumination immediately after excitation by average daylight being of the order of 1.5 equivalent foot candles, depending upon the actual specimen of powder, thickness of coating, mode of application, etc. The initial brightness of strontium sulphide phosphor excited by other sources is as follows:

B.S.I./18 Standard Source 3ft. 0.1 e.f.c.
125 W. Black Glass Lamp 3ft. 1.0 e.f.c.
200 W. Tungsten Black Glass Lamp 3 ft. 0.02 e.f.c.

Strontium sulphide phosphors are not excited well by wavelengths shorter than about 3,000 AU, the limiting wavelength causing excitation is 4,500 AU. This can be simply demonstrated by projecting a continuous spectrum upon a screen of the phosphor.

The majority of artificially produced phosphors are very sensitive to mechanical stresses. Grinding, for example, in many cases, greatly reduces the intensity of the luminescent effects displayed by them. This phenomenon is displayed by alkaline earth sulphide phosphors to a rather greater extent than by other types, although some of the zinc and zinc cadmium sulphide phosphors are very sensitive to grinding as well.

The energy stored in the molecule is released much more rapidly if the phosphor is warmed; thus the brightness produced is much greater, but persists for a much shorter period of time. This effect is also produced by infra-red radiation of long wavelength, which, on absorption, increases the temperature. This must be contrasted with the effect produced by exposure to infra-red radiation of short wavelength. In this case the result is totally different, the phosphorescence being more or less completely extinguished.

Alkaline earth sulphide phosphors do not attain their maximum fluorescent and phosphorescent intensity until they have been exposed to the incident radiation for a period of time. This period varies with the type of incident radiation. It is quite short with strong ultra-violet radiation given by a black lamp, but is much longer if the source of radiation is the light from a tungsten filament lamp (after passing through a suitable filter to remove most of the visible radiation). The final brightness attained with different types of radiation is also different.

The instability and other qualities of alkaline earth phosphors have necessitated the development of special paint media in which they are incorporated. Such media must be without any action upon the phosphors and must therefore obviously be free from acid. They must also be of a highly waterproof nature, as otherwise atmospheric moisture will gradually attack the phosphors.

The weight of phosphor per unit area of painted surface affects the maximum brightness obtainable. The brightness increases with increase of coating weight when the amounts are small, rising to an approximate maximum value after a certain coating weight has been attained. This amount represents the most effective coating weight for the phosphor in question. Large increases of coating weight above this amount, even to double, only increase the brightness by 2 to 3 per cent.

Phosphorescent paint can be applied either by painting or by spraying, but in the latter case a finer particle size is required and the resulting maximum illumination obtainable is diminished.

Owing to their instability it is more difficult to produce a satisfactory phosphorescent vitreous enamel from alkaline earth sulphide phosphors than in the case of the zinc sulphide phosphors, and a satisfactory enamel has not yet been produced containing an alkaline earth sulphide.

The question of incorporation of alkaline earth sulphide phosphors in plastics has now been satisfactorily solved, and two or three special plastics are

Fig. 2. Decay curves for luminescent vitreous enamel F(P) activated by different sources.

(1) Daylight Illumination = 350 f.c.'s.
(2) CO_2 = 60 f.c.'s.
(3) 125-W. black lamp at 3 ft. from specimen; Initial B = 4.0 e.f.c.'s
(4) 500-W. Tungsten projector lamp + Wratten 18 A filter (not B.S.I.) at 3 ft. from specimen; Initial B = 0.1 e.f.c.'s.

(Continued at foot of page 179)

ELECTRONICS AND TELEVISION & SHORT-WAVE WORLD

Comprehensive Guide

to

THE WORLD'S SHORT-WAVE STATIONS

Mc/s.	Metres.	Call.	Station Name.
31.60	9.494	W1XKA	Boston, Mass.
31.60	9.494	W2XDV	New York City.
31.60	9.494	W3XKA	Philadelphia.
26.55	11.3	W2XGU	New York City.
26.55	11.3	W2XQO	New York City.
26.05	11.51	W9XH	South Bend, Ind.
25.95	11.56	W6XKG	Los Angeles, Cal.
25.72	11.664	WCAB	Pennsylvania.
25.60	11.719	WRUW	Boston, Massachusetts.
21.65	13.857	WLWO	Mason, Ohio.
21.64	13.86	GRZ	Daventry, England.
21.63	13.8	WRCA	Bound Brook, N.J.
21.59	13.895	WGEO	South Schenectady, N.Y.
21.57	13.91	WCBX	Wayne, N.J.
21.565	13.92	DJJ	Berlin.
21.55	13.92	GST	Daventry, England.
21.54	13.93	WPIT	Pittsburgh, Pa.
21.54	13.93	W8SK	Pittsburgh, Pa.
21.53	13.93	GSJ	Daventry, England.
21.52	13.94	I2RO16	Rome, Italy.
21.52	13.94	WCAB	Philadelphia.
21.50	13.95	WGEA	Schenectady, N.Y.
21.48	13.96	PH13	Huizen, Holland.
21.47	13.97	GSH	Daventry, England.
21.46	13.98	WRUL	Boston, Mass.
21.45	13.99	DJS	Berlin.
19.02	15.77	HS6PJ	Bangkok, Siam.
18.48	16.23	HBH	Geneva, Switzerland.
17.85	16.8	TPB3	Paris, France.
17.845	16.81	DJH	Zeesen.
17.84	16.82	HVJ	Vatican City.
17.84	16.82	—	Moydrum, Athlone, Eire.
17.83	16.83	WCBX	New York City.
17.82	16.84	2RO8	Rome, Italy.
17.81	16.84	GSV	Daventry, England.
17.80	16.85	OIH	Lahti, Finland.
17.80	16.85	XGOX	Chungking, China.
17.79	16.86	GSG	Daventry, England.
17.785	16.86	JZL	Tokio, Japan.
17.78	16.87	WNBI	Bound Brook, N.J.
17.78	16.87	WPIT	
17.77	16.88	PH12	Huizen, Holland.
17.76	16.89	WLWO	
17.76	16.89	DJE	Zeesen.
17.755	16.9	ZBW5	Hongkong.
17.75	16.90	LKW	Oslo, Norway.
17.31	17.33	W2XGB	Hicksville, N.Y.
17.280	17.36	FXE8	Djibouti, French Somaliland.
15.55	19.29	CO9XX	Tuinicu, Oriente, Cuba.
15.51	19.34	XOZ	Chengtu, China.
13.37	19.52	HAS3	Budapest, Hungary.
15.36	19.53	DZG	Zeesen, Germany.
15.36	19.53	—	Berne, Switzerland.
15.34	19.56	DJR	Zeesen.
15.33	1956	WGEA	Schenectady, N.Y.
15.33	19.56	KGEI	San Francisco, California.
15.32	19.58	OZH	Skamlebak, Denmark.
13.30	19.6	GSP	Daventry, England.
15.3	19.61	YDB	Soerabaja, Java.
15.3	19.61	XEBM	Mazatlan, Mex.
15.3	19.61	I2RO6	Rome, Italy.
15.29	19.62	VUD	Delhi, India.
15.29	19.62	LRU	Buenos Aires.
15.28	19.63	DJQ	Zeesen.
15.27	19.65	HI3X	Ciudad, Trujillo.
15.27	19.65	WCAB	Phila., Pa.
15.27	19.65	WLWO	Mason, Ohio.
15.27	19.65	WCBX	Wayne.

Mc/s.	Metres.	Call.	Station Name.
15.26	19.66	GSI	Daventry, England.
15.25	19.67	WRUL	Boston, Mass.
15.245	19.68	TPA2	Paris, France.
15.24	19.68	I2RO	Rome, Italy.
15.24	19.68	CR7BD	Lourenco, Marques, Mozambique.
15.23	19.7	OLR5A	Podébrady, Bohemia.
15.23	19.7	HS6PJ	Bangkok, Siam.
15.22	19.71	PCJ2	Huizen, Holland.
15.21	19.72	WPIT	Pittsburgh, Pa.
15.2	19.74	DJB	Zeesen.
15.195	19.74	TAQ	Ankara, Turkey.
15.19	19.75	OIE	Lahti, Finland.
15.18	19.76	GSO	Daventry, England.
15.18	19.76	RW96	Moscow, U.S.S.R.
15.17	19.77	TGWA	Guatemala City, Guat.
15.166	19.78	LKV	Oslo, Norway.
15.16	19.79	JZK	Tokio, Japan.
15.16	19.79	XEWW	Mexico City.
15.155	19.79	SM5SX	Stockholm, Sweden.
15.15	19.8	YDC	Bandoeng, Java.
15.140	19.82	GSF	Daventry, England.
15.135	19.82	JLU3	Tokio, Japan.
15.13	19.83	TPB6	Paris, France.
15.13	19.83	WRUL	Boston, Mass.
15.13	19.83	WRUW	
15.120	19.84	HVJ	Vatican City.
15.120	19.84	CSW4	Lisbon, Portugal.
15.11	19.85	DJL	Zeesen.
15.1	19.87	CB.1510	Valparaiso, Chile.
15.1	19.87	I2RO12	Rome, Italy.
15.08	19.95	RKI	Moscow, U.S.S.R.
14.96	20.05	RZZ	Moscow, U.S.S.R.
14.93	20.09	PSE	Rio de Janeiro, Brazil.
14.92	20.11	KQH	Kahuku, Hawaii.
14.78	20.28	IQA	Rome, Italy.
14.60	20.55	JVH	Nazaki, Japan.
14.535	20.64	HBJ	Geneva, Switzerland.
14.44	20.78	—	Radio Malaga, Spain.
14.42	20.80	HCIJB	Quito, Ecuador.
14.166	21.15	PIIJ	Dordrecht, Holland.
13.997	21.43	EA9AH	Tetuan, Spanish Morocco.
12.862	23.32	W9XDH	Elgin, Ill.
12.486	24.03	HIIN	Trujillo City, Dominica Rep.
12.460	24.08	HC2JB	Quito, Ecuador.
12.310	24.37	VOFB	St. Johns, Newfoundland.
12.235	24.52	TFJ	Reykjavik, Iceland.
12.230	24.53	COCE.	Havana, Cuba.
12.2	24.59	—	Trujillo, Peru.
12	25	RNE	Moscow, U.S.S.R.
11.970	25.06	CB.1180	Santiago, Chile.
11.97	25.07	HI2X	Ciudad, Trujillo, D.R.
11.94	25.13	TI2XD	San Jose, Costa Rica.
11.94	25.13	XMHA	Shanghai, China.
11.90	25.21	CD.1190	Valdivia, Chile.
11.9	25.21	XGOY	Chungking, China.
11.895	25.23	I2RO13	Rome, Italy.
11.885	25.24	TPA3	Paris, France.
11.87	25.26	WPIT	Pittsburgh, Pa.
11.87	25.26	VUM2	Madras, India.
11.87	25.26	WLWO	Mason, Ohio.
11.865	25.28	—	Berne, Switzerland.
11.86	25.3	GSE	Daventry, England.
11.85	25.31	DJP	Zeesen.
11.85	25.32	OAK2A	Trujillo, Peru.
11.84	25.35	KZRM	Manila, P.I.
11.84	25.35	CSW	Lisbon, Portugal.
11.84	25.35	OLR4A	Prague, Bohemia.

GUIDE TO WORLD'S SHORT-WAVE STATIONS—II

Mc/s.	Metres.	Call.	Station Name.
11.83	25.36	W9XAA	Chicago, Illinois.
11.83	25.36	WCBX	Wayne.
11.81	25.4	12RO4	Rome, Italy.
11.805	25.41	OZG	Skamlebak, Denmark.
11.801	25.42	DJZ	Berlin.
11.80	25.42	COGF	Matanzas, Cuba.
11.80	25.42	JZJ	Tokio, Japan.
11.795	25.42	DJO	Zeesen.
11.79	25.45	WRUL	Boston, Mass.
11.78	25.47	HP5G	Panama City.
11.78	25.47	OFE	Lahti, Finland.
11.77	25.49	DJD	Zeesen.
11.76	25.51	TGWA	Guatemala City, Guat.
11.76	25.51	XETA.	Monterey, Mexico.
11.76	25.51	OLR4B	Prague, Bohemia.
11.75	25.53	GSD	Daventry, England.
11.74	25.55	HVJ	Vatican City.
11.74	25.55	CR6RC	Loanda, Angola.
11.735	25.57	COCX	Havana, Cuba.
11.735	25.57	LKQ	Oslo, Norway.
11.73	25.58	WRUW	
11.73	25.57	PHI	Huizen, Holland.
11.73	25.58	WRUL	Boston, Mass.
11.725	25.58	JVW3	Tokio, Japan.
11.720	25.6	CJRX	Winnipeg, Canada.
11.72	25.60	ZP14	Villarica, Paraquay.
11.71	25.62	—	Saigon, French Indo-China.
11.705	25.63	SBP	Motala, Sweden.
11.7	25.64	HP5A	Panama City.
11.70	25.65	CB.1170	Santiago, Chile.
11.766	25.7	IQY	Rome, Italy.
11.402	26.31	HBO	Geneva, Switzerland.
11.04	27.17	CSW5	Lisbon, Port.
11.00	27.27	PLP	Bandoeng, Java.
10.95	27.40	—	Tananarive, Madagascar.
10.67	28.12	CEC	Santiago, Chile.
10.66	28.14	JVN	Nazaki, Japan.
10.53	28.48	JIB	Taihoku, Taiwan.
10.40	28.85	YSP	San Salvador.
10.36	28.96	EAJ43	Teneriffe.
10.35	28.99	LSX	Buenos Aires.
10.33	29.04	ORK	Ruysselede, Belgium.
10.26	29.24	PMN	Bandoeng, Java.
10.1	29.7	—	Deutche Freiheits Sender.
10.05	29.85	TIEMT	San Jose, Costa Rica.
10.05	29.16	DZC	Zeesen, Germany.
10.04	29.87	DZB	Zeesen, Germany.
9.995	30.02	COBC	Havana, Cuba.
9.92	30.24	JDY	Dairen, Manchukuo.
9.892	30.33	CPI	Sucre, Bolivia.
9.955	30.45	EAQ	Madrid, Spain.
9.83	30.52	IRF	Rome, Italy.
9.815	30.57	COCM	Havana, Cuba.
9.785	30.66	HH3W	Port-au-Prince, Haiti.
9.753	30.75	ZRO	Durban, S. Africa.
9.735	30.82	CSW7	Lisbon, Portugual.
9.73	30.83	CB.970	Valparaiso, Chile.
9.705	30.92	—	Fort-de-France, Martinique.
9.7	30.93	HNF	Baghdad, Iraq.
9.69	30.96	LRAI	Buenos Aires.
9.69	30.96	ZHP	Singapore, Malaya.
9.69	30.96	GRX	Daventry, England.
9.685	30.96	TGWA	Guatemala City.
9.675	31.01	DJX	Zeesen.
9.67	31.03	WRCA	Bound Brook, N.J.
9.665	31.04	12RO9	Rome, Italy.
9.66	31.06	LRX	Buenos Aires.
9.66	31.06	HVJ	Vatican City.
9.65	31.09	WCBX	Wayne.
9.65	31.09	CS2WA	Lisbon, Portugual.
9.65	31.09	IABA	Addis Ababa, Ethiopia.
9.645	31.10	JLT2	Tokio, Japan.
9.64	31.12	CXA8	Colonia, Uruguay.
9.635	31.13	2RO3	Rome, Italy.
9.62	31.19	CXA6	Montevidale, Uruguay.
9.618	31.20	HJ1ABP	Cartagena, Col.
9.61	31.22	LLG	Oslo, Norway.

Mc/s.	Metres.	Call.	Station Name.
9.606	31.23	ZRL	KLipheuval, S. Africa.
9.6	31.25	RAL	Moscow, U.S.S.R.
9.6	31.25	CB.960	Santiago, Chile.
9.6	31.25	GRY	Daventry, England.
9.595	31.27	HBL	Geneva, Switzerland.
9.59	31.28	HP5J	Panama City.
9.59	31.28	VUD2	Delhi, India.
9.59	31.28	PCJ	Huizen, Holland.
9.59	31.28	VK6ME	Perth, W. Australia.
9.59	31.28	VK2ME	Sydney, Australia.
9.59	31.28	WCAB	Philadelphia, Pa.
9.59	31.28	WLWO	Mason, Ohio.
9.58	31.32	LRX	"El Mundo," Buenos Aires.
9.58	31.32	GSC	Daventry, England.
9.58	31.32	VLR	Melbourne, Australia.
9.57	31.35	KZRM	Manila, P.I.
9.57	31.35	WBOS	Millis.
9.57	31.35	WPIT	Pittsburgh, Pa.
9.56	31.36	CXA8	Belgrano, Buenos Aires.
9.566	31.37	OAX4T	Lima, Peru.
9.56	31.38	XGAP	Peking, China.
9.56	31.38	DJA	Zeesen.
9.55	31.41	HVJ	Vatican City.
9.55	31.41	TPB11	Paris, France.
9.55	31.41	WGEA	Schenectady, N.Y.
9.55	31.41	OLR3A	Prague, Bohemia.
9.55	31.41	XEFT	Vera Cruz, Mexico.
9.55	31.41	YDB	Soerabaja, Java.
9.55	31.41	VUB2	Bombay, India.
9.54	31.45	DJN	Zeesen.
9.538	31.46	VPD2	Suva, Fiji.
9.53	31.46	—	Schwarzenburg, Switzerland.
9.53	31.48	WGEO	Schenectady, N.Y.
9.53	31.48	KGEI	San Francisco, Cal.
9.53	31.48	BUC2	Calcutta, India.
9.526	31.49	ZBW3	Hongkong, China.
9.525	31.49	LPC	Jeloy, Norway.
9.523	31.5	ZRG	Roberts Heights, S. Africa.
9.52	31.51	OZF	Skamleboaek, Denmark.
9.52	31.51	RV96	Moscow, U.S.S.R.
9.51	31.55	GSB	Daventry, England.
9.51	31.55	HS8PJ	Bangkok, Siam.
9.51	31.55	—	Hanoi, French Indo-China.
9.503	31.57	XEWW	Mexico City.
9.50	31.58	PRF5	Rio Janeiro, Brazil.
9.50	31.58	HJU	Buenaventura, Columbia.
9.5	31.58	VK3ME	Melbourne, Australia.
9.5	31.58	OFD	Lahti, Finland.
9.497	31.59	KZ1B	Manila, Philippine Islands.
9.488	31.6	EAR	Madrid, Spain.
9.465	31.70	TAP	Ankara, Turkey.
9.445	31.77	HCODA	Guayaquil, Ecuador.
9.437	31.8	COCH	Havana, Cuba.
9.390	31.95	OAX5C	Ica, Peru.
9.370	32.02	XOY	Chengtu, China.
9.355	32.05	HCIETC	Quito, Ecuador.
9.35	32.08	COCD	Havana, Cuba.
9.345	32.11	HBL	Geneva, Switzerland.
9.340	32.12	OAX4J	Lima, Peru.
9.295	32.28	HI2G	Ciudad, Trujillo, D.R.
9.280	32.33	LYR	Kaunas, Lithuania.
9.2	32.61	ZMEF	Sunday Island.
9.2	32.61	COBX	Havana, Cuba.
9.188	32.65	HC2AB	Ecuador.
9.17	32.72	HC1G	Quito, Ecuador.
9.125	32.88	HAT4	Budapest, Hungary.
9.124	32.88	HC2CW	Guayaquil, Ecuador.
9.12	32.89	CP6	La Paz, Bolivia.
9.100	32.61	COCA	Havana, Cuba.
9.091	33.00	PJCI	Curacao, D.W. Indies.
9.03	33.32	COBZ	Havana, Cuba.
8.965	33.44	COKG	Santiago, Cuba.
8.841	33.5	HCJB	Quito, Ecuador.
8.830	33.98	COCQ	Havana, Cuba.
8.7	34.46	HKV	Bogota, Columbia.

GUIDE TO WORLD'S SHORT-WAVE STATIONS—III

Mc/s.	Metres.	Call.	Station Name.
8.665	34.64	COJK	Camaguey, Cuba.
8.665	34.64	W2XGB	Hicksville, N.Y.
8.652	34.67	HJ4DAU	Medellin, Colombia.
8.580	34.92	YNPR	Managua, Nicaragua.
8.572	35.02	—	Bucharest, Roumania.
7.894	37.99	YSD	San Salvador.
7.870	38.1	HCIRB	Quito, Ecuador.
7.854	38.2	HC2JSB	Guayaquil, Ecuador.
7.797	38.48	HBP	Geneva, Switzerland.
7.614	39.39	CRAA	Lobito, Angola.
7.520	39.89	KKH	Kahuku, Hawaii.
7.49	40,05	EAJ43	Teneriffe, Canary Islands.
7.45	40.27	TI2RS	San Jose, Costa Rica.
7.44	40.32	FG8AH	Point-a-Pitre, Guadeloupe.
7.41	40.46	HCJB4	Quito, Ecuador.
7.31	41.01	GIG	Port Moresby, Papua.
7.28	41.21	TPB12	Paris, France.
7.26	41.32	CSW8	Lisbon, Portugal.
7.22	41.55	HKE	Bogota, Col., S.A.
7.22	41.55	YDX	Medan, Sumatra.
7.177	41.75	CR6AA	Lobita, Angola.
7.128	42.09	YN3DG	Leon, Nicaragua.
7.1	42.25	FO8AA	Papeete, Tahiti.
7.088	42.3	PI1J	Dordrecht, Holland.
6.97	43.05	XPSA	Kweiyang, China.
6.96	43.10	Z2ZB	Wellington, N.Z.
6.88	43.60	XOJD	Hankow, China.
6.79	44.16	PZH	Paramirabo, Surinam.
6.775	44.26	HIH	San Pedro de Macoris, Dom. Rep.
6.73	44.58	HI3C	La Romana, Dominica Rep.
6.72	44.64	PMH	Bandoeng, Java
6.69	44.82	TIEP	San Jose, Costa Rica.
6.675	44.94	HBQ	Geneva, Switzerland.
6.625	45.28	PRADO	Riobamba, Equador.
6.565	45.70	HI5P	Puerto, Plata.
6.55	45.8	XBC	Vera Cruz, Mexico.
6.49	46.2	TGWB	Guatemala City, Guat.
6.47	46.36	YNLAT	Granada, Nic.
6.384	46.99	ZIZ	Basseterre, W.I.
6.335	47.33	OAXIA	Ica, Peru.
6.324	47.4	COCW	Havana, Cuba.
6.28	47.77	HIIG	Trujillo City, D.R.
6.235	48.12	HRD.	La Ceiba, Honduras.
6.23	48.15	OAX4G	Lima, Peru.
6.19	48.47	JLK	Tokio, Japan.
6.19	48.47	HVJ	Vatican City.
6.19	48.47	WGEO	South Schenectady, N.Y.
6.19	48.47	KGEI	San Francisco, Cal.
6.17	48.62	HJ3ABF	Bogota, Columbia.
6.17	48.62	WCBX	Wayne.
6.153	48.75	H15N	Moca City, D.R.
6.15	48.78	VPB	Colombo, Ceylon.
6.15	48.78	CJRO	Winnipeg, Canada.

Mc/s.	Metres.	Call.	Station Name.
6.148	48.8	ZTD	Durban, S. Africa.
6.147	48.8	ZEB	Bulawayo, Rhodesia.
6.14	48.83	—	Leopoldville, Belgian Congo.
6.14	48.86	WPIT	Pittsburgh.
6.137	48.87	CR7AA	Laurenco Marques, E. Africa.
6.13	48.94	VP3BG	Georgetown, British Guiana.
6.13	48.94	CHNX	Halifax, N.S., Canada.
6.125	48.98	CXA4	Montevideo, Uruguay.
6.122	49	HP5H	Panama City.
6.122	49	FK8AA	Noumea, New Caledonia.
6.12	49.02	WCBX	Wayne.
6.117	49.03	XEUZ	Mexico City.
6.115	49.05	OLR2C	Prague, Bohemia.
6.10	49.18	WNBI	
6.097	49.2	ZRK	Klipheuvel, S. Africa.
6.097	49.2	ZRJ	Johannesburg.
6.095	49.22	JHZ	Tokio, Japan.
6.09	49.26	CRCX	Toronto, Canada.
6.083	49.31	VQ7LO	Nairobi, Kenya, Africa.
6.08	49.34	CRY9	Macao.
6.077	49.35	OAX4Z	Lima, Peru.
6.075	49.35	VP3MR	Georgetown, British Guiana.
6.07	49.42	CFRX	Toronto, Canada.
6.07	49.42	VE9CS	Vancouver, B.C.
6.065	49.46	SBO	Motala, Sweden.
6.06	49.5	YDD	Bandoeng, Java.
6.06	49.5	WCAB	Philadelphia, Pa.
6.06	49.5	WLWO	Cincinnati
6.057	49.53	ZHJ	Penang, Fed. Malay States.
6.05	49.59	GSA	Daventry, England.
6.045	49.6	XETW	Tampico, Mexico.
6.04	49.65	WDJM	Miami Beach, Florida.
6.04	49.65	WRUL	Boston, Mass.
6.033	49.75	HP5B	Panama City, Pan.
6.03	49.75	CFVP	Calgary, Alta, Canada.
6.03	49.75	RW.96	Moscow, U.S.S.R.
6.03	49.75	OLR2B	Prague, Bohemia.
6.023	49.82	XEUW	Vera Cruz, Mexico.
6.02	49.83	DJC	Zeesen, Germany.
6.01	49.92	OLR2A	Prague, Bohemia.
6.01	49.92	VK9M1	S.S. Kanimbla.
6.01	49.92	CJCX	Sydney, Nova Scotia.
6.007	49.94	XYZ	Rangoon, Burma.
6.007	49.94	ZRH	Roberts Heights, South Africa.
6.005	49.96	CFCX	Montreal, Canada.
6.005	49.96	VE9DN	Drummondville, Quebec Canada.
6.00	50.00	CXA2	Prieto, Buenos Aires.
5.990	50.08	ZEA	Salisbury, Rhodesia, Sth. Africa.

"Short-wave Radio World"

(*Continued from page* 176)

as the type 56. The lower wavelength limit of the 6L6-G is about 4½ metres, which is considerably in excess of that for the other varieties of beam tetrodes. The author explains this as a result of shielding of the beam-forming plate between the anode and the screen, the area of the plate exposed to the screen in the 6Y6-G is not much greater than the anode area exposed to the grid in the cylindrical 56. Since the average distance between the anode and screen in the beam tetrode is nearly double that of the triode, the effective anode-screen capacity of the former cannot be larger than the anode-grid capacitance of the latter. It is concluded that by reducing the resistance of the circuit within the valve by shortening and thickening the anode and screen leads, efficiencies approaching a total power conversion efficiency of 25 per cent. may be obtained in the external part at a frequency as high as 150 mc. With the 6Y6-G in its present design, a maximum efficiency of only 7 per cent. is obtained in terms of the external part of the circuit.

(King—Jour. Appl. Phys.).

"Phosphorescent Phosphors"

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available in which alkaline earth phosphors can be satisfactorily incorporated without any sensible depreciation of their luminescent qualities.

B.S.I. Specification

The interest in phosphorescent preparations which has been aroused owing to the black-out regulations, has led to the compilation of a specification by the British Standards Institution, designed to control the quality of fluorescent and phosphorescent paints for A.R.P. purposes. The specification calls for a minimum brightness of 0.05 equivalent foot candles for a phosphorescent material of the zinc or zinc cadmium sulphide phosphors, one minute after irradiation by a standard test lamp. The brightness after the lapse of a period of time after irradiation which it is left to the manufacturer to specify, during which the preparation must be kept in the dark, must not fall below 0.0001 equivalent foot candles.