ELECTRONICS AND TELEVISION & SHORT-WAVE WORLD

APRIL, 1941.

1/6

ELECTRO-ACOUSTICAL AIRCRAFT "SPOTTER" *Full Details*

THE FIRST TELEVISION JOURNAL IN THE WORLD

CONTAINS—

FIRST REPRODUCTION OF TELEVISION IMAGE IN COLOUR

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ELECTRONICS and TELEVISION

& SHORT-WAVE WORLD

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CURRENT ELECTRONIC LITERATURE

Application of Automatic Welding Controls (Avers). Developments in automatic control of welding operations are reviewed. In butt-welding, control of current cut-off and forging pressure were first developed, but a different technique was required for flash-welding. It has also been found that better results in seam-welding are obtainable if the current is regularly and frequently interrupted and thyratrons and ignitrons have come into use for control of this operation. Machines are now available for control of heavy currents and pressures —*Welding Industry*, November, 1940.

An Improved Sound-level Meter (Mikelson). A sound-level meter incorporating improvements on previous models has been designed to adhere to the American Standards Association specifications, which cover several important performance characteristics. A description is given of this instrument, which consists of a five-stage amplifier together with microphone, indicating instrument and range selector. The range of sound levels which can be measured is from 24 to 130 decibels. —*A.S.E. Bulletin*, December 12, 1940.

Central Control of Municipal Street Lighting (P. Troller). For more than eighteen months 4,800 street lamps and 1,200 lamps of traffic signs with a total connected rating of about 1,000 kW in the city of Basle have been automatically remote controlled from a central point by an installation combining switch clock and photoelectric cell. The author describes the switching system employed and its interlocking arrangements. —*A.S.E. Bulletin*, Decmeber 12, 1940.

Insulating Materials (Dunton). This brief article is concerned with the effect of war restrictions on insulating materials and the progress made in the manufacture of substitutes. Mention is made of the use of Premix, of glass which permits higher temperature operation, of various moulded insulations made on the injection principle, of Nylon, and the flame resistant Flamenol.—*Electrical Times*, January 9, 1941.

Thermostatic Bimetals. An outline description is given of a process used in the manufacture of bimetals for thermostatic control purposes. There follows a consideration of metals of low expansivity for use in bimetal strip. Invar produced as a result of a study of iron-nickel alloys has a very low thermal expansion at ordinary temperatures, and consideration is given to the effect of small percentages of chromium and manganese on the expansivity of this alloy; changes effected by mechanical or thermal treatment are also considered. —*Electrical Times*, January 9, 1941.

Changes in the Shape of Spherical Spot Welding Electrodes (Hess & Wyant). A report is given of an investigation carried out for the American Welding Research Committee into the use of dome-shaped electrodes for spot-welding purposes. A complete account of the preparation of the material and welding procedure is included. The authors examined the effects of electrode pressure on weld strength, current density and weld diameter, and also noted changes in profile of the electrodes throughout a series of welds. Certain conclusions are reached and discussed.—*Welding Industry*, January, 1941.

The Design of a Cathode-ray Oscillograph for Spot-welding Research (Tylecote). Spot welding is essentially a short-time operation and therefore entails difficulties in the measurement of current and other variables. This article describes an oscillograph designed for the simultaneous measurement of the current flowing through contacts, the voltage across the intersheet faces and the voltage across the electrode to sheet contacts in order to investigate contact resistance in the spot welding of light alloys. A brief indication of results is given. —*Welding Industry*, January, 1941.

Abstracts by Research Department, Metropolitan-Vickers Electrical Company Ltd.

PRINCIPAL CONTENTS APRIL, 1941

Contributions are invited and will be promptly considered : they should be accompanied by a stamped addressed envelope for return in case of non-acceptance.

Manufacturers are invited to send details of new productions for review.

Electronics AND TELEVISION & SHORT-WAVE WORLD

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EDITORIAL, ADVERTISING AND PUBLISHING OFFICES
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News and Views

THIS issue will become of historical interest. It contains a reproduction of the first photograph ever taken of a colour television picture. Those who have followed the gradual development of colour television will realise how great is John Logie Baird's achievement, the more so as latterly he has been working alone in his private laboratory without the resources of a big company behind him. The story of this great advance is told elsewhere in this journal, but it will be useful to state here that the reproduction has been made from a photograph taken by the Dufay process and has not been retouched in any way; also the picture is that of a living model. The original picture on the screen was 2 ft. 6 in. by 2 ft., and it is interesting to note that even at this size no trace of scanning lines can be observed, however closely the screen is viewed. The second point of vital importance is that colour pictures of this nature can be transmitted with the same width of frequency band as employed for ordinary black and white pictures. There is also but little increased complication as regards either the transmitter or receiver.

Good as we believe our readers will judge this reproduction to be, most will realise the difficulties that have had to be surmounted in its production and appreciate that it is inevitable that in all the processes involved some part of the original clarity and colour must have suffered. The photographing of an ordinary monochrome television picture presents certain difficulties owing to the nature of the built-up picture, but these difficulties have been more than trebled in the present instance, and, in addition, of course, all movement is lost which always enhances the screen picture. The present value of colour television is empirical, but the reproduction of a picture in this issue is convincing proof that development is still going on despite war conditions, and that Baird is in the forefront of progress just as he was in the original development of what in the future will be a most important factor in everyday life.

Not so very long ago it was generally supposed that the introduction of colour in television meant adding to the difficulties to a very considerable extent, but this idea has now been proved a fallacy—a little increased complication there certainly is, but its extent is not sufficient to militate against the system. In our opinion, obtained from personal comparison, colour in television is of more value than colour in the cinema. We should be interested to hear our readers' views on this point.

We should like to draw our readers' attention to the first of a new type of article which appears in this issue. We refer to the article entitled " Review of Progress in Electronics." It is intended that the series will cover photo-conductivity, photo-electricity, photo-voltaic cells, thermionic emission and electricity in gases, and will indicate and review all the most important sources of information, followed by articles on current practice as represented by current literature. Our view is that in this way we shall be able to place before research workers, development engineers and students all the latest information and indicate how development has taken place. The scheme we have in mind has been carefully drawn up with the object of making the series of the most informative nature possible, and we believe it will prove of very real value.

TELEVISION IN COLOUR

J. L. BAIRD'S NEW ADVANCE

The first photograph of a television image ever published, the image on the screen of Mr. Baird's first televisor in 1926

While the theory of television was well-known long before 1926, no practical success had been achieved in transmitting television images. It had only been possible to send shadows of shapes ; in other words, the televised image was then nothing more than a transmitted shadowgraph. On January 27th, 1926, however, for the first time, true living pictures—that is, images modelled by light and shade—were shown by a system of television invented by John Logie Baird, a demonstration being given to members of the Royal Institution and other scientists on that date. This achievement created a sensation which most of us remember, and much appeared in the Press at that time, a good deal of it greatly exaggerated. What was actually shown in that year is simply and authoritatively described in an article by Dr. Alexander Russell, F.R.S. a past president of the I.E.E. and of the Physical Society, writing in "Nature" of 3rd July, 1926. He states :—

"We saw the transmission by television of living human faces, the proper

(Miss Paddy Naismith, the well-known Airwoman)
The first photograph of a colour television image ever published, the image on the screen of Mr. Baird's 600 line colour televisor.

gradation of light and shade, and all movements of the head, of the lips and mouth, and of a cigarette, and its smoke were faithfully portrayed on a screen in a theatre, the transmitter being in a room at the top of the building. Naturally, the results are far from perfect. The image cannot be compared with that produced by a good kinematograph film. The likeness, however, was unmistakable, and all the motions are reproduced with absolute fidelity. This is the first time we have seen real television, and, so far as we know, *Mr. Baird is the first to have accomplished this marvellous feat".*

Mr. Baird's 600 line colour televisor. The screen receives either 600 line colour pictures or by pressing a button the B.B.C. 405 line monochrome pictures. It measures 2' 6"× 2' 0". The set includes an automatic record-changing radiogram and an all-wave wireless receiver.

The "marvellous feat" in 1926 is a common-place today. A photograph taken of the television image of 1926 is reproduced in the illustration at the head of the preceding page. The original apparatus itself is preserved in the Science Museum, South Kensington.

Baird's first apparatus

was named by him a "Televisor", which word was for some time a commercial trade mark but has now come into general use for any television receiver.

The actual televised image was considerably clearer than either the photograph or the illustration here given. Authentic photographs of television images are difficult to take and are invariably much inferior to the real picture. Any variations of the televised image causes blurring in the photograph, and of course, the realism of the moving image is largely lost in the photograph.

Television had a chequered early history. Baird had a struggle to obtain the co-operation of the B.B.C. which looked with some scepticism on his claims to be able to transmit television by wireless. Finally, the matter was settled by a Government Committee under the Chairmanship of the late Lord Selsdon (then Sir Mitchell Thompson, Postmaster General) advised by the experts of the Post Office and the B.B.C. This committee was given a demonstration, the transmission being made from 2LO (the B.B.C.'s station in Savoy Hill), while the receivers were placed at the General Post Office in St. Martin's-le-Grand, and also at the B.B.C. Headquarters at Savoy Hill. This demonstration so convinced the Committee that in due course they reported the result as

a "Noteworthy Scientific Achievement"

and recommended that the B.B.C. should provide broadcasting facilities for the Baird system.

Following this report, television transmissions by the Baird process started in 1929, not only in London through the B.B.C. but also in Berlin, Baird apparatus being installed in the Berlin Broadcasting Station by the German Post Office.

The great electrical combines, inspired without doubt in great measure by Baird's pioneer work, saw the possibilities of the new art. They applied their gigantic resources to its development and television as we know it to-day represents the pooled results of a great number of research workers. The little flickering images which caused such a sensation in 1926 have become pictures of a size and clarity which rivals the cinema itself,—and now colour is being added.

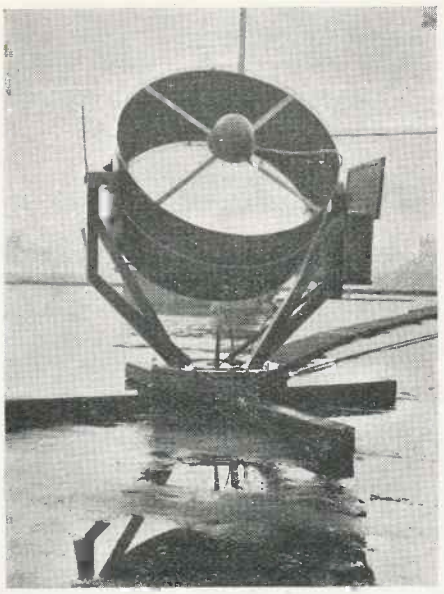
Colour television was shown for the first time as far back as 1928 when Baird demonstrated a colour television image a few inches square to the British Association. It is gratifying therefore to find that in 1941 he still maintains leadership in its development.

In spite of manifold difficulties caused by the war and working entirely independently in his private laboratory he has developed a 600 line television system for

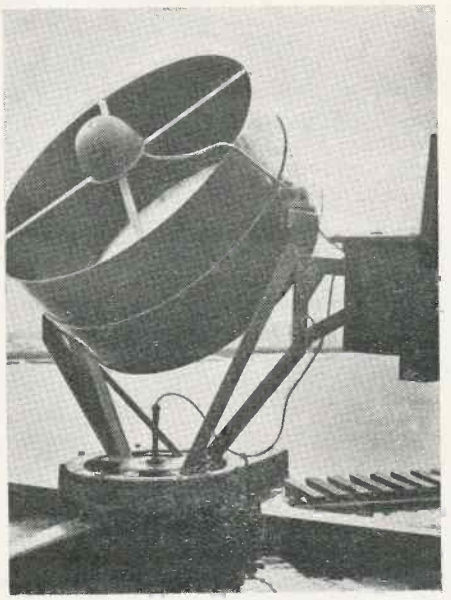
televising in natural colours.

We present on the preceding page a reproduction of the colour television image, *the first photograph of such an image ever reproduced.* It is obvious that any loss sustained in photographing the monochrome image is multiplied when the image is in colour, but the Dufay untouched colour photograph, here reproduced as faithfully as mechanical processes permit, will give an idea, but only a very inadequate one, of Baird's new achievement.

It is encouraging to know that, in spite of all the great difficulties of the time, television research still continues in this country and we can be assured that when the war ceases Great Britain will once again hold the leading position in the television field.



Aeroplane "Spotting" *by* Electro-Acoustical Methods



Commercial Development of the System described in the Dec. (1940) Issue

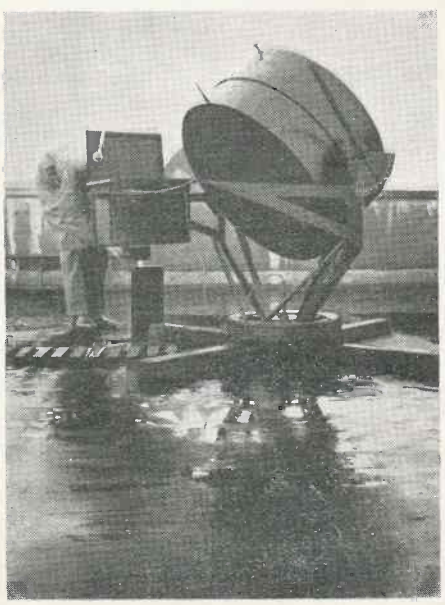
The system of electro-acoustical sound location described in the December (1940) issue has proved so successful in practical use that it has been produced in commercial form as described here.

THE series of experiments conducted on the developments of apparatus for the location of aircraft by electro-acoustical methods which were described in the December 1940 issue of ELECTRONICS AND TELEVISION have been continued and now the apparatus has reached a form in which it can be produced commercially and its operation learnt in an hour or two.

In the February 27 (1941) issue of the *Aeroplane Spotter* an article by the Technical Department of Benjamin Electric, Ltd., of Tottenham, was published describing the apparatus that had been made and designed by them for use at their works which follows the general principles as first disclosed in ELECTRONICS AND TELEVISION. The Benjamin Company have reported that during a recent week their employees were in the shelters for about 2½ hours only, whereas employees of adjacent factories spent over ten hours in the shelters. This resulted in a saving of some 6,000 man-hours for that week alone. Also the smoothness of production was not affected, and the employees worked under the happy circumstances of knowing that their lives were not being risked by ineffectual spotting.

Since the first article appeared several notable improvements have been made and application for a patent has been made. The photographs show the apparatus as used by Benjamin Electric, Ltd. It will be seen that a very accurate metal parabolic reflector, having a diameter of 3 ft., is mounted on a massive turntable which is located on the roof of a building (preferably one without any adjacent sound reflecting surfaces). The turntable enables the whole of the reflector to be turned through 360 degrees whilst a further control enables the angle of elevation to be adjusted to any degree.

Located very accurately at the focal point of the reflector is a microphone and surrounding the outer periphery of the reflector is an acoustic tube so adjusted as regards length that it acts as a Helmholtz resonator. This resonator not only increases the



The photographs on this page show the complete aeroplane-spotting apparatus, including the amplifier.

Aeroplane "Spotting" by Electro-acoustical Methods

magnification, but it also greatly reduces wind noises and pick-up due to mechanical vibration. The microphone and reflector unit are very similar to a searchlight in appearance, as will be seen from the accompanying photographs.

The signal output from the microphone is fed into a high-stage gain amplifier which incorporates a special filter network so that it acts as an acoustic band-pass filter. By means of a selector control, various bands of audio frequencies can be accepted and all other signals attenuated. The output from the amplifier is applied to a pair of headphones or to the "Y" plates of a cathode-ray tube.

By rotating the reflector unit in the direction of the aircraft, a signal of low audio-frequency will be heard in the phones. As the reflector is adjusted carefully, the intensity of the signal will increase or diminish, dependent on the direction of flight. For example, if the engine noises of a plane are heard, and in order to hear the maximum signal the elevation angle of the reflector has to be continually increased, it indicates that the aircraft is heading straight for the observer. If, however, it is necessary to hold the elevation angle constant but rotate the reflector, then the aircraft is flying in an arc with the sound locator at the centre of the circle and no danger is imminent.

Again, if both rotation and change of elevation are found to be required then by relating these two known quantities, the position and direction of flight can be determined and the degree of safety approximated. The acceptance range of the device is about eight miles. Due to the relative lack of sensitivity of the ear at large volume levels, a cathode-ray tube acting as an A.C. voltmeter is a desirable adjunct.

By means of the acoustic filtering in the reflector unit and electrical filtering in the amplifier, an electro-acoustical band-pass filter was developed and the results obtained are a great improvement over the earlier models. The effect is that all sounds outside the band of frequencies produced by aircraft engines and the auxiliary aircraft noises, are greatly attenuated, so that a quiet background exists. Also by employing a larger reflector and a smaller microphone the amount of magnification obtained acoustically has been increased. In order that the sound field is not deformed by the microphone itself, it is mounted in a streamline housing with streamlined supports, and on sorbo rubber so as to exclude mechanical vibration.

One of the difficulties that occurred in the early development of the apparatus was the concentration of heat on the face of the microphone if the apparatus was used in sunny weather, even in winter time. The piezo crystal microphone becomes rather insensitive with rising temperature and hence a special dynamic microphone has been designed which is unaffected by temperature changes.

Due to the variations of electricity supplies, the amplifier has been completely redesigned so that it can be operated on both A.C. and D.C. mains, or in the case of districts which are not provided with electrical supply from a vibrator unit and accumulators.

In order to train spotters in the use of the apparatus, a portable sound source, such as a gramophone or a radio receiver, can be used. The sound source should be placed at such a distance that it cannot be heard direct and the operator is blindfolded so that he cannot see the sound radiator. The operator then slowly moves the reflector round until he hears the radiated sound at maximum volume. After a brief practice the sound source should be moved about, with the operator endeavouring to follow its movement. Finally, the sound radiator should be placed at various heights above the operator and by rotation and elevation, the source discovered. About one or two hours' practice following this method enables the operator to become quite efficient.

The following observations should be noted. The sound locator will pick up sounds from distances in excess of 8 miles away. The angle of acceptance of a sound wave to give maximum signal strength is better than 5 degrees. Aircraft can be followed both during *day and night*, and an efficient operator can predict the possibility of bombs falling in his area with a great degree of accuracy.

The value of nuisance raiders to the enemy is greatly diminished if efficient means of locating enemy aircraft are provided as production will be maintained at the highest level compatible with safety.

"Review of Progress in Electronics"

(*Continued from page 152*)

SUMMARY.

In the foregoing sketch of development we have mentioned in historical order the salient points of progress in electron physics, and the references in the accompanying bibliography represent some of the most important contributions to the literature of the subject. In the space of a single article it is obviously impossible to deal adequately with the history of electron physics, so that our sole object has been to develop the subject logically to the stage from which practical progress in various directions began to take place. In this way the respective branches of electronics may be traced back to their origins so as to present a continuous picture of development, and at the same time to indicate the principal sources of information in relevant literature.

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News Brevities—

Commercial and Technical

THE chairman of the Radio Manufacturers' Association for the ensuing year is Mr. J. H. Williams, of A. C. Cossor Limited. Mr. M. M. Macqueen (General Electric Company) was re-elected vice-chairman. The council comprises representatives of eight set manufacturers and four component manufacturers; the set manufacturers represented are Rush Radio, Ltd., E. K. Cole, Ltd., A. C. Cossor, Ltd., General Electric Co., Ltd., Marconiphone Co., Ltd., Murphy Radio, Ltd., Pye, Ltd., and Ultra Electric, Ltd., and the component manufacturers, Belling and Lee, Ltd., A. F. Bulgin and Co., Ltd., Plessey Co., Ltd., and Westinghouse Brake and Signal Co., Ltd.

* * *

We regret to announce that Mr. Albert Hall, A.R.C.Sc., Wh.Ex., Chief Radio Engineer of Ferranti, Limited, was recently killed in a road accident.

* * *

It is estimated that eleven million radio receivers were manufactured in America during 1940 and that 52 per cent. of the total were table models; car radio receivers numbered 2,300,000. There were approximately 52,000,000 receivers in use at the beginning of this year representing a total investment of $3,200,000,000 and an annual cost of $220,000,000.

* * *

Frequency-modulation radio equipment has been installed for two-way communication between United States quarantine tugs and the Quarantine Administrative Headquarters at the Custom House, Boston, Massachusetts. The quarantine tugs go out five miles each day to subject all vessels entering the port of Boston to inspection. Since the frequency-modulation equipment provides noise-free, reliable communication between quarantine tugs and the Custom House, the necessity of returning to shore to check records is eliminated.

The radio equipment installed in each vessel consists of a General Electric 25-watt frequency-modulation transmitter and receiver which maintain contact with a General Electric station transmitter and receiver at Quarantine Administrative Headquarters in the Custom House. A special aerial on the 20th floor of this building facilitates efficient operation. Technicians operating the frequency-modulation equipment have made tests as far out to sea as 30 miles and report 100 per cent. good reception and performance at this range. Static caused by compressors and other machinery operating in nearby plants at Boston Commonwealth Pier does not affect communication.

* * *

Observation by ultra-violet radiation is gaining in popularity in industrial applications. By the use of simple apparatus which employs a high-pressure quartz-mercury lamp, rapid examination of small articles (where it is impracticable to use X-rays) is possible. The visible light emitted by the mercury lamp is absorbed by a filter made of a special kind of glass "blackened" with nickel oxide. The lamp is surrounded by an outer bulb of this filter glass, and mounted in a reflector made of aluminium.

The applications of this method of observation, known as luminescence analysis, are many. For example, it is possible to inspect hen's eggs to determine their age—the shell of a fresh egg fluoresces red and that of a stale egg blue. If invisible ink (which is fast to washing) is used to mark linen, and the laundry sorted by the light of a luminescence lamp, disfiguring marks are obviated. Another interesting application of luminescence investigation is supplied by the textile industry. The printing of materials is often done with soluble colourless reduction products of dyes, the leuco-bases. Only in the following step, oxidation, is the insoluble absorbed dye itself obtained. Printing faults can generally be seen only after the oxidation when it is no longer possible to correct them. As practically all the leuco-dyes fluoresce strongly upon irradiation with ultra-violet light, however, the printed material may easily be inspected before the oxidation process with the help of a luminescence lamp.

* * *

General Electric (U.S.A.) recently added a new mercury-vapour rectifier to their range of valves for experimental and commercial use. The valve, designated the GL-866A/866, has a spiral edgewise-wound cathode with its axis vertical and surrounded by a heat-conserving shield which is at cathode potential. The glass envelope is of the dome type with the anode placed at the lower end of the small portion of the dome. This leaves only a very small space between the edge of the anode and the glass, thus minimising ionisation at the back of the anode and near the anode lead. The valve has a standard medium four-pin base, and its rating is: filament voltage 2.5 volts, filament current 5 amp., maximum inverse peak anode voltage 10,000 volts, average anode current 0.25 amp., maximum instantaneous anode current 1.0 amp.

* * *

Large molybdenum and tungsten works were recently opened by Russia in the Caucasian mountains.

* * *

The 1941 medal of honour of the Institute of Radio Engineers has been awarded to Dr. Alfred Norton Goldsmith for "his contribution to radio research, engineering and commercial development, his leadership in standardisation, and his unceasing devotion to the establishment and upbuilding of the Institute and its proceedings." Dr. Goldsmith is at present consulting engineer to the Radio Corporation of America.

* * *

A new system of call letters has been adopted for frequency modulation stations in America. The first letter for stations operating west of the river Mississippi will be K and for those operating east of the river W. Following the first letter will be a number to indicate the frequency assignment, and the second letter, or combination of letters, will indicate the location of the station—for example, stations in Boston will terminate with a letter B, while those in New York will end with N.Y., those in the District of Columbia with D.C., etc. The stations used for solely educational purposes will have the letter E in their calls.

* * *

A novel transmitting and receiving equipment with which a man on foot may keep in communication with radio cars in a limited area has been devised by the Police Telegraph Bureau of the United States. The apparatus, which has been designed primarily for use between policemen

on patrol and police cars, weighs 10 lb., and is so small and compact that it can be worn under the clothing, while the microphone is strapped to the operator's wrist. The transmitting range of the equipment is approximately a quarter of a mile.

* * *

The death occurred recently of Professor Jacques Arsene D'Arsonval, famous French scientist and physicist. Professor D'Arsonval will best be remembered for his contributions in the fields of electrical measuring instruments and electro-therapy. He was 89 years of age.

* * *

An American television programme was recently transmitted for a distance of 190 miles. The transmission was made from the Bell Telephone Laboratories in New York over a coaxial telephone cable to Philadelphia and back to an hotel in New York. The pictures were reproduced on a giant tube specially designed and developed in the Bell Laboratories. Viewers compared the long-distance picture with the same scene transmitted a few miles across New York, and at the usual distance of five or six feet from the screen, the difference between local and long-distance cable transmission was imperceptible.

* * *

One of the most recent applications of the photo-cell is its use for graphically indicating the velocity of the wind. As a windmill rotates at a speed depending on the relative velocity of the wind, a slotted ring at its base is also made to rotate. A small lamp is placed inside this ring, and each time a slot passes through the beam of light projected towards a photo-cell outside the ring, a pulse of current is produced and sent through an amplifier. This causes a relay to be energised and its local circuit actuates a tape recorder. By noting how many pulses occur in a given time, the relative velocity of the wind can be calculated. If a large number of humps appear on the recorder, in a period of one second for example, then the wind velocity is high; if only a small number of humps appear in the same time period, the wind velocity is low.

* * *

Mr. S. Sagall, managing director of Scophony, Ltd., recently demonstrated the Scophony system for large-screen television pictures to an audience consisting of members of the American Press in New York, and also to the council of the National Television Systems Committee recently set up to formulate the proposed standards of American television. Scophony engineers have been engaged for the past three months in changing their mechanical-optical receiver, which was, of course, originally designed and built in this country for European standards, to conform to the somewhat higher American standard of 60 frames per second at 441 lines.

An audience of about 100 saw pictures 9 ft. by 12 ft. projected on a translucent screen from the Scophony apparatus located 12 ft. behind the screen. The pick-up was accomplished in a small studio on the same floor of the building where the demonstration was held and carried by wire to the receiver. Several smaller receivers were also demonstrated.

Our two American contemporaries, *Electronics* and *Radio and Television*, in reporting the demonstration, agree that the brightness of the screen does not approach that of a directly-viewed cathode-ray tube, or quite come up to the brightness of the modern motion picture. While the eye failed to differentiate very much between the cathode-ray tube and the projection screen, light measurements showed the decrease to be about eight to one.

* * *

The General Electric Company (U.S.A.) has taken over a large club-house in Schenectady and is remodelling it to provide a new television studio for W2XB. It is hoped that the new studio will be ready for operation by late spring or early summer.

When completed the station will be devoted exclusively to television and will embody many special features, including an aerial 125 ft. high for relaying programmes to the main transmitter in the Helderberg mountains 12 miles outside Schenectady. This aerial will be heated electrically during the winter to prevent ice formation.

The main studio will be 70 ft. long by 46 ft. wide by 18 ft. high, and will occupy the entire main floor. Illumination will be provided by water-cooled mercury-vapour lamps using the midget cigarette-type newly developed by General Electric. These lights will provide 1,000 foot-candles.

* * *

Arrangements are being made to link up two well-known radio institutions, the British Institution of Radio Engineers and the Institute of Wireless Technology. The following were among the suggestions made at a meeting of the council of the British Institution of Radio Engineers, at which the President and honorary secretary of the Institute of Wireless Technology were present, on January 25:—

The combined body to be known as the British Institution of Radio Engineering incorporating the Institute of Wireless Technology.

The headquarters of the combined body to be at Duke Street House. Duke Street, W.1, where additional offices will be taken and the combined library housed adequately.

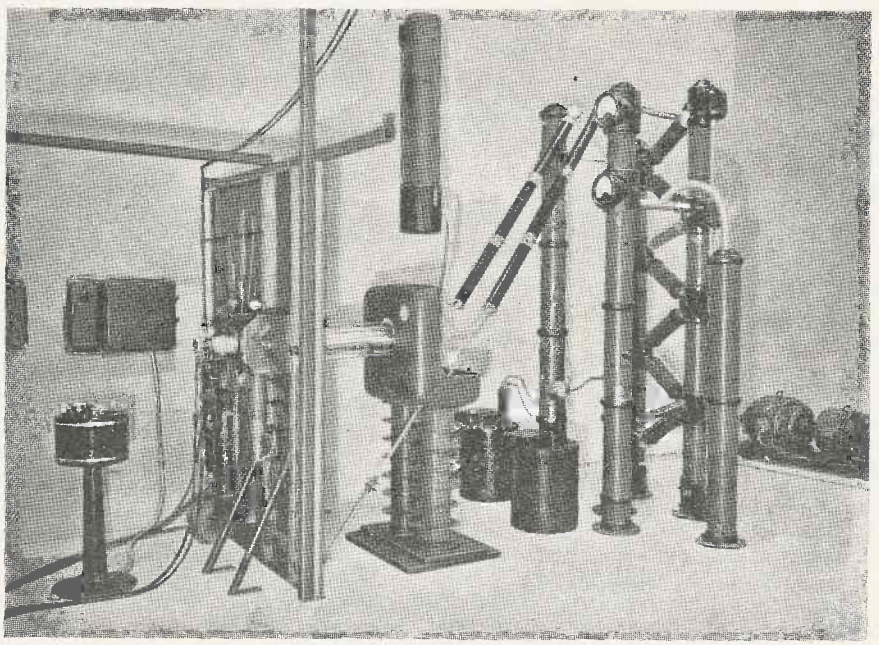
All members to have the opportunity of transferring to the combined body with the same grade as they now hold.

Mr. G. D. Clifford, general secretary of the British Institution of Radio Engineers, states that the fusion has, in principle, been approved, and actually the Fusion Committee, comprising L. Grinstead, M.I.E.E., and A. L. Beedle (members of the Brit. I.R.E.) and Mr. S. A. Hurren, M.C., and one other member of the I.W.T., are now really only concerned with technical details.

Production and Use of Neutrons

By F. A. Heyn

This article describes apparatus which was developed in the Philips' Laboratory for the production of neutrons, the uncharged particles of matter which are recognised as of great importance in several fields of application. We are indebted to Philips' Technical Review for the information.



Photograph of a complete neurton generator for 300 kV. In the high-voltage chamber to the right of the partition is the canal ray tube with a high-voltage apparatus. At the extreme right stands the convertor from 50 to 500 c/s. for the source voltage. Above the tube may be seen the insulated cooling pump. The extremity of the tube projects through the partition into the room on the left, where the neutrons are produced on an earthed target.

IN 1932 Chadwick discovered the elementary particles of matter which he called "neutrons" and which have been added as new components of matter to our picture of the universe along with the already known electrons and protons. In the few years which have elapsed since their discovery, numerous experiments have been carried out which have enlarged our knowledge of the properties of these particles. At the same time, the technique of producing neutrons has made great progress, especially since it soon appeared that neutrons could be put to practical uses.

The discovery of the neutron was considered to be of such great importance that Chadwick was awarded the Nobel Prize. Actually he was not the first to observe the existence of neutrons: German physicists had already noticed that when beryllium is bombarded with *a* particles (helium nuclei emitted by radio-active substances) it sends out a very penetrating radiation which can be shown by the ionization which it causes under certain circumstances. They believed them to be concerned with y-rays (extremely hard X-rays).

This radiation was also investigated by others, but Chadwick was the first to be able to prove that there was no question of y-rays here, but that the beryllium, when bombarded with *a* particles, sends out uncharged particles of matter with a mass about equal to that of the proton, i.e., the nucleus of the hydrogen atom. These neutral particles were called neutrons. It soon appeared that they play a very important role in the structure of atomic nuclei.

The Production of Neutrons

According to present conceptions, atomic nuclei are composed of neutrons and protons. If we wish to obtain free neutrons, we must get them out of the atomic nuclei. This can be done by bombarding the nuclei with fast particles—for instance, with the already mentioned *a* particles. Nuclear reactions then occur in which, in some cases, neutrons are freed from the nucleus. For example, in the experiment which led Chadwick to make his discovery, the nuclear reaction proceeded as follows:—

$$Be + a \Rightarrow C + n, \quad \ldots \quad (1)$$

which means in so many words that a beryllium nucleus, struck by an *a* particle (a), is transformed into a carbon nucleus with the emission of one neutron (n). In practice, this reaction is brought about simply by mixing beryllium powder with a substance which emits *a* particles, such as radium or radium emanation. The mixture then emits neutrons in all directions.

The yield of reaction (1) is not high. If we bombard beryllium with the *a* particles produced by 1 mg. of radium, i.e., $1.5 \cdot 10^8$ *a* particles per second, we obtain about $2 \cdot 10^4$ neutrons per second. Thus only one in about seven thousand *a* particles produces a neutron. With other substances bombarded with *a* particles we find a still lower yield. If, for example, 100 mg. of radium is available it is possible in this way to produce $2 \cdot 10^6$ neutrons per second.

This quantity of neutrons is usually insufficient for the applications to be mentioned later. More radium (i.e., more *a* particles per second) would be necessary. Apart from the very great expense, however, the world's supply of purified radium is limited, so that the investigator will not in general have a larger quantity than the above-mentioned (100 mg.) at his command.

Fortunately other nuclear reactions are now known in which neutrons are freed. In the first place, there are the reactions in which "duetrons" nuclei of heavy hydrogen (the isotope with atomic weight 2 of normal hydrogen, indicated by D as abbreviation for "due-

to 1 : 10 without affecting the purity of the waveform.

Reference to the circuit diagram will show that the output from a conventional thyratron time base is fed into the grid circuit of a pentode anplifier operating at zero bias, the output from this first shaping valve being fed into a similar stage where it is further shaped to become the square-wave output. Since the first shaper is only capable of accepting about 1 per cent. of the output from the time base, the transition period is only 1 per cent. of the total duration of the wave. This is, of course, only true at low repetition frequencies; at higher frequencies the effect of the valve capacitances extends the transition period.

The mechanism by means of which the first shaper transforms the saw-tooth waveform into the required square waveform is interesting. The condition when the marking-spacing ratio is at a minimum (ratio control set to zero resistance) will be considered first.

The time constant of the coupling circuit from time base to shaper is sufficiently long to transmit sensibly without distortion the slowest speed saw-tooth voltage. Since the time base condenser charges in a negative direction, the first shaper is cut off for the major part of the cycle. At the time base flyback the shaper grid receives a large positive voltage pulse, which causes grid current to flow and discharge the coupling condenser until the shaper again becomes cut off and the cycle repeats. The voltage appearing at the shaper valve anode is constant at the value of the H.T. rail voltage during that period of the cycle when the valve is cut off, but has a rapid negative pulse during the period of the positive excursion of the grid. The transition from positive to negative is governed in duration only by the flyback time of the time base, while the return transition depends upon the magnitude of the charge held by the coupling condenser, the impedance through which this condenser is discharged, and the ratio of the discharge impedance to the normal external grid-earth resistance. It follows, therefore, that if this latter ratio be reduced by increasing the discharge impedance, the return transition time will be increased.

This increase in discharge impedance is obtained by inserting a variable resistance in series with the coupling condenser and the grid of the shaper. In practice, the negative pulse on the anode of the first shaper has a flattened top which is further shaped to become truly square by the second shaper. By means of this ratio control the marking-space ratio may be varied from 1 : 1 to 1 : 10 as previously stated.

The front panel layout is shown in the photograph. The controls reading from left to right along the top row are the condenser switch for the time base, the Synch. control for synchronising the time base, the Coarse output control giving a coarse control of output voltage, and the Out to Mon. potentiometer an output control for feeding a monitor C.R.O., the purpose of which will be explained in more detail below. Along the bottom row there is the Velocity control of the time base giving fine control of time base frequency, the Ratio control, the purpose of which has been explained above, the Fine Output control, and a switch marked Mon-amp. On the left-hand side of the front panel are provided three terminals for the synchronising input, the saw-tooth time base output, and earth. On the right-hand side of the panel is a screened socket for the square-wave output, and three terminals marked respectively, D.C., R.C.C. and Mon.

Testing Procedure

When using the square-wave generator with a single beam C.R.O., the normal testing procedure is to compare the output from the generator (input to amplifier) with the output from the amplifier. If the output from the amplifier be connected to either the terminal marked D.C. or that marked R.C.C. (this interposes a coupling circuit of 10 secs. time constant) and the Y plate of the C.R.O. connected to the Mon terminal, the C.R.O. may be switched to either the output from the generator or to that from the amplifier by means of the switch marked Mon.-amp. The Out to Mon. control permits the output from the generator to be adjusted to the same amplitude as the output from the generator to be adjusted to the same amplitude as the output from the amplifier. When using a double beam C.R.O. the Y_1 plate should be connected to the amplifier output and the Y_2 plate to the Mon. terminal of the generator with the switch in the Mon. position. The use of the double beam C.R.O. is of considerably greater utility, for by this means the two traces may be viewed simultaneously and may be superimposed to indicate more clearly the differences resultant upon the passage of the wave through the amplifier. This applies particularly in the case of amplifiers which introduce 180° phase shift.

The information that may be extracted from particular distorted waves appearing at the output is very large and for this reason cannot be dealt with thoroughly here, but anyone who has had the opportunity of adopting this method of testing will be fully aware of the extreme simplicity of the method. To illustrate this, it is only necessary to quote one example—that of adjusting a frequency-compensated resistance attenuator. Such attenuators commonly consist of a network of resistances forming a potentiometer across the input, the output being tapped across the lower leg of this potentiometer.

If a capacitance exists across the output terminals, the value of attenuation expected from consideration of the ratio of the resistance of the bottom leg to that of the whole potentiometer will be exceeded with increasing frequency. To compensate for this, capacitances may be placed across the top leg of the potentiometer, having a value bearing a ratio to the capacitance across the lower leg which is the inverse of the ratio of the lower resistance leg to the upper leg. These capacitances must be accurately adjusted, and to do this by the classical method, the frequency response of the network at each attenuator setting must be delineated by a step-by-step measurement. Using the square-wave method the output from the generator is applied to the input of the attenuator, and the Y plate of the C.R.O. is applied alternately to this signal and to the output of the attenuator. The trimmers may then be adjusted to the correct value (i.e., when the output waveform matches the input waveform) in a few seconds.

More comprehensive treatment of the square-wave testing method may be found in the articles to which reference is made below :—

1. "Amplifier Testing by means of Square Waves." — G. Swift, *Communications*, February, 1939, p.22.
2. "Square-Wave Harmonics" — Donald L. Merr, *Electronics*, May 1940, p.34.
3. "The Transient Aspect of Wide Band Amplifiers" — O. S. Puckle, *Wireless Engineer*, May 1935, p.25.
4. "Distortion Factor of a Complex Wave" — Hans Roder, *Radio Engineering*, Feb. 1937, p.10.
5. "Transient Amplifier Analysis" — Walker, *Electronics*, Nov. 1939.

The construction of the Don Lee television station W6XAO at Los Angeles is proceeding. A novel feature of the building is that it is entirely shielded with copper sheeting on all four sides and the roof. More than 22,600 square feet of copper were used. The metal was applied to eliminate outside and intra-building interferences. The two-storey building will have one television stage 60 ft. by 100 ft. and another 25 ft. by 40 ft. with monitor rooms, in addition to complete office facilities, transmitter room, experimental laboratory, scene storage rooms, make-up room, lounge viewing room, artists' lounge and other theatrical facilities. It is anticipated that this new station, situated as it is on top of a 1,700-foot mountain, will have a service area of approximately 60 miles.

Proposed American Television Standards

THE commercial development of television in the U.S.A. has been practically at a standstill for nearly a year pending the recommendations of the National Television Systems Committee to the Federal Communications Commission on the question of standards. A group of twenty-two transmission standards has now been approved and it is expected that they will be officially adopted. Two years ago the Radio Manufacturers' Association made certain recommendations and it is interesting to note that the latest ones are very similar, the principal difference being that frequency modulation should be used for the sound transmissions. This is very surprising for a very exhaustive inquiry has been made of several alternative suggestions. The new suggested standards are given below :—

I. THE TELEVISION CHANNEL.

The width of the standard television broadcast channel shall be six megacycles per second.

It shall be standard to locate the picture carrier 4.5 megacycles per second lower in frequency than the unmodulated sound carrier.

It shall be standard to locate the unmodulated sound carrier 0.25 megacycles per second lower than the upper frequency limit of the channel.

II. SCANNING SPECIFICATIONS.

The standard number of scanning lines per frame period in monochrome shall be 441, interlaced two to one.

The standard frame frequency shall be 30 per second and the standard field frequency shall be 60 per second in monochrome.

The standard aspect ratio of the transmitted television picture shall be 4 units horizontally to 3 units vertically.

It shall be standard, during the active scanning intervals, to scan the scene from left to right horizontally and from top to bottom vertically, at uniform velocities.

III. PICTURE SIGNAL MODULATION.

It shall be standard in television transmission to use amplitude modulation for both picture and synchronising signals, the two signals occupying different amplitude ranges.

It shall be standard that a decrease in initial light intensity cause an increase in radiated power.

It shall be standard that the black level be represented by a definite carrier level, independent of light and shade in the picture.

It shall be standard to transmit the black level at 75 per cent. (with a tolerance of plus or minus 2.5 per cent.) of the peek carrier amplitude.

IV. SOUND SIGNAL MODULATION

It shall be standard to use frequency modulation for the television sound transmission.

It shall be standard to pre-emphasise the sound transmission in accordance with the impedance-frequency characteristic of a series inductance-resistance network having a time constant of 100 micro-seconds.

V. SYNCHRONISING SIGNALS.

It shall be standard that the time interval between the leading edges of successive horizontal pulses shall vary less than one half of one per cent. of the average interval.

It shall be standard in television studio transmission that the rate of change of the frequency of recurrence of the leading edges of the horizontal synchronising signals be not greater than 0.15 per cent. per second, the frequency to be determined by an averaging process carried out over a period of not less than 20, nor more than 100, lines, such lines not to include any portion of the vertical blanking signal.

VI. TRANSMITTER RATINGS.

It shall be standard to rate the picture transmitter in terms of its peak power when transmitting a standard television signal.

It shall be standard in the modulation of the picture transmitter that the radio frequency signal amplitude be 15 per cent. or less of the peak amplitude, for maximum white.

It shall be standard to employ an unmodulated radiated carrier power of the sound transmission not less than 50 per cent. nor more than 100 per cent. of the peak radiated power of the picture transmission.

It shall be standard in the modulation of the sound transmitter that the maximum deviation shall be plus or minus 75 kilocycles per second.

VII POLARISATION.

It shall be standard in television broadcasting to radiate horizontally polarised waves.

"Production and Use of Neutrons"

(Continued from page 173)

Another special property of neutrons, and for practical purposes perhaps the most important one, is that practically all the elements of the periodic system may be made radio-active by bombarding them with neutrons. The activiation usually takes place by a "process of capture" as described above. The atomic nucleus which has captured a neutron is now, however, unstable and breaks up after some time with the emission of β particles, as do many natural radio-active elements.

Applications

In the applications, use is made in the first place of the artificial radio-activity induced by neutrons. The amount amount of radio-active material which can be made with neutrons is considerable and is, for example, enough for medical purposes. Compared to the natural radio-active substances, the artificial ones have several advantages from the medical point of view. For example, they can be introduced into the body in

the form of all kinds of compounds, which is not generally possible with natural ones. The natural radio-active substances form series of equally radio-active decomposition products, some of which have long lifetimes, so that once introduced into the body they cause a permanent irradiation, which is not desirable. The artificial radio-active substances, however, do not form such series; their decomposition products are no longer radio-active. If, for example, a patient is allowed to drink a solution of common salt which has been made radio-active, the radiation in his body will disappear entirely after some time.

Furthermore, elements which have been rendered radio-active may be used as indicators in chemical and biological experiments. They behave chemically just like ordinary non-radio-active elements, while their presence can be detected by their radio-activity, a method which is much more sensitive and universal than chemical methods. In the realm of biology, important results have already been obtained with this method. For example, the distribution of phosphorus compounds throughout the body has been investigated by feeding animals with radio-active phosphorus compounds and then finding out what parts of the body had become radio-active.

In experiments carried out in Amsterdam it was found that neutrons have an action on organic tissues which is analogous to that of X-rays. There is, however, a certain difference. While X-rays exert their influence by the ionization which they cause in the tissue by their reaction with the electrons present in it, neutrons cause an ionization due to the fact that they transfer energy to hydrogen atom nuclei present in the tissue by collision, and the latter in turn cause ionization in the tissue. In the last case, the ionization is much more local, while the ionization by X-rays is more homogeneous. It may also be expected that it will be easier to irradiate more deeply lying parts with neutrons.

In the case of insects irradiated with neutrons, it was found possible to provoke mutations, as may be done with X-rays. Here especially several differences were observed as a result of the different manner of ionization.

Workers must be well protected against neutrons just as against X-rays and γ-rays. On the basis of the properties mentioned above, it follows that this cannot be accomplished with lead as in the case of X-rays. The best method is by surrounding the source of neutrons with water or paraffin, about which a layer of cadmium can be added.

"U.S.W. Anti-static Aerials"

(*Continued from page* 183)

noise) is practically constant over a wide range of variation of height.

A receiving system consisting of two horizontal aerials, one close to the ground and the other at some height, can therefore be employed to give a very good signal/noise ratio if the outputs of the two aerials are phased so as to cancel the noise voltage.

The arrangements illustrated in the accompanying diagrams show simple methods of achieving this effect. Fig. 4 shows an upper aerial A and lower aerial B, each connected to a transmission line linked by movable contacts with a third line C connected to a receiver, the line C being terminated by an appropriate resistance D. The phase cancellation adjustment is made by means of the movable links E, and the intensities of the two noise voltages are equalised by sliding the contacts F along the resistance D.

Fig. 5 shows an alternative which is more convenient in practice, the feeder from the upper aerial being transformer-coupled to the receiver line, while phase adjustment is provided by sliding contacts along an artificial line connected to the lower aerial and terminated by the appropriate resistance.

In both the above arrangements, of course, when the correct adjustments are made to balance out the noise voltages, the desired signal will still be received at high strength because of the wide difference of signal intensity in the upper and lower aerials.

Fig. 6 shows a further application of the same principle, the two aerials in this case being connected to superhet receivers which co-operate with a common high-frequency oscillator so to produce an intermediate frequency output. This development is reported from the laboratories of the Radio Corporation of America.

Investigations carried out in New York have proved that lightning strikes the same place more than once, and that even in a single storm, a single place can be struck repeatedly. By means of lightning recording instruments, eight strokes on the Empire State Building were recorded in the space of 24 minutes. Details of the apparatus used were given in two articles by Mr. J. H. Hagenguth in the May and June 1940 issues of *General Electric Review*.

American Catalogues

Relays. — Break-in, change-over, remote control, time delay, miniature and radio-frequency relays are listed in the literature of the Standard Electrical Products Company. Also manufactured by this company is a code practice oscillator (comprising an audio oscillator and permanent magnet dynamic speaker), and a variable transformer which is a portable and efficient variable voltage regulator providing smooth control of A.C. lines, power, heat, light and speed. Standard Electrical Products Company, St. Paul, Minnesota.

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A new Western Electric circuit using temperature controlled crystals which give a frequency stability of .0025 per cent., is employed in the frequency modulation transmitter, W2XOR, operating on 40.3 Mc. The station is on the air daily from 3 a.m. until 6 p.m. (B.S.T.).

* * *

Owing to the lack in Soviet Russia of special generators and transformers of high capacity, for testing, the "Donenergo" high voltage laboratory has developed special arrangements which enable switches to be tested under power conditions considerably in excess of the capacity of the available testing plant. Current at reduced voltage is applied whilst by means of condensers, high voltage is applied after the current has reached zero value. By this means switches can be tested at ratings 5 to 10 times in excess of that of the test plant itself.

* * *

Photo-electric control of four red warning lights on a 125-ft. standpipe is a new scheme used at a New York aerodrome for enabling pilots to land and take-off safely. As dusk falls, or the atmosphere becomes foggy, the lights automatically light up, and go out as daylight approaches. This system is similar to the photo-electric control of street lighting in London.

* * *

General Electric of America are erecting a new 50-Kw. frequency-modulation transmitter which will serve the area surrounding Schenectady and Albany. The transmitter consists of a 250-watt exciter unit feeding a 3,000-watt intermediate power amplifier which in turn feeds a 50,000-watt power amplifier. Air-cooled valves are used in the intermediate amplifier and water-cooled valves in the final amplifier. A newly-designed three-bay turnstile aerial, fed by a pair of $2\frac{5}{8}$-in. concentric transmission lines, will radiate the power of this new station.

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An integrating-sphere Densitometer, a new instrument for measuring the density or pattern of light and shade which comprises the image on a motion picture film, has been developed by Dr. J. G. Frayne and G. R. Crane of Electrical Research Products, Inc. This new instrument operates in the same manner as a photographic exposure meter, but has the added advantage that it can be used for controlling the development of both positive and negative. The principle of operation is briefly as follows: in taking measurements, the Densitometer traps that portion of a beam of light which succeeds in penetrating a test sample of motion picture film. The trap consists of a hollow ball or sphere, the inner surface of which is finished in white and fitted with a photo-electric cell. Light entering the globular chamber is reflected many times, and finally falls on the photo-electric cell as a thoroughly mixed or integrated product. Its value or brightness is then translated into electrical current

---

The National Broadcasting Company has carried out an exacting field test of frequency modulation. The purposes of the field tests were to ascertain the advantages of frequency modulation over amplitude modulation on the ultra-high frequencies by painstaking measurements, comparison the two systems under all kinds of actual service conditions in the field and determining how much of the theoretical advantage of F.M. could be obtained in practice. The conclusions reached are briefly as follows: Frequency modulation offers advantages over amplitude modulation on the ultra-high frequencies. The advantages to the listener of frequency modulation on the ultra-high frequencies consist of freedom from the 10-Kc. beat note and side-band interference which result from the frequency allocation of standard broadcasting, and also the reduction of locally generated noise, atmospherics, and interference from distant stations operating on the same channel. Standard broadcasting has the advantage of providing clear channel night-time service to vast areas which would not be served by frequency modulation on the ultra-high frequencies.

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