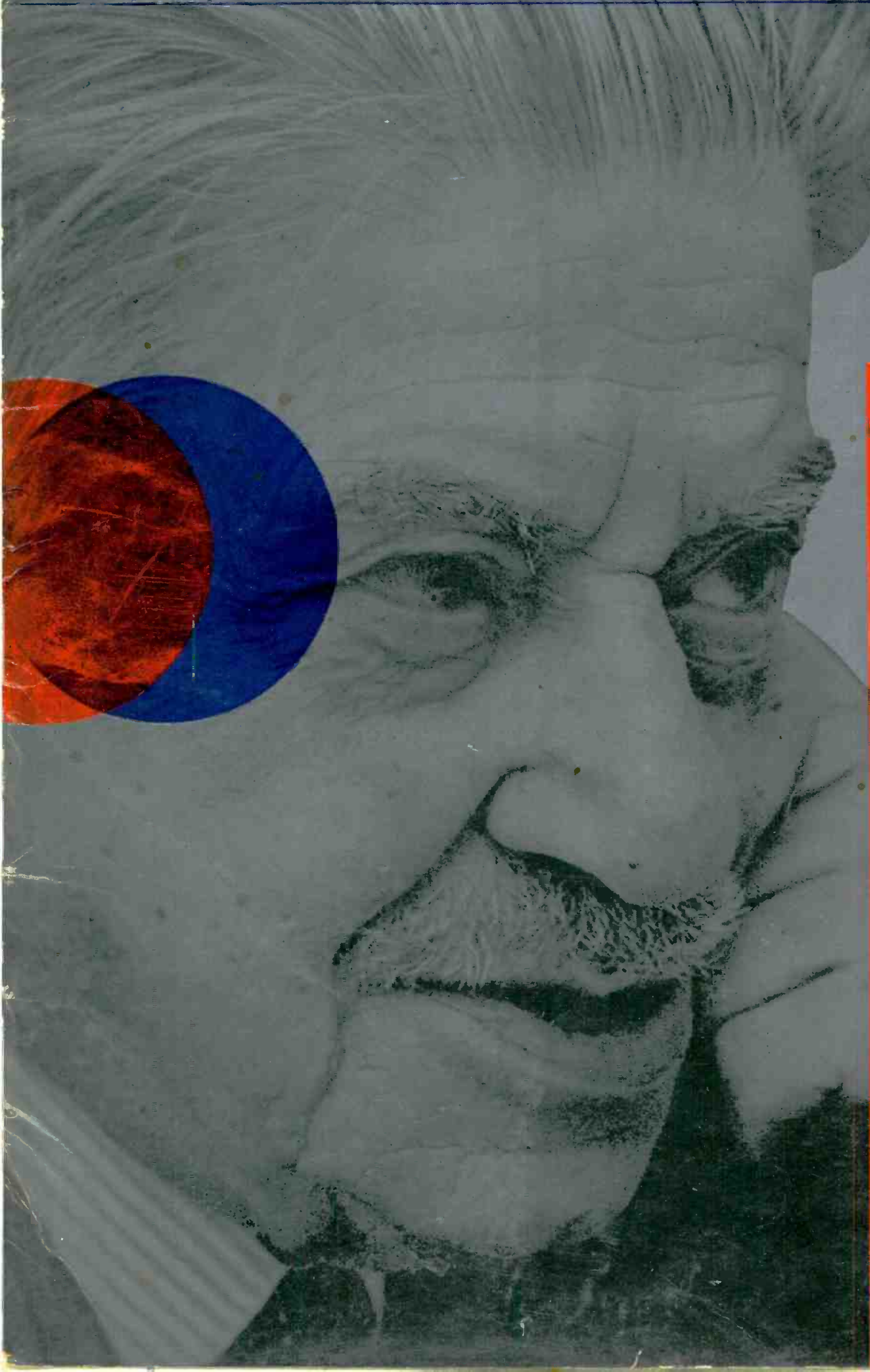
INTERNATIONAL TV TECHNICAL REVIEW PUBLICATION 1961 2s 6d

25 YEARS OF WORLD TELEVISION



FIRST FROM THE START

EMI Emitron Cameras used at the opening of the London TV Service in 1936.

Television celebrates its Silver Jubilee this year—thanks to the pioneer work of Isaac Shoenberg and his brilliant research team at EMI Laboratories in the early 1930's.

This dedicated team gave Britain a world lead in television, when in 1936 the BBC transmitted the first regular public high-definition programmes using the electronic system developed by Mr. Shoenberg and his colleagues. That system is the basis of television as used throughout the world today.

The lead, established by EMI twenty-five years ago has never been relinquished. It is reflected today in the most up-to-date range of Television Broadcasting and Studio Equipment in the world. (See back cover).

ISAAC SHOENBERG MIEE
Director Electric & Musical Industries Ltd. Born Pinsk, Russia 1880. Developed earliest Russian transmitting stations. Came to Britain 1914. General Manager Columbia Gramophone Co 1928. (Merged with Gramophone Co. to form EMI Ltd) Director of Research EMI 1931. Awarded Faraday Medal 1954.

LONDON, 1961. PRICE 2s. 6d.

25 years of world television

FROM THE PIONEERS TO A LEGEND IN A QUARTER CENTURY

When the B.B.C. inaugurated the world's first high-definition television service 25 years ago, there were 50 receivers to pick up the programmes. Today there are nearly 90,000,000 licenced sets throughout the world.

These figures dramatically illustrate the expansion of the art — or industry, if you prefer. Its growth has been so fast and fantastic that already its origins appear to be misty. Some names have become legendary, others have been forgotten in a way that usually takes a process of many decades rather than this brief quarter century.

When researching into the early development, it is heartening to see how much is owed to individuals, pioneers who were obsessed with the magical prospect of sending pictures through the air. To these quiet visionaries this publication is respectfully dedicated.

Of necessity it is primarily concerned with the technical aspects, but as with other new industries television has stimulated vastly divergent fields of human endeavour — from the graphic arts to the production of commercials. To deal thoroughly with this complex would therefore require several volumes.

Marc Alexander

EDITOR, INTERNATIONAL TV TECHNICAL REVIEW

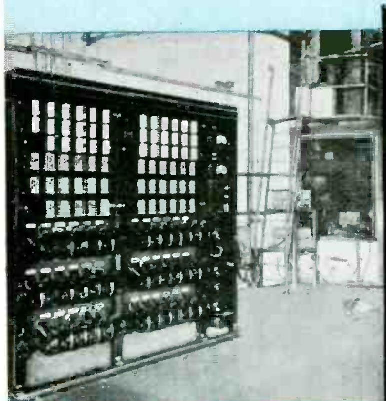
Behind the Screens

When the first television signals left the Alexandra Palace and nosed their way through the ether Strand Electric had been lighting theatre stages for 25 years. They had already developed the first Light Console by which one man could control the whole of the lighting of the largest theatre.

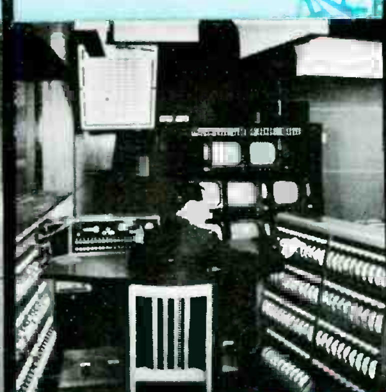
Thus it was that Strand Electric were requested to supply the Television lighting control system for the first high definition broadcasts from Alexandra Palace in 1936. Strand have continued to meet the BBC's exacting requirements ever since with developments such as the memory preset and more channels in even more compact consoles.

It followed naturally that this proved success of Strand lighting control systems would lead to their adoption by the independent companies who came to share the networks in 1955.

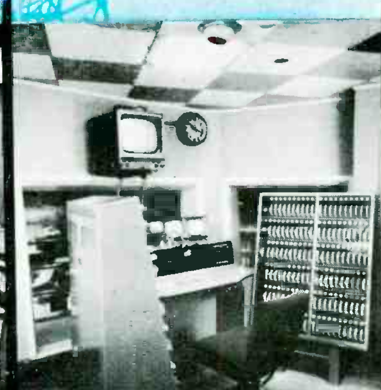
Now the new BBC TV centre, every independent programme company in Britain and a score or more studios abroad are using Strand remote control systems exclusively.



BBC, Alexandra Palace



BBC, Television Centre



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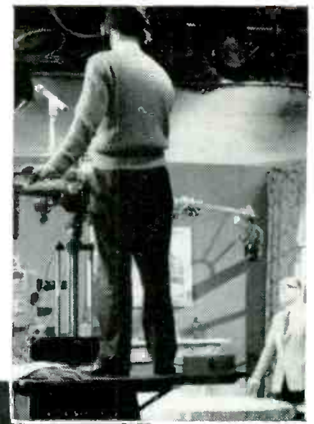

25 years of world television

This booklet, commemorating a quarter century of television since the first high-definition public service was started from Alexandra Palace, London, in 1936, is being circulated with 'TV Technical Review' to the following countries:

Algeria : Andorra : Argentina : Australia : Austria : Belgium : Bermuda : Brazil : Bulgaria : Canada : China : Colombia : Cuba : Cyprus : Czecho-Slovakia : Denmark : Dominica : Ecuador : El Salvador : Finland : France : German Federal Republic : Germany (West) : Great Britain : Guatemala : Hawaii : Honduras : Hong Kong : Hungary : India : Iran : Iraq : Italy : Japan : Korea (South) : Kuwait : Lebanon : Luxembourg : Malaya : Marianas : Mexico : Monaco : Netherlands : New Zealand : Nicaragua : Nigeria : Norway : Panama : Peru : Puerto Rico : Philippines : Poland : Portugal : Rhodesia : Rumania : Ryukyu Islands : Saudi-Arabia : Singapore : Spain : Sweden : Switzerland : Thailand : Turkey : USSR : USA : Uraguay : Venezuela : Yugoslavia.

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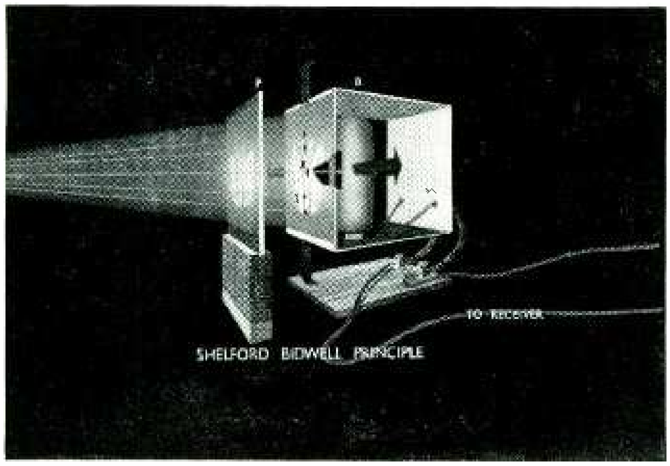
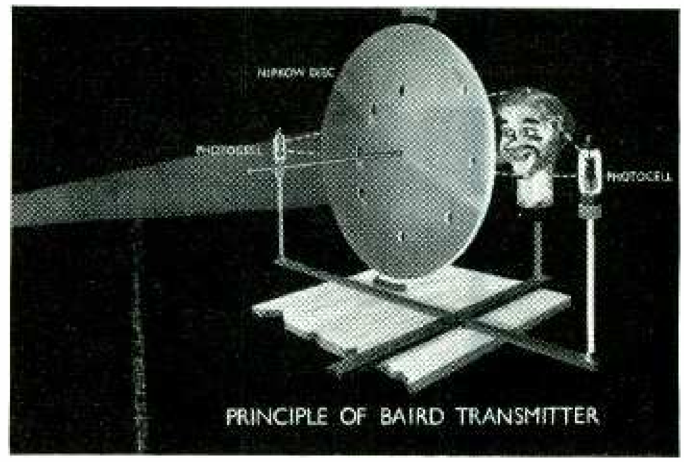




YEARS OF IDEAS AND EVOLUTION

The long and fascinating story of the research into the proposition of transmitting a picture by mechanical and electronic means is told briefly in this article. Illustrated above are two of the various important developments which are not themselves an essential part of modern television but nevertheless lent momentum to the following through of what was then an exciting idea and is now an important element of society throughout the world.

THE invention of television can be attributed exclusively to no one individual or nation. Many technological marvels combine to make television possible and inventors of several nations must be credited with the discovery and development of these. Nevertheless many of the most important discoveries took place in Britain, the outstanding figure in the development of television, J. L. Baird, was British and this country saw the first practical demonstration of television and the first regular public service in the world. These are matters of fact and must outweigh any nebulous claims based on ideas put forward but not developed or experiments made without practical following up.

The complete story of the origin and development of television would fill a very large book indeed and in these pages can only be attempted an outline of the subject. It is hoped that within these limits due recognition can be given to those scientists and engineers who played the most prominent parts in the whole story and that some of those who have perhaps not had their due share of the credit may receive some of the recognition they deserve.

The discovery of Selenium— 1817

Perhaps the first significant date in the origins of television was the discovery of the element Selenium in 1817 by the Swedish chemist Berzelius. A member of the same chemical family as Sulphur and Tellurium, Selenium was found to have a very high resistance to the passing of a current of electricity under normal conditions. Not until much later, however, was it discovered that Selenium's resistance altered considerably on exposure to light.

The electrochemical effect of light— 1839

Fundamentally, television depends on the phenomena known as photo-electricity or the physical changes which are produced by light. The original discovery of these effects was made by Alexandre Edmond Becquerel, a member of a family of French scientists of distinction. He observed that an electromotive force was generated between two electrodes immersed in a suitable electrolyte and illuminated by a beam of light. This discovery could not be put to practical use until 1873 when the further important quality of Selenium was discovered.

Early attempts at electrical transmission of pictures

Before television became the goal of inventors, experiments took place to discover ways of electrically transmitting still pictures from one point to another. In 1842, Alexander Bain, an important figure in the early history of telegraphy and telephotography (or facsimile) made a chemical recorder. This apparatus consisted of metal letters set up in a composing stick and connected to an earthed battery. Five metal brushes connected to five lines were passed over chemically prepared tape resting on an earthed conducting plate. As the currents were received over the line, marks were made on the paper and a copy of the type faces was obtained. Bakewell, another

ANGLIA ДРАМ
ANGLIA DRAMAT
ANGLIA GEKI
ANGLIA DRAMA
ANGLIA ΔΡΑΜΑ
ANGLIA LE DRA

Anglia Television—local station with the international look

Every six weeks, Anglia Television presents a dramatic production for the national network, starring internationally famous names. On the left is Diane Cilento in 'Jeanette'—to be presented on the national network on December 21st, 1961.

'S.O.S. Rhino', filmed in Uganda, was one of the dramatic programmes in Anglia's networked 'Survival' series.

British scientist, made similar apparatus in 1847. The Abbe Caselli set up a much more elaborate system in 1862 by which drawings, contours and diagrams were transmitted over wires by electric current. This system was in practical operation for several years between Paris and Amiens.

These systems, of course, provided for only one picture at a time very slowly and could not reproduce motion at all. Although they laid the foundation for the modern facsimile transmission of text and pictures and introduced the process of synchronous sequential scanning they did not stimulate much thinking towards the transmission of scenes involving motion.

The light properties of Selenium— 1873

In 1873, Willoughby Smith reported in a letter which was published in the Journal of the Society of Telegraph Engineers (vol. 2, page 31, 1873) that in using some high resistances composed of selenium it had been discovered that the instruments behaved erratically when the sun shone on the resistances. This had been traced to the fact that the electrical resistance of selenium decreased when exposed to light. The discovery was made by May, Smith's chief assistant at his Greenwich works during practical experiments with the submersion of long submarine cables, at Valentia in the West of Ireland, the terminal station of the Atlantic Cable.

This discovery, coupled with the invention of the telephone by Bell in 1875, led to numerous theoretical schemes for "seeing by electricity." The schemes, however, came to nothing largely owing to the lack of many other technical facilities which had not yet been developed.

G. R. Carey

One of the earliest, and most practical of these schemes was that put forward by G. R. Carey of Boston in 1875. He planned to build a transmitter consisting of a mosaic of light-sensitive selenium cells and a receiver consisting of a mosaic of electric lights, against which would be pressed a sheet of sensitised paper. It required however a very great number of conductors. A second scheme by Carey incorporated the elements of a practical mechanism for scanning the image and required only the use of a single line-wire for transmitting the signal currents. The clockwork scanning mechanism at transmitter and receiver had no synchronizing device and for this, and other, reasons it seems that Carey never put his ideas in practice although he published a full account of them in *Design and Work* (vol. 8, page 569, 1880).

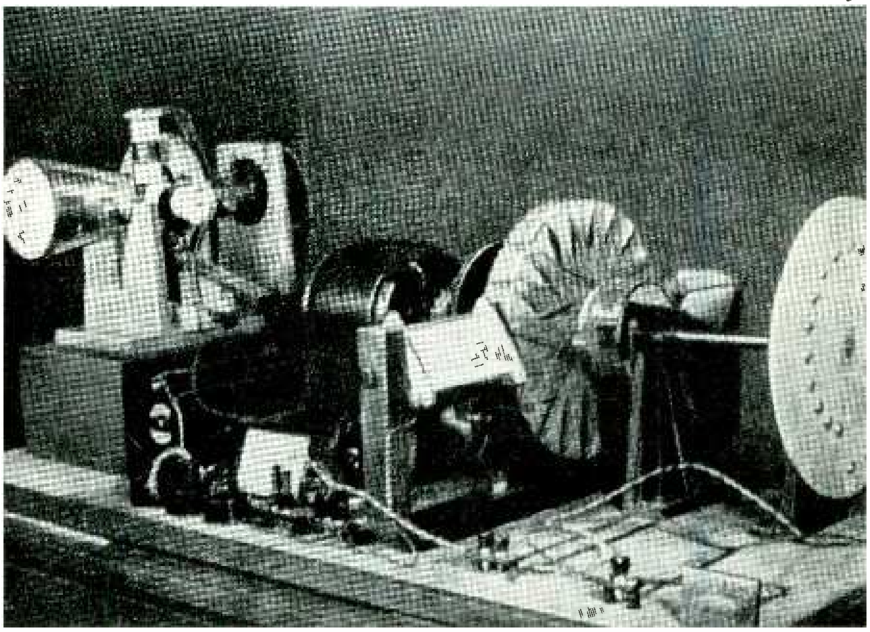
Ayrton and Perry

Another scheme probably developed at about the same time as Carey's was that of Ayrton and Perry of which an account was published in 1880 in *Nature* (vol. 21, page 589, 1879-1880). The apparatus consisted of many wires for transmission purposes each having a selenium cell connected to it. At the receiving end, a corresponding number of magnetic needles operated in unison with the action of the selenium sells, so that each time a magnet moved light passing through an aperture was either shut off or allowed to pass on. The back of a small square of ground glass received the light and a picture was built up from the many such cells forming the receiver.

Shelford Bidwell

The practicality of many of these schemes may be questioned but that of Shelford Bidwell cannot be disputed. In 1881 he demonstrated his apparatus to members of the Royal Institution, the Physical Society and the British Association for the Advancement of Science. In 1908, the Science Museum acquired what is probably the second of the two machines he constructed. In the transmitter a shadowgraph image was projected on to the front of the box with a pin-hole aperture containing a selenium cell. The image was scanned by the rise-and-fall motion of the box and its slow lateral traverse, which was made possible by means of a cam mechanism. The receiver consisted of a platinum-covered brass cylinder mounted horizontally on a spindle similar to that of the transmitter and coupled to it for demonstration purposes. The receiving drum carried paper soaked in potassium iodide on which was traced the image transmitted. A platinum point was attached to a flexible arm and traced out the lines upon the paper with an intensity which varied in accordance with the current through the selenium cell.

Other scanning methods were proposed by various inventors of whom Leblanc had one of the most interesting ideas. This was to use a small mirror arranged to oscillate about two axes simultaneously on widely different frequencies so that each little area of the image was projected in turn on to a selenium cell.

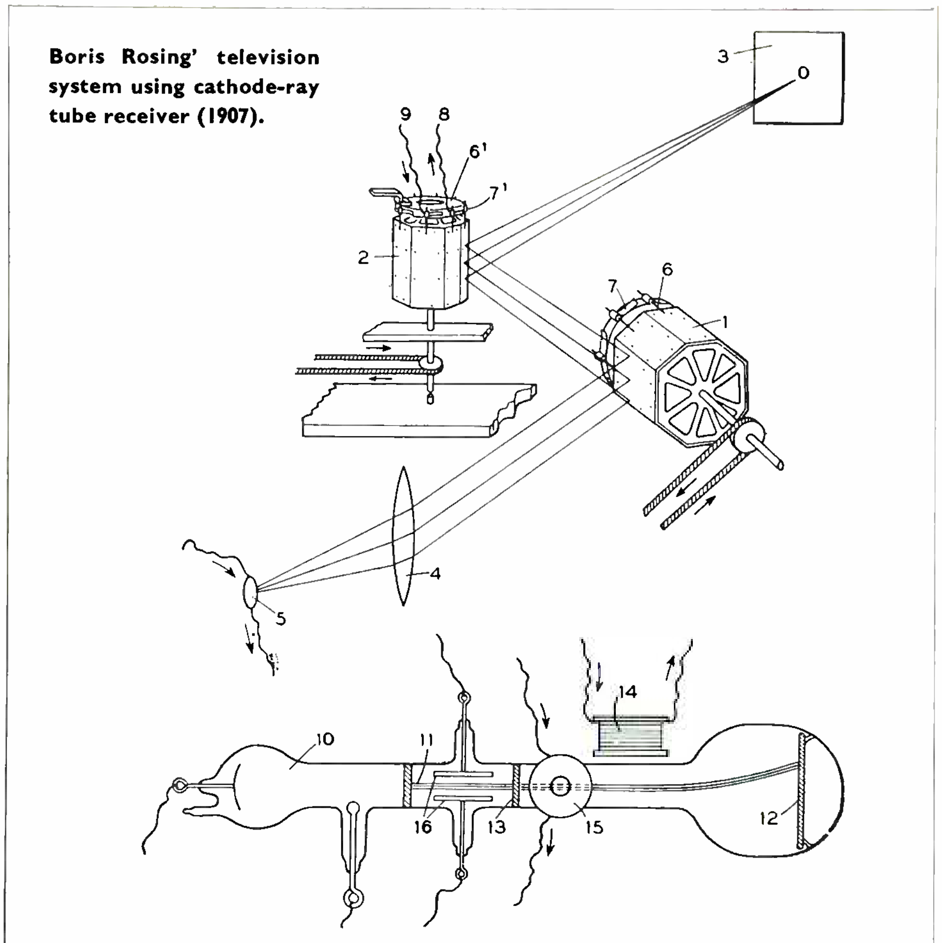


Earliest experimental model of German cathode-ray tube television receiver (Dieckmann 1906).

Nipkow's scanning disk – 1884

It had become obvious that it would be necessary in order to produce pictures without using thousands of conductors between the transmitter and receiver to dissect the picture in various ways and transmit each element in quick succession. In addition to those attempts at scanning mentioned above there were several other ideas put forward. Of these, the one which has played the biggest part in developing television is the Nipkow Disk. Paul Nipkow was a Russian engineer who invented a television machine and patented it in Berlin in 1884 (German Patent No. 30105). It seems to have been theoretical only as there is no other record of his work but this Patent. The scanning disk was of large diameter with a series of small holes near the preiphery arranged in the form of a spiral. Only a small area of image compared with the size of the disk could be scanned but it could be used with the stationery optical systems available at that time. Light from the object whose image was to be transmitted would fall on a selenium cell behind the disk and would be converted into a modulated current. The signal would travel by wire to the receiver where there would be a similar disk through which the viewer would watch the image built up on flint glass. The small currents passed by selenium and the absence of any means of amplification prevented this system working practically although the theory contained all the basic elements of a workable television system.

Boris Rosing' television system using cathode-ray tube receiver (1907).

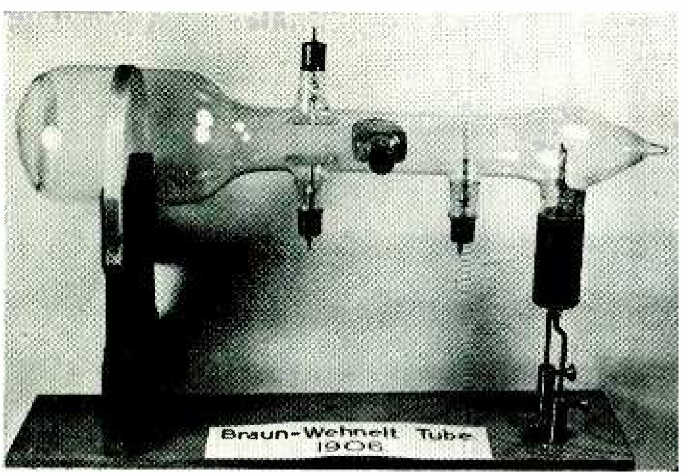


The mirror drum

The other important early scanning system was the mirror drum first used by Ll. B. Atkinson in 1882 whose apparatus is now in the Science Museum. As no description was published at the time, L. Weiller is generally recognised as the inventor of this method which he proposed in 1889, the year Edison invented the motion picture. A series of mirrors was mounted around the circumference of a wheel, each mirror tilted at a slightly different angle from the one following or preceding it. As the drum rotated, the light from each mirror reflected a different part of the scene to be scanned on to a light sensitive element. This system provided greater reflecting power than the Nipkow disk and was used as the basis for many subsequent mechanical attempts at picture transmission.

Unsuitability of Selenium

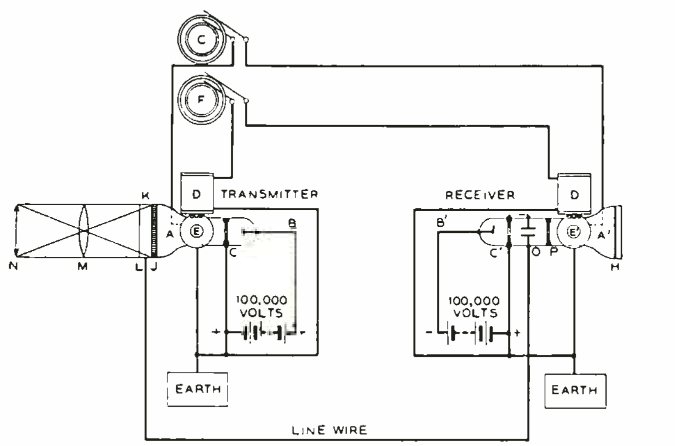
After many theoretical schemes and patents granted to inventors in several countries the activity generated largely by the discovery of selenium's light sensitive properties it seems that eventually that element's unsuitability became recognised. The main draw back was the time-lag of selenium and its consequent insensitivity to rapid light changes. Enthusiasm died down and the flow of ideas for television systems ceased.



A development of the cathode ray tube by' Karl F Braun, who perfe-. cted a tube in 1897 with a fluorescent screen bombarded by a stream of electrons.

The Cathode-ray tube

Meanwhile, the various devices which were to be found to be essential to the electronic television system were being discovered, developed and perfected. The father of the X-ray, the neon sign, the camera tube, the television receiver tube and the fluorescent lamp was the Crookes tube invented by Sir William Crookes, a wealthy English business man and one of the great figures in the field. The negative terminal through which electricity passed into the partial



Campbell Swinton's system of television using cathode-ray tubes as transmitter and receiver (1911).

vacuum of the glass tube was called the cathode and the discharge of electricity through the tube became known as cathode rays.

Karl F. Braun perfected a cathode-ray tube in 1897 which had a fluorescent screen at the end which was bombarded by the stream of electrons. The point of impact was thus visible and the beam could be moved by means of an external magnetic field to fall on any point of the screen.

Boris Rosing

In 1907, a teacher at the Technological Institute of St. Petersburg, Boris Rosing, first suggested the use of the cathode-ray tube as the receiver in a system of electrical transmission of images. He was granted a British patent (No. 27,570). The transmitting system was to use two mirror drums revolving at right angles to each other at different speeds to scan the image. Unfortunately successful results were not obtained largely because of the lack of any means of amplification. A second patent issued in 1911 proposed different ideas but without any great improvement in results.

A. A. Campbell Swinton

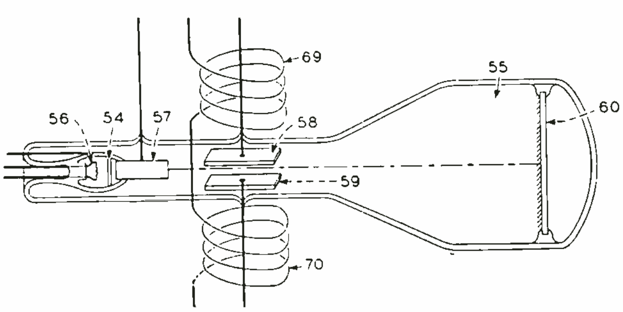
At about the same time as Rosing's activities, A. A. Campbell Swinton was proposing entirely independently of Rosing's ideas a system of high-definition television. Shelford Bidwell, still interested in the idea of television, had written to *Nature* (vol. 78, page 105, 1908) concerning the impracticability of a mechanical television system suggested by Armengaud of Paris. Campbell Swinton wrote a reply to this letter *Nature*, (vol. 78, page 151, 1908) in which he suggested that "the problem of obtaining distant electric vision can probably be solved by the employment of two beams of cathode rays (one at the transmitting and one at the receiving station) synchronously deflected by the varying fields of two electromagnets placed at right angles to one another and energized by two alternating electric currents of widely different frequencies, so that the moving extremities of the two beams are caused to sweep synchronously over the whole of the required surfaces within one-tenth of a second necessary to take advantage of visual persistence. Indeed, so far as the receiving apparatus is concerned, the moving cathode beam has only to be arranged to impinge on a sufficiently sensitive fluorescent screen, and given suitable variations in its intensity, to obtain the desired result. The real difficulties lie in devising an efficient transmitter. . . . Possibly no electric phenomenon at present known will provide what is required in this respect, but should something suitable be discovered, distant electric vision will, I think, come within the region of possibility".

Although at about this time De Forest was developing his audion several of which by being coupled together could form a cascade amplifier to build up a feeble signal to large proportions, there was then no practical amplifier available, radio communication and vacuum techniques were in their early days and photocells were inefficient. Campbell Swinton recognised the difficulties inherent in his scheme but had clearly indicated the basis for future development.

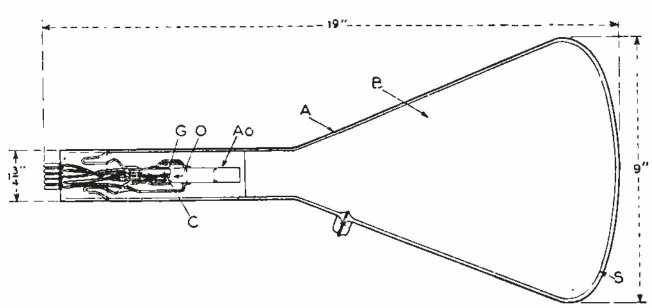
In November, 1911, he gave a Presidential Address to the Röntgen Society in which he gave much more detailed information about his scheme. Campbell Swinton never built the apparatus he described but the Marconi-E.M.I. Company built a working model in 1937 for the Television Exhibition at the Science Museum.

The year of importance—1923

1923 was a year of great importance in the history of television. In that year J. L. Baird and C. Francis Jenkins began their experiments into low-definition television and V. K. Zworykin filed his patent application for his new camera tube later called the Iconoscope. C. Francis Jenkins of the United States, was one of the early developers of the motion pictures and

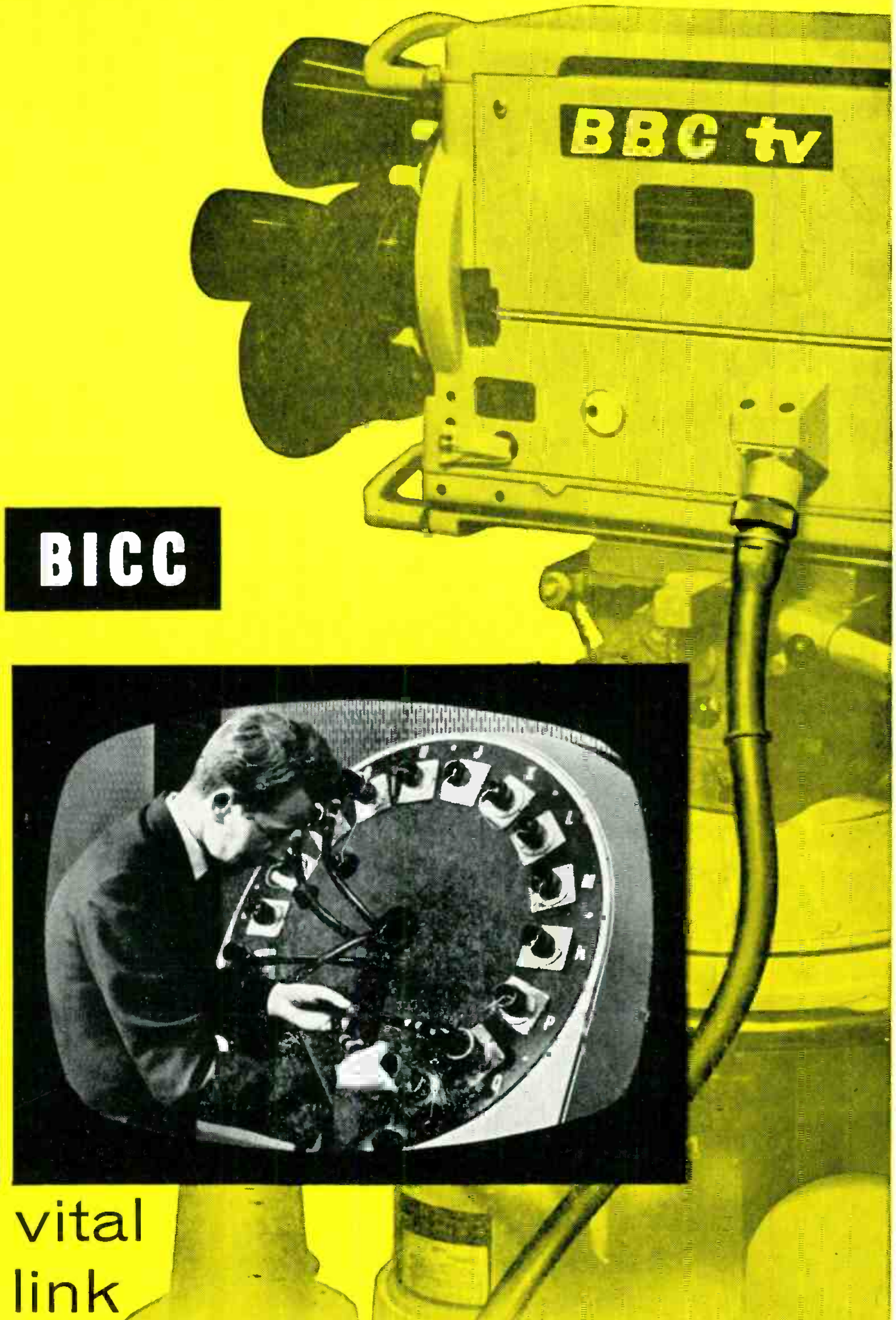


Zworykin's earliest form of cathode-ray receiving tube (1923).



Early Zworykin cathode-ray receiving tube (1933).

BICC



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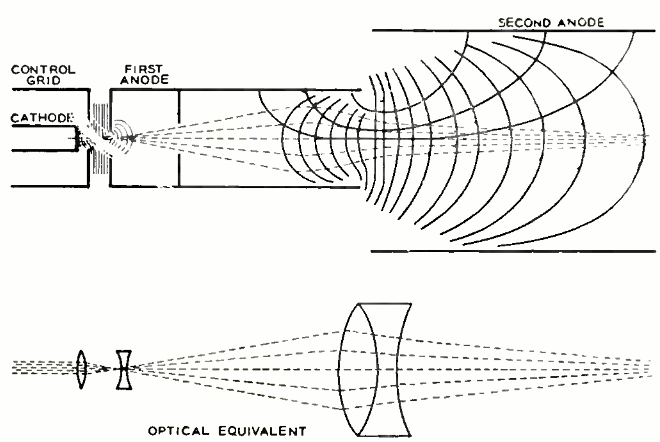
had founded in 1916 the Society of Motion Picture Engineers. He was a prolific inventor and in 1923 had successfully transmitted still pictures by wireless. He then turned his attention to the transmission of moving images by radio and devised a scanning system which used a pair of special circular glass prisms with belled edges. The angle of bevel changed continuously around the circumference of each disc and by rotating one disc many times faster than the other the whole surface of the image could be scanned.

At about the same time in Austria, a Hungarian inventor, Dénes von Mihály experimented with a system employing a small double-sided mirror rotating on an axis of a stationery drum which had small mirrors on its interior surface. This system was later developed and called by Mihály the "Telehor" which he claimed transmitted simple geometrical silhouettes.

J. L. Baird

John Logie Baird is probably the best known name in the development of television and his true part in it has been a matter for great controversy. He was the son of a Scottish Minister and was born in 1888. Ill-health haunted him all his life particularly in his youth. He started on a career in engineering and began his life-long interest in developing a workable television system while he was at Glasgow University studying electrical engineering. Later he abandoned engineering temporarily to try a commercial career which was successful until his health broke down and at the age of 34 he left London to seek quietness and improved health in Hastings. Here he devoted himself to experiments carried out with very little money or proper equipment.

In April, 1925, shoppers in Selfridges Store in Oxford Street were handed leaflets which proclaimed the demonstration on one of the upper floors of the building of a practical, albeit crude system of television. This was Baird's three week demonstration of his television apparatus made from worn out electric motors, biscuit tins, a hat box, darning needles and bicycle lamp lenses. It was the world's first public demonstration of television although Baird had accepted Gordon Selfridge's offer of £25 per week for financial reasons rather than the publicity. A paper mask was the first object thus televised and this and the apparatus are preserved in the Science Museum. The press had already become interested in his experiments at Hastings and the resultant publicity enabled Baird to raise a small sum to finance further experiments. In January, 1926, he invited members of the Royal Institution to witness a demonstration of his improved apparatus and so many accepted that they had to enter his laboratory in Frith Street, Soho, in batches of half a dozen at a time. Here many of them sat in front of the transmitter and were recognised by colleagues watching the receiver in the next room.



Constructional details of early Zworykin cathode-ray receiving tube (1933).

Baird's apparatus

Baird used for scanning the subject a Nipkow disk of cardboard with 32 lenses. Mounted on the same shaft were two additional disks, one with a large number of radial slots and the other with a single spiral slot.

The front disk was revolved at 800 revs per minute causing a series of images of the object to be passed through the aperture to the light sensitive cell. On the way the light was broken up by the slots in the second disk which revolved at 1000 revs per minute. The disk having the spiral slot gave a backwards and forwards motion to the slot admitting light to the cell and divided the image into a greater number of strips. At the receiving end the apparatus was practically identical with the variations of the light intensity forming an image on a ground glass screen. Synchronism was obtained by using two motors, a direct current motor supplying the driving power and an alternating current generator which sent out a synchronising signal.

The image achieved measured only $1\frac{1}{2}$ by 2 inches with pronounced flicker but it was possible to recognise the faces televised.

Baird gave frequent demonstrations in the next few years, retaining public interest and spurring on other inventors. In May, 1927, he televised his low definition images between London and Glasgow over telephone wires and in 1928 he sent images from London to New York without wires and from London to the liner *Berengaria* in mid-Atlantic. Earlier, he had demonstrated the "Noctovisor" in which the subject to be televised is in total darkness by making use of infra-red rays and which was thought to be useful in fog penetration. Another device was the "Photovisor," or the storage of television images on wax so that the image can be reconstructed when required. Simple colour television and stereoscopic television were demonstrated to the British Association in Glasgow in August, 1928, and stereoscopic television in natural colours was also the subject of experiments.

The main drawback of all this was, of course, the extremely low definition. The picture had a definition of 30 lines with a repetition frequency of 5 frames per second.

In 1929, the B.B.C. and the Baird Television Company made arrangements for the regular transmission of television pictures on an experimental basis from the London station. Transmissions were made on five days each week for half-hour periods with the same definition of 30 lines but a repetition frequency of 12.5 frames per second. The Baird Televisor was the first television receiver to be offered for sale to the public in February, 1930, at a price of 25 guineas. Until 1932, the B.B.C. had no share in either the technical or the programme aspects of the transmission, but of course the Corporation watched the progress made very closely. In that year they took over responsibility for the transmission of programmes.

Progress in the United States

In the United States progress on the development of low-definition systems was being made notably in the Bell Telephone Laboratories. In April, 1927, an experimental demonstration was given of television both by wire between Washington D.C. and New York and by radio between Whippany, New Jersey, and New York, a distance of 22 miles. Two sizes of receiver were used, the smaller one being primarily intended for use with the telephone so that people in New York could see their friends in Washington when they telephoned them. A public-address system was used with the larger screen so that the voices of entertainers could be heard as well as their pictures seen.

The introduction of high-definition

The entry of the B.B.C. into the field by purchasing a complete transmitter from the Baird Company is a suitable time to pause and briefly review the position up to that time — 1932.

Since the middle of the nineteenth century, individual scientists, engineers and experimenters had been striving after the goal of practical television. Patents had been taken out, experiments and demonstrations made, theories advanced, solutions to problems suggested. Mechanical systems of television had worked successfully but the low-definition pictures obtained did not suggest prospects of commercial uses.

In the later 1920's, however, and particularly after the theories put forward by Campbell Swinton, the possibilities of electronic television and consequent high-definition pictures attracted the larger radio and electrical firms. Research then became conducted behind closed doors, and results were not published although patents gave some indication of progress. It becomes less easy for the chronicler to assign definite dates to developments and discoveries in what was now to become a race between interests.

V. K. Zworykin.

V. K. Zworykin was born in Russia and had studied under Rosing at St. Petersburg, going to the United States in 1919. In the Westinghouse Research Laboratories he worked on a form of camera pickup tube for television on the general theory put forward by Campbell Swinton although apparently not aware of Campbell Swinton's work. The Iconoscope as it was named was the subject of a Patent application in 1923 but this was not granted until 1938. Zworykin also worked on a special cathode-ray tube to be used as a picture screen in an electrical system of television. Zworykin realised the limitations of mechanical methods of scanning and steadily worked on improving his all-electrical system. He patented another tube similar to the Iconoscope but adapted for colour television.

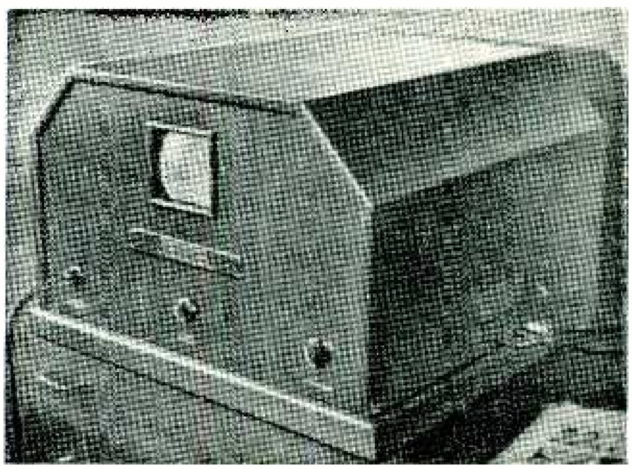
P. T. Farnsworth and others

Also in America at about the same time P. T. Farnsworth was developing and perfecting his non-storage dissector tube. This was not as sensitive as the iconoscope but provided a sharper picture and worked, not on the principle of focussing on a mosaic but of focussing on to a photocathode with a thin coating of light sensitive material. In England, C. E. C. Roberts, and in Germany, Dieckman and Hell were working on similar tubes.

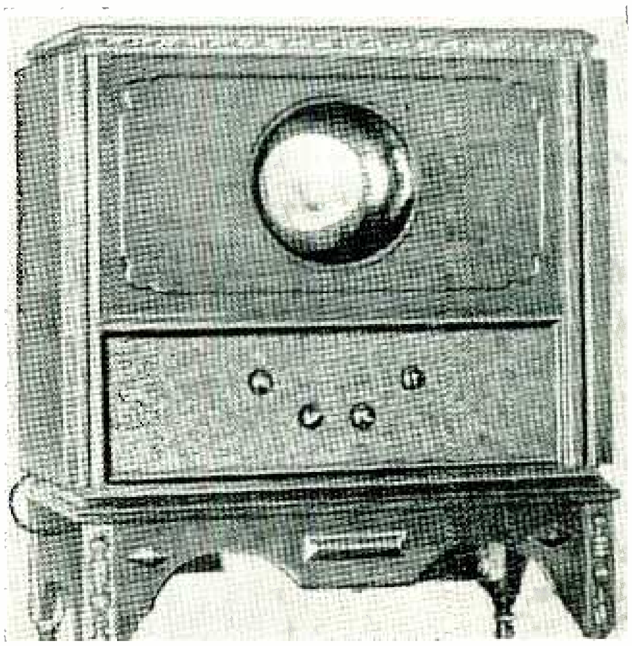
E.M.I.

In England, several companies were engaged in a serious study of the problems of television. Besides the Baird Company, there were the Gramophone Company, Scophony Ltd., and the Cossor Company as well as others.

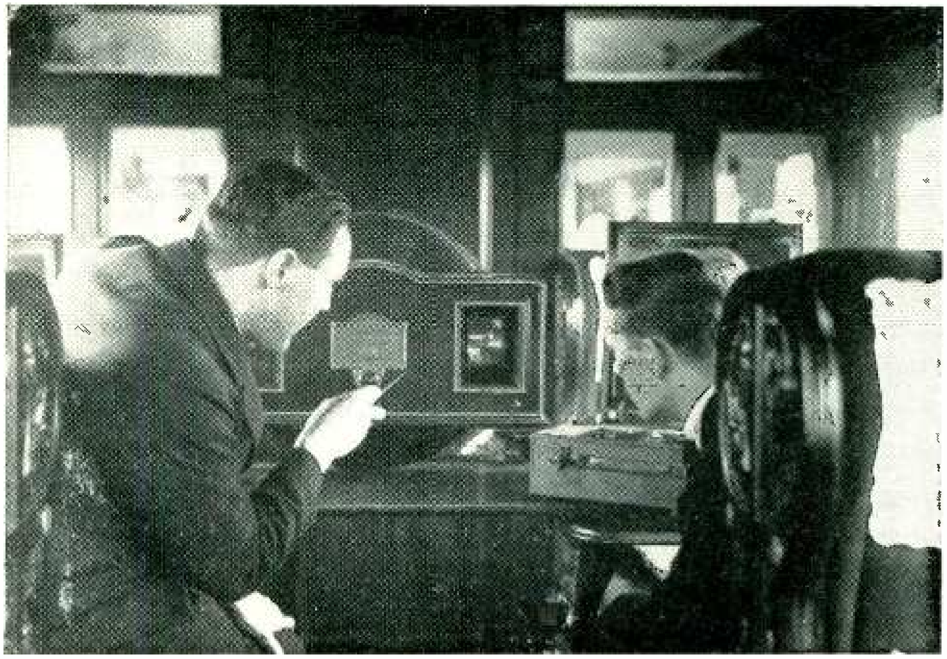
The Gramophone Company had a team under the leadership of G. E. Condliffe and C. O. Browne and they successfuly demonstrated in January, 1931 a mechanical system using five channels, each of 30 lines, to make up a 150 line system with a frequency of 12½ times a second. In 1931, the Gramophone Co., the Columbia Gramophone Co., and others merged to form Electric and Music Industries Ltd. Isaac Shoenberg, Russian-born, who had studied at the Kiev Technological Institute and had come to Britain in 1915, was appointed Director of Research. In his team were A. D. Blumleim, P. W. Willians and other engineers. Under Shoenberg's guidance mechanical scanning was improved to provide pictures of 180 lines from film originals and later a 243 line picture was achieved. In 1932, however, the obvious limitations of the mechanical system led E.M.I. to concentrate on the electronic method. Developed independently of Zworykin,



Early model of German cathode-ray tube television receiver.



Early American cathode-ray tube television receiver (Farnsworth 1931).



The first television signal received from a train (Britain 1932).

they produced the Emitron pick-up tube for which Dr. J. D. McGee was largely responsible. Great progress was made without a great deal of publicity and by 1935 the choice of definition standards faced E.M.I. The research team was by no means united in its opinion but finally, in that year Schoenberg decided upon the very high definition for those times of 405 lines, with interlaced frames giving 25 pictures/second.

The first public service

The B.B.C. transmissions continued with growing interest from the nation and the government itself. In May, 1934, a House of Commons Committee was appointed " to consider the relative merits of the several systems and on the conditions under which any public service could be provided ". Evidence was taken from representatives of firms, societies and from individuals and a delegation visited America and another went to Germany. In both countries roughly parallel technical progress had been made but all transmissions were on an experimental basis. The Selsdon Committee reported to the Government and as a result the B.B.C. were entrusted with the inauguration of the television service.

Two companies were chosen to provide the apparatus — Baird Television and Marconi-E.M.I. The Baird Company used three pick-up methods. Firstly there was Baird's mechanical scanning system operating on a 240 line standard with 25 frames/second sequentially scanned. Next there was the use of the Intermediate-film method permitting the televising of large studio entertainments. The mechanical scanning method required the studio to be in darkness except for the subject and was unsuitable for much television other than interviews and close-ups. The film process involved the photographing of the scene to be transmitted, the immediate development and then the negative was passed into the scanning unit. There was a 60 second delay for developing and fixing and the method had its obvious disadvantages compared with instantaneous methods. The third method was to be the use of an electronic type of television camera developed under licence from the Farnsworth Television Laboratories. Baird had unfortunately discouraged his staff from research on their own electronic camera until it was too late to catch up with the others in the field.

Marconi-E.M.I. used the system perfected in the E.M.I. Laboratories using the 405 line standard which was far better than the Government's minimum stipulation of 240 lines.

Each company's system was to be used alternately for a week at a time.

On November 2nd, 1936, at 3.30 p.m. the worlds first regular service came into being. For this first transmission both systems were used and speeches were made by Sir Harry Greer, Chairman of Baird's (televised by the Baird system) and by Mr. Alfred Clark, Chairman of E.M.I. (by the E.M.I. system). The first simple programme created tremendous interest and amazement at the quality of the picture received.

Transmissions continued on the alternate week per system basis. Then on November 30th in the disastrous Crystal Palace fire the Baird Company lost all their own equipment which had been installed there in an experimental studio and stopped all development on the Farnsworth type camera. After three months of the dual transmission service came the expected announcement that a single set of standards should be adopted, the Marconi-E.M.I. system being the one chosen. The quality of their picture was higher, the interlacing system gave much less flicker than the sequential scanning method and finally the electronic camera offered the greatest scope for development compared with the intermediate film method.

The rest of the world

Britain had won the race to the first public service. Overseas in various countries there was great experimental activity particularly in the United States and Germany, Japan, Russia, France, Italy, and others were preparing for public services some of which had not materialised by the beginning of the Second World War.

Success — and after

The B.B.C. went from success to success. The Coronation on May 12th, 1937, was television's biggest test to that date. Despite the stormy conditions, excellent pictures were received as far afield as Brighton and Ipswich. The televising of Wimbledon followed. Plays, ballet, music, opera and more sport — the Boat Race, the Derby, cricket, boxing, rugby, all came to the screens of the 23,000 sets licensed by 1939. In the first week of September, 1939, Alexandra Palace, the home of British television was closed. The television service was suspended for the duration of the war and many of the engineers and others concerned with its development went on to hush-hush work. Some of the E.M.I. engineers, notably A. D. Blumlein, lost their lives in the cause of the development of this vital British weapon, radar.

Grateful acknowledgement is given to the Television Society and the Society of Motion Picture and Television Engineers for photographs and diagrams with this feature.

A Friend Recalls the Man Who Inspired Television

By R. HOWARD CRICKS, Hon. FBKS, FRPS

John Logie Baird

John Logie Baird is the mystery man of television, his part in the development of the medium has never been clearly defined. None of his patents are used today, yet there can be no doubt that his dogged enthusiasm for television did much to stimulate both official and public interest and bring about the first service a quarter of a century ago. When discussing him, people are likely to become partisan—he was either an inspired genius who showed the world the way, or a backroom inventor whose gadgets were of no practical value. Perhaps the truth lies somewhere between these extremes. But outside the realms of opinion and conjecture, the facts of Baird's life prove him to have been a remarkable man. Not only did he work on monochrome TV, but also colour and 3D colour, on recording signals on wax discs and the transmission of pictures across the Atlantic. These bold experiments are enough to ensure his place in history.

IT is 25 years since the world's first high-definition television transmissions were put out by the B.B.C. I wonder what would be the views of John Logie Baird if he were alive today — if he could see the enormous ramifications of television, not only in the entertainment field, but in its applications in commerce and technology?

Baird was a typical inventor. He was a shy hesitant Scotsman, inspired by a whole-hearted faith in the future of television, but he cannot justly be regarded as the true inventor of television — that is an honour that must be shared among innumerable workers. Nevertheless it was his enthusiasm that aroused practical interest in television — that ultimately compelled the establishment to take note of it.

First Backer

Today television and the film are becoming more and more closely interlinked. It is perhaps not realised that the association is of long standing.

Back in the early days of the film industry there was a fairground showman, Will Day — a remarkable character, and as complete an antithesis to the quiet-spoken Baird as one can imagine. Earlier Will Day had assisted William Friese-Greene who had a purely legal claim to be considered the inventor of kinematography. As a showman he foresaw the enormous possibilities of television, and he was so far as I know the first to back Baird financially.

It was through Will Day that I first heard of Baird and his work. But for a long time I was not allowed to meet him or to see his results: Will Day was insistent that no reports should appear in the technical Press, although lay journalists were allowed to see his results — and of course generally failed to appreciate the potentialities of what they saw. Am I being unfair in suggesting that Will Day — a shrewd business man — realised that Baird's patents would not stand investigation, and was anxious to stall off technical examination until further progress had been made?

It was Will Day who installed Baird in the historic laboratory in Frith Street, Soho, London, where the quaint equipment now on show at the Science Museum was developed. Later, improved premises were acquired in Long Acre, and it was here that I first met Baird and saw the prototype of the 30-line equipment with which the B.B.C. put out experimental transmissions in 1929 — seven years before the establishment of a high-definition service.

Gradually it became known that Baird's work was being financed by two brothers who at the time were prominent in the film trade. Isadore and Mark Ostrer were city financiers who had bought their way into the film industry, and were the founders of what is today the vast empire ruled by Lord Rank.

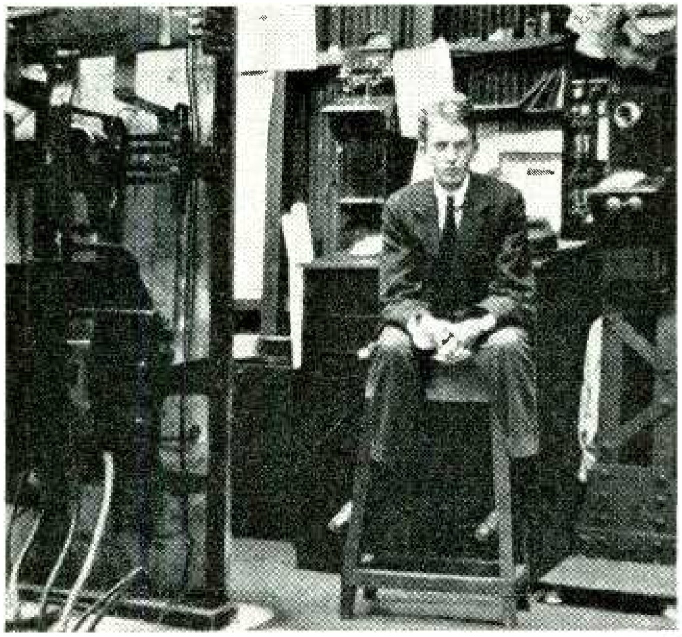
Large Screen

They provided Baird with well-equipped laboratories at the Crystal Palace—chosen of course because its altitude lent itself to radio transmission. Their prime interest obviously was in large-screen television for the cinema; with their support Baird developed several such systems, both mechanical and of the lamp-screen type, in which the picture was produced by 2100 flash lamps energised mechanically under the

Televised image of one of Mr. Baird's engineer assistants.

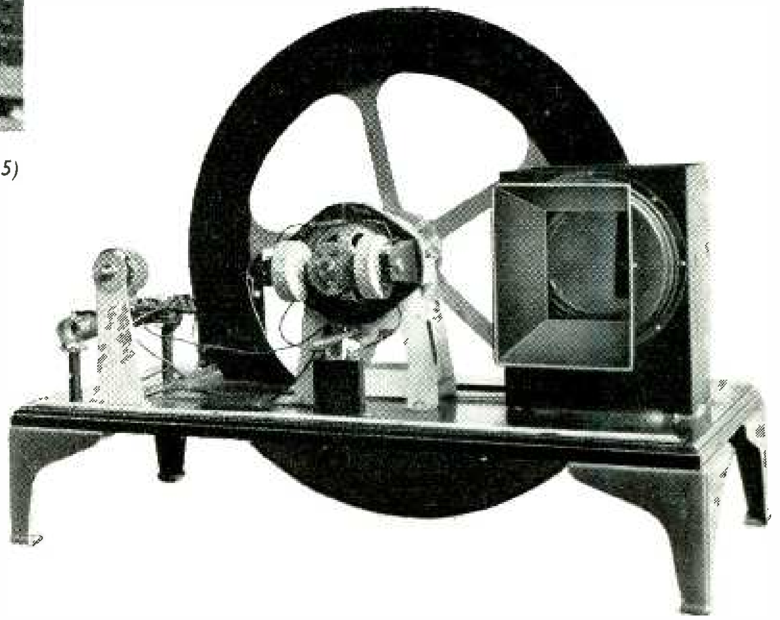
BAIRD AND THE SHADOWY BEGINNINGS OF TELEVISION

Illustrations for this feature have been kindly loaned by the Television Society



J. L. Baird in the Clyde Valley Power Co. sub-station at Rutherglen (1915)

The first television picture ever produced. This is a photograph of the image seen on Baird's first television apparatus and was taken in 1925.



Baird's "Televisor" 1929. The aluminium black disc revolved at 750 r.p.m. carrying a spiral of 30 holes. The picture was viewed through the lens at the right-hand side. As the source of light was a neon lamp the picture appeared reddish and was composed of 30 vertical lines (as against 405 in Britain). No sound receiver was incorporated — this had to be made separately, but most people used the sound of their radio sets. Price about £30.

control of a photo-electrically scanned film.

But I suspect that before long their first flush of enthusiasm, inspired by Will Day and by Baird himself, wore off. For in 1933 the late Capt. A. G. D. West, formerly of the BBC, was appointed technical director of Baird Television Ltd. (now Rank-Cintel Ltd.).

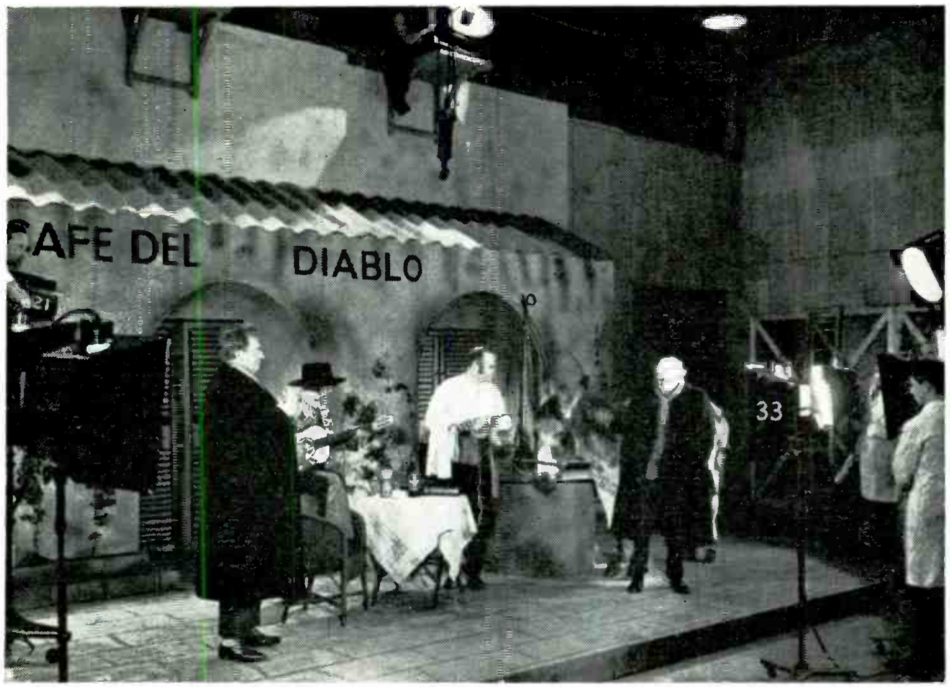
West was of course an electronics man (he had worked with Lord Rutherford at Cambridge); undoubtedly he quickly realised the inadequancy of the mechanical systems still favoured by Baird. It seems there must have been two divergent lines of development within the one company.

On the one hand Baird produced the equipments, mechanical and intermediate film (the latter in conjuction with T. Thorne Baker) with which the BBC 240-line service was launched in 1936 (alongside the 405-line Marconi-EMI transmissions). On the other hand West concentrated on electronic systems with special reference to large-screen projection, and in 1938 and 1939 he gave a number of demonstrations of large-screen cathode-ray projection; equipment was indeed permanently installed in the Tatler Theatre, Charing Cross Road.

I believe it was a fact that eventually Baird was paid a regular salary on condition that he stayed away from the Crystal Palace. He was rather bitter at this outcome; but he maintained faith in mechanical systems, and in a small laboratory in the garden of his house at Norwood I remember his showing me several demonstrations of his work.

He experimented with colour and stereoscopy. It was in connection with the latter that I first saw evidence of his conversion from mechanical to electronic systems: he produced right-and left-eye images on anodes inside a cathode-ray tube which were viewed through magnifiers. But of course his work was by now hopelessly behind that of other experimenters, notably his old company.

Nevertheless, his name still counted,



Baird and Sir Ambrose Fleming in the "Baird Television" Studios at Crystal Palace, 1935.

and as soon as the Ostrer company dropped the name of Baird Television Ltd., it was perpetuated in a new company, which of course still continues the name.

John Logie Baird was an altogether typical example of an inventor who, like all true inventors, was before his time. Remember that when he started his experiments sound radio was still a novelty; the idea that electronics could be applied to picture transmission seemed at the time rather fantastic (for a time I shared his faith in mechanical systems, when I experimented on a mechanical scanning system for high definition). The modern generation of technician, born into an age of electronics, finds it difficult to realise that for centuries all invention had been based on mechanics.

What actually did Baird invent? His transmitter and receiver employed a disk with 30 square holes arranged in a spiral — the device invented by Nipkow a century ago. I remember hearing that, unable to obtain a satisfactory selenium cell (the modern photo-cell did not then exist) he procured one from America by devious means, and would in fact have been in patent trouble had he not found a replacement. I feel sure he never designed an amplifier — he was a mechanical engineer.

Signals on Record

Baird filed many ingenious patents — one I remember related to the recording of T.V. signals upon an ordinary gramophone record, obviously an idea which could be used only for 30-line signals. His patents included large-screen projection, colour, stereoscopy. But so far as I know not one of these patents forms the basis of any present-day equipment.

On the other hand, it would be wrong to ignore his services to television. It is probably safe to say that, while many people had designed TV systems on paper, nobody before him had ever actually transmitted a picture electrically. It was his enthusiasm which, in spite of his shy and retiring nature, induced first Will Day, then the Ostrer brothers, to back his work, and ultimately served to convince the Selsdon Committee that the B.B.C. should inaugurate television transmissions. It is to his enthusiasm that we owe our present great industry.

Above: Baird with his "Telechrome" tube for colour television projection.

Right: First demonstration of crude two-colour television by Baird in 1928, using 30-line scanning disc with red and green filters.

LOOKING BACK ON THE PIONEERING DAYS

By D. C. BIRKINSHAW, M.B.E., M.A., M.I.E.E.

Superintendent Engineer, Television British Broadcasting Corporation

I SUPPOSE there will be a few people who will realise that the B.B.C.'s first active interest in television goes back to 1928 when it watched with interest the experiments of John Logie Baird. While it is not possible to say that Baird is the inventor of television, or even that his methods are those in current use, it is he who was the first to produce an image of a scene through television. Shortly afterwards the B.B.C. made available certain periods on their London sound broadcasting transmitters, so that Baird could attempt the transmission of elementary pictures using a standard of 30 lines. This led to the B.B.C. in 1932 taking a further step by building their own 30 line television studio on the same standard. This ran from August 22, 1932, to September 11, 1935, and it is true to say that it was during that period that we learnt many of the fundamental rules of operational television engineering which still apply in the more sophisticated operations of to-day.

D. C. BIRKINSHAW

By the beginning of the decade, however, there were other people working on television notably A. C. Cossor and the E.M.I. Co. Ltd. They and Baird also were doing experiments on higher lines standards such as 60, 90, 120 and 180 lines. It may not be remembered that apart from the 30 line transmissions other experiments were done from Broadcasting House upon 120 and 180 lines in 1933.

By 1934 it was being seriously thought that this new television business might perhaps be worthy of more serious consideration, even to the extent of launching a public service. What an extraordinary thought this seems to us now when a large number of countries have established television services, when television has become a major influence in those countries which possess it, and when we have reached the stage where there are many young people alive who have never lived in a world without television!

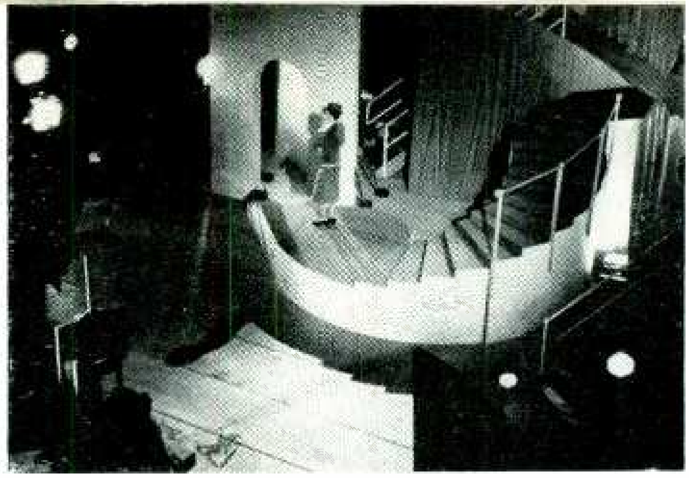
The Government Committee appointed in 1934 by the Government to look at all this reported in 1935 that a public service should be started, beginning in London. However, they could not settle upon one system as being in their view the best and it charged the B.B.C. with the extremely difficult task of setting up two systems, one of the Baird Co. on 240 lines and the other of the E.M.I. Co. on 405 lines. These were to be tried out against each other in open competition. The sites selected for this first joint station was Alexandra Palace. The B.B.C. had the job of setting up two systems instead of one, of dealing with two companies instead of one, and of ensuring that in this potentially difficult situation there should be an atmosphere of harmony. This, which I suppose may be termed a domestic problem, was obviously far from easy and was a task ancillary to our public duty of trying to set up the first public television broadcasting service on high definition which the world had ever seen, a service calculated to be acceptable to, and welcomed by, the public. I always think it most remarkable that the Corporation accomplished this task in the very short time between January, 1935 when the Committee reported and November, 1936 when the service started. Even so, this start was preceded by a short preliminary canter in August, 1936. The Radio Industry were due to hold their annual exhibition on August 26 and quite understandably asked the B.B.C. to try and produce some television transmissions for reception at the exhibition, even if it became necessary to close down immediately afterwards to prepare for the real opening on November 2. This was a most difficult request to meet, but we managed it, although conditions at Alexandra Palace were to say the least of it somewhat chaotic.

The first television play in the world 'The Man with a Flower in His Mouth'. Producer was Lance Sieveking (left)

Alexandra Palace in 1936

What then was the picture at Alexandra Palace in those exciting days? Those Londoners and others who for the past 25 years have occasionally strolled in Alexandra Park will have seen the mask which is still there but used for rather different purposes. At this time stretching along the ground floor of the building from the mast, there were the transmitter for the E.M.I. system and the transmitter for the Baird system separated by the common sound transmitter. On the first floor on top of the E.M.I. transmitter, was the E.M.I. studio and its control room and telecine. Similarly, above the Baird transmitter were the Baird studios, control rooms and telecine I say studios, because the Baird Co. had offered and the B.B.C. had agreed for it

OF BBC TELEVISION



Pre-war Radiolympia, the event at which a public television service was given a world debut in September, 1936, about two months before it was officially started by the BBC This picture shows the BBC's 'Forecast of Fashion' at Radiolympia, 1938

to provide two studios, one of about 2,000 sq. ft. and one small one for announcements. The only common parts of the complete installation were the sound transmitter, of which obviously only one was required, and the aerials. It would have been extremely cumbersome to have tried to put up two aerials on one mast. Even had this been done they would have had to be at different heights, and this would have presented a point of unfairness in the forthcoming comparison of the two systems .

Vast Differences in Systems

It will be appreciated that the B.B.C. had purchased a television system complete from camera to transmitter output from each company. Naturally each system was designed in accordance with the researches of its company. There were vast differences between the designs of the two systems. The Baird system comprised a small studio employing the long forgotten system of spotlight scanning. In this the normal action of camera pick-up was reversed. There was no camera in the true sense of the word. The artist was in darkness and was scanned by as powerful a spot of light as could be contrived by means of a vast arc, whose efforts were almost entirely negatived by the large scanning disk which let a negligible amount of its light fall in the shape of a scanning beam across the artist, in 240 lines. The reflected light was picked up by photocells which therefore produced the video signal. The main Baird studio consisted of a film camera associated with a forerunner of what is now available as a matter of course, a quick processing unit. This developed washed and fixed the film in 64 seconds when it was immediately scanned while wet by another disk. The whole of this structure was bolted to the ground and it seems strange nowadays to realise that transmissions were ever contemplated using a wholly immobile camera. Nevertheless, in those days one had to televise with the best equipment one thought one could devise and this was the method selected by the Baird Co. It is only fair to add that the disadvantages of this immobility soon became clear to the Baird Co. and they supplemented this equipment with a mobile camera based on the now obsolete principle of the Farnsworth Image Dissector. The equipment was completed by two excellent telecines using scanning disks.

On the E.M.I. side we had apparatus which was very similar to the sophisticated arrangements which one will find in the modern television studio. The cameras were electronic being based upon the iconoscope in the form of the standard emitron developed by the E.M.I. Co. This is now also obsolete having been superseded in modern times by the image orthicon, the C.P.S. emitron and image iconoscope. They were, of course, mobile. It is true to

The novel experience of seeing a star performer on home screens — Art Tatum featured in 'Starlight' April 19, 1938.

Television control room at No. 16 Portland Place, London, where many of the early BBC experiments in TV were carried out.

Television begins to exploit its value as a witness of events. A Super-Emitron camera at the Horse Guards' Parade Whitehall, June, 1938.

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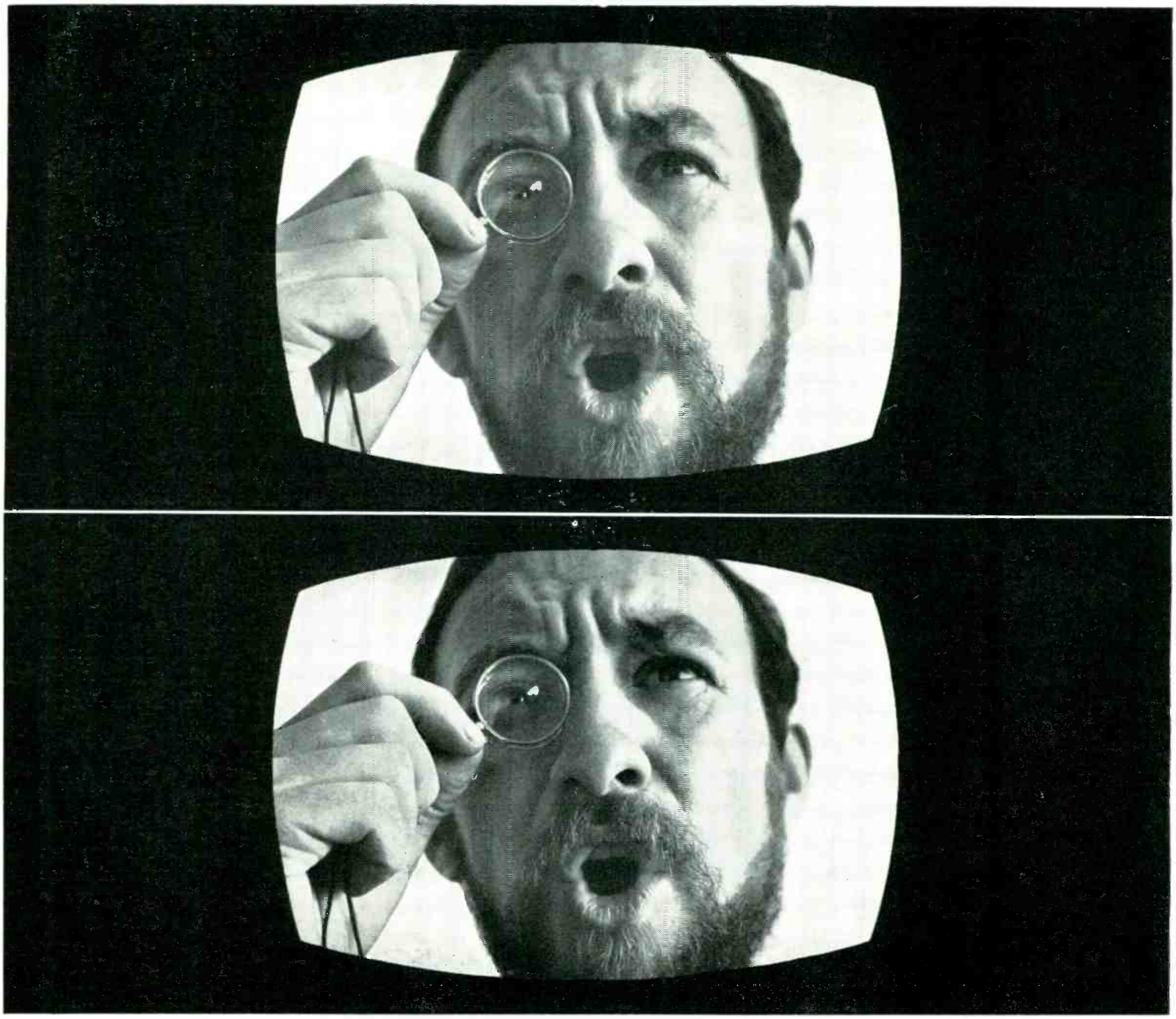

Which is the Video Tape recording?

At the top? Or the one below? It's impossible to say: a successful video tape recording looks live. But which tape made the recording? Here you can speak out with confidence. Virtually every video tape recording for transmission is made on SCOTCH Brand Video Tape No. 179, which 3M have been producing in quantity for over three years. SCOTCH Brand is still the video tape used on almost every transmission by the B.B.C. and Independent Television Contractors.

TRADE MARK **SCOTCH** BRAND VIDEO TAPE No. 179

PRODUCT OF 3M COMPANY RESEARCH

the tape that gives the 'live look' to recording

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say that they were even more mobile than current cameras because they were much lighter.

As can be imagined our days and for that matter our nights with this early equipment were punctuated by quite extraordinary experiences. For example, the intermediate film equipment in the main Baird studio naturally used a lot of water and this was drawn from tanks situated high up in the towers at the corners at Alexandra Palace. I regret to say that while the capacity of these tanks had always been found to be sufficient for the domestic requirements of Alexandra Palace, it was possible for the Baird intermediate film equipment to drain them more rapidly than they could be refilled and we broke down one afternoon for a reason no more complicated than that we had run out of water. It was also difficult at times to prevent a little air getting mixed with this water with the result that the wet film passing through the gate was sometimes covered by a bubble of air which, of course, largely obliterated the picture. Another feature worth recalling is that it was not long before it became known amongst artist circles that 64 seconds elapsed between the end point of their act and the radiation of the corresponding picture. Understandably, therefore, it became the thing for an artist at the end of his broadcast to make a dive for the Control Room in order to see the last minute or so of his performance. This was all very well when a single artist was involved but it became a little complicated when a complete orchestra wished to do this and when the members thereof did not spare the time to discard their cellos and double basses before doing so.

Pioneer Programme a Difficult Task

However, as a result of very hard continuous work by the staff of the B.B.C., the Baird Co., the E.M.I. Co., Marconi Co. and other contractors and sub-contractors too numerous to mention here, the installation gradually came together. Through the Summer of 1936 the pace was kept up. In every corner, somebody would be either installing something or testing something or, understandably enough, altering something. In the meantime, the first Director, Gerald Cock, was gathering together our programme staff including the first Programme Organiser, Cecil Madden and his Administrative Head, Leonard Schuster, now retired

The first studio play shown on high-definition TV was 'Marigold' in November 1936. Sophie Stuart, John Bailey, Geoffrey Steele and Wyndham Milligan on the Baird studio set.

The first outside broadcast was made in 1936 from these grounds of Alexandra Palace. This picture was taken the following May during a demonstration by the Women's League of Health and Beauty.

The famous occasion when Thomas Woodruffe fulfilled a rash promise to "eat his hat." It was featured in the pre-war BBC-TV "Picture Page," an equivalent of the present-day "Tonight" programme.

from the B.B.C. Just as we, in the field of engineering, had to create something new, and preferably successful, with no experience to go on, Gerald Cock had to devise the first form of service in exactly the same conditions. This I always think must have been a very difficult task. Would the public regard this as a great adventure to be shared with us in a helpful spirit, or would it assume that we would, from the outset, achieve a standard with which it was familiar in film, and castigate us if we failed?

We managed by all this hard work to be ready by the end of the third week in August and the first time when we went on the air, with a serious purpose in view, was August 25, 1936, when a pre-opening demonstration was given to a small circle of V.I.P.'s. This was attended by all sorts of mishaps and only got going two hours after the scheduled time. However, the next day all was well. The exhibition was a great success and indicated to manufacturers that if they would now begin to make sets at prices around £100 the public would buy. As forecast we closed down for six weeks in order to complete our preparations for the real opening and quite frankly to lick our wounds. Eventually the service opened at 3 p.m. on November 2, the opening speech being made by the Postmaster General, Major G. C. Tryon. For the next four months the Baird and E.M.I. services were compared, one with the other. At the end of that time it had become clear that the system designed by the Baird Co. was not quite as efficient nor as convenient as that provided by the E.M.I. Co., neither did it hold out any considerable prospect of competing in the future. It was, therefore, discontinued on February 5, 1937. It would be only fair in this reminiscent article to pay a tribute to the many who laboured to make this system a success but who were understandably beaten by the manifest advantages of the all electronic E.M.I. system.

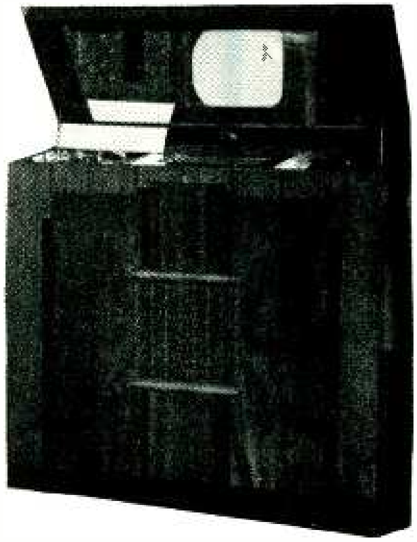
At this time the programmes were of very limited duration, and the atmosphere in which one approached them was quite different. They ran from 9 p.m. until 10 p.m. instead of being perpetually on tap, as they are now. Consequently one approached the evening's performance in the same spirit as when one goes to the theatre. The family assembled in the sitting room at about 8.45 p.m., when the set would be switched on to warm up and a thrill of expectancy would build up. Then at 9 p.m. the programme started and the next hour passed very quickly. This is perhaps the strangest contrast of all between the viewing habits of the pioneering days and the present day.

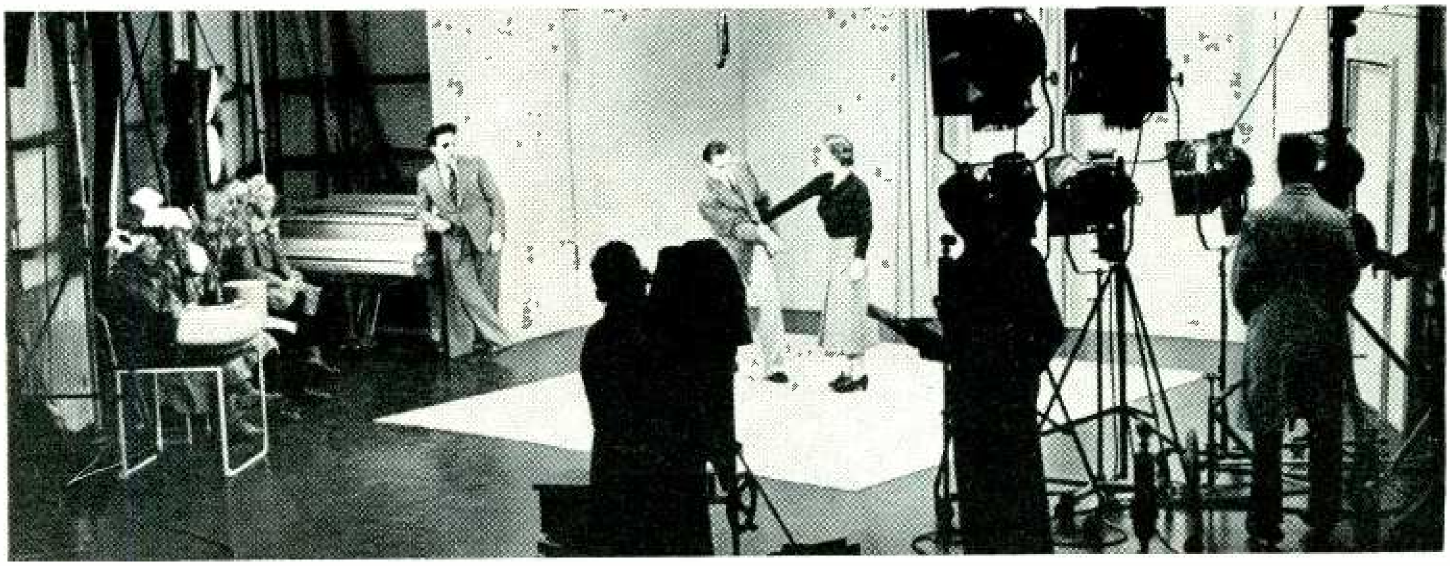
Rush Arrangements to Cover Coronation

It had been a considerable achievement to make a start in public television at all and as I have indicated this was confined to origination from studio and film. The planning had not been complicated by any contemplation of O.B.'s and very wisely. It was necessary to begin indoors first, and having got the hang of that, to consider going outside later. Even when the service was starting we realised that a major event, the Coronation of the late King George VI and Queen Elizabeth, would take place on May 12, 1937, and the idea arose of trying to televise it. It may seem quite extraordinary to some readers now that there could have been any difficulty, but one must remember that one had not got sensitive cameras. Neither was there any means in existence of connecting up the ceremonial centre in London with the Alexandra Palace. This is quite apart from the fact that we had not got any outside broadcast equipment at all. Moreover, it would have been elementary prudence to start with something a good deal less important than this major national event and after many experiments attempt the Coronation. There was, however, no time for this. All we could do was to ask the E.M.I. Co. if they could rapidly make another set of their studio equipment, see if it would go into a van and try and devise some means of connecting Hyde Park Corner to Alexandra Palace. That company had foreseen this type of development and had developed a type of cable which would transmit the signals over the 8 miles involved without visible distortion, and on this

AN EARLY CAMERA AND RECEIVER

Left: One of the EMI cameras used to record the opening of the London Television Service on November 2, 1936. Below: A 1937 receiver, the picture being projected from a mirror in the lid, necessitated by the length and vertical position of the tube.





'The Art of Self-defence', a television presentation on the Baird system in December 1936.

cable being demonstrated it was immediately put in by the Post Office. Secondly the E.M.I. Co. could and did build a set of their studio equipment into a large van. To cut a long story short the first Outside Broadcast of the world's first high definition television service was that of the Coronation on May 12, 1937. We were not even encouraged by the weather. It turned very grey and tested the sensitivity of the cameras to the utmost. But we did it.

It was, of course, clear that the service must expand both in the number of hours transmitted in the week and in its ability to draw from a much wider range of programme material. Three steps were taken to achieve this. Firstly, the Baird studio was re-equipped with a further set of E.M.I. equipment to the single British standard of 405 lines. Secondly, we acquired a further Outside Broadcast unit. Thirdly, we gave the O.B. units greater freedom of action by improving their communications. This was achieved by acquiring two radio links and by the installation by the Post Office of further balanced pair cable in London.

Of the numerous technical accidents and incidents in that period, I have only space to recall one. The weather was particularly bad one day and a gale was rising. By nightfall it was blowing and raining really hard. The aerials at the top of the Alexandra Palace mast were not able to withstand the force of the wind and were blown into a tangle and the evening's transmission could not proceed. We were determined that we would try and put it on if we could, and to that end we got powerful lights out of the studios, put them on the roof to try to illuminate the mast. Our staff went up in these extremely hazardous conditions to try and rectify the situation. We did not manage the transmission on that night, but owing to work through the night in these appalling conditions we were rewarded by being able to resume the transmissions next day.

In April, 1938, the Boat Race between the Universities of Oxford and Cambridge was first televised but this was nearly prevented by the action of a workman in the road in the Alexandra Palace grounds, who accidentally cut a cable with his pick. The pictures were all right but sound commentary had to be given by a commentator watching a monitor at Alexandra Palace.

When the End Came

By the time 1938 arrived I think we all realised that the art which we loved might be overshadowed by events of infinitely greater importance because Hitler was beginning to stage his six months crises. The end came when at 10 o'clock on September 1, 1939, I was warned from Broadcasting House that I must prepare to shut down the service at midday. By 11 o'clock the possibility had grown almost to be a certainty and by 11.30 a.m. I was told to do so. While one's reason told one that television had no place in whatever might lie ahead, the task of putting an end to that which we had built up and loved over four years was perhaps the hardest thing I have ever been called upon to do. I was not to know at that time how wonderful would be the reward in seeing 150 of the engineering staff at Alexandra Palace distinguishing themselves in the new science of radar in the Forces, or in the vital propaganda broadcasting which the B.B.C. was immediately called upon to do.

It is truly a great privilege to have lived through the period which I have described and to have been further privileged to continue in the development of this science when we took up our task again in 1945.

It was Faith, Hope and Hard Work that Created a New Medium

Interviewer: Mr Madden, how were you connected with the opening of television 25 years ago?

Madden: I have the exciting honour of producing the first programme on high definition TV in the world. It happened a little earlier than we expected in August, 1936, because of a radio show at that time. We had to put a programme on rather ahead of schedule and we called it "Here's Looking At You." It was a sort of put-together variety show, and was the only programme that I, personally, have been at all satisfied with. This was because we did it for 20 performances . . . two a day for ten days of the show. Today no producer can possibly be allowed to do a thing more than once. So each time we got it a little better. The moment we had finished the Radio Show programme, we said "Please give us a little money and let us find out what we can do." And they said: "Well, what sort of things do you want to do?" We said: "First of all, we'll take the studio cameras out of doors and do things in the grounds of Alexandra Palace." So we did golf and gardening and things like that immediately to see if we could get good outdoor pictures with indoor cameras. After that I very much wanted to do a magazine and the difficulty was how to create the link. So I thought of the idea of having a switchboard girl with an electronic switchboard. We had a very good Canadian actress Joan Miller available, and so she became the first outstanding television personality by becoming the "Picture Page" girl. We started "Picture Page" in October, 1936, and although I created it and edited it all its pre-war run, it was produced by a different director every week. We made it a compulsory round with the staff, and as a result it trained everybody. Because everybody was trying to do it differently to everyone else, it became a test of ingenuity. Altogether, it ran seven years. It was like the Tonight of those days.

I understand that pre-war you got some really top stars interested in the new medium.

Yes. It it difficult to say what names are interesting today, but we had every-

TALKING ON TAPE
An interview recorded with
CECIL MADDEN
Assistant to Controller, Programmes, BBC Television Service.

body who was worth having. There was terrific enthusiasm for television amongst show business folk. Laurence Olivier appeared with Judith Anderson in Macbeth, and soon after that we were doing television in theatres. In that way we televised Michael Redgrave and Peggy Ashcroft. Ralph Richardson came up and did a studio play for us. These stars didn't get much money, but they were interested and wanted to have a try. The whole of our pre-war policy was basically based on plays. The dilemma was what was going to be the thing you filled your programmes with most, and we came to the conclusion that the writer would never let us down. We might let him down, but he would never let us down. In those first three years we did 326 plays. We did them all twice, so you see we presented 652 drama performances.

And this was before any other country had a public television service in operation.

That's right. We presented every type of play, classical, modern, Continental, drama, comedy . . . everything. We even did plays in Hebrew. It was a very exciting time.

I believe Danny Kaye appeared before your cameras?

What happened was, in order to get our variety extremely good, we didn't put together too much of it ourselves, instead we engaged complete shows, often in London night clubs and hotels . . . there was Grosvenor House, the Dorchester, and the Trocadero which had two shows nightly, and the C. B. Cochrane Shows. All these companies used to come in coaches and do their shows for us at Alexandra Palace. And in one of these shows there was an American dancer called Nick Long Junior, whose partner was Danny Kaye.

Most of the presentation was done in our own studios.

Yes. One of the great sources of supply was the Birmingham Repertory. They did a new production every month, so by making an arrangement with them for every third Sunday we were able to televise a play. We sent our producer to their stage so he could rehearse with them, then they would come at the crack of dawn on the third Sunday to Alexandra Palace to rehearse all day on our set and do it at night. We didn't ring up until nine.

Was all your programming live?

Yes. Except we got all our news on film. We didn't have a news department of our own so we used newsreels. There were five available to us, so we used them in rotation. We were also able to show Walt Disney cartoons,

THE
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congratulates the
British Broadcasting Corporation
on the **25**th anniversary
of the worlds first
public Television service
made possible by
MARCONI-E.M.I.Television System

and had one in every programme.

Was there a vast difference in production then compared with today.

Not much. The main thing was the cameras. No zooms . . . to get a close-up you had to bring the camera forward. But we managed quite a lot that way, and in many ways the artists, seeing the camera coming close, realised it was a close-up and catered for that shot.

How about outside broadcasts?

We did the Boat Race, the Derby twice, the famous Boon-Danahar fight, and we also went to film studios. That was another quite important ingredient. We took our cameras to Pinewood, Elstree and Denham and we televised the stars on the sets. Then of course there was the coronation of King George V—that was an important one—we did all the test matches, the Chelsea Flower Show, the Trooping of the Colour, polo, the Proms, Wimbledon tennis, the Lord Mayor's Show the Cup Final, motor racing . . . In fact there isn't very much that we are doing today that we were not doing then.

Did you have an idea in those not-so-far-off pioneering days that within 25 years television would have spread right round the world.

No. You see, we had so much to do, so little money and such a small staff that we were at it day and night . . . and thinking about the future was the least thing we had time for. You can't blame us for it, either.

Do any occasions stand out in your memory?

I remember when Bernard Shaw came along. That was a great moment. We caught him at lunch . . . he answered the phone himself in an unguarded moment, so I told him that we were doing his play that afternoon. "Oh, begorra," he said, or some wonderful Irish expression. I said: "Please come along," and he said: "I think I will," and to our great pleasure a rather old car chugged up to the Palace a few hours later, and there was the great man. He had a wonderful afternoon, enjoyed himself talking to Greer Garson, who was in the production, and told us it was a very bad play indeed.

What was the public reaction at the time?

Well, anyone who had a television set then was very, very popular. Television parties were the thing in those days. Oh yes, people were enthusiastic. We always had a very good Press. The newspapers put a lot of important critics on the job. And I was very pleased at the wonderful support we got from the ballet world. The Vic-Wells, which is now the Royal Ballet, did no less than ten key productions for us over that period, and companies from other countries all wanted to appear for use when they visited London. It seemed to me then that television was the best medium for ballet. And will be especially when we come to colour . . . Incidentally, we always did everything in colour because—apart from anything else—colour stimulates even if it is televised in black and white.

Where did your staff come from?

The original staff was chosen as one person for each thing—I mean, one from the films, one from the theatre and so on. So we started with a very accomplished but very mixed staff. On that very first programme "Here's Looking At You" all these key people co-operated in jobs that they wouldn't normally do. It was a terrific team, and some of the people in that first studio doing technical jobs are now controllers of commercial networks.

Were you nervous with that very first show?

I was. But, as I said, we got it better as the days went by. As you know, we had two systems, and we had to do it in Studios A and B alternatively . . . just to add to our problems.

Did you personally produce any other shows?

Oh, yes! One of which I was very proud was "Cabaret Cartoons". I used to get a very good artist, Harry Rutherford, to draw at one side of the stage while the cabaret artist performed in the centre. At certain points, I merged the two, and you could see Rutherford's drawing of the artist as he was doing whatever they might. As they finished I made them both blend together. It was pure television.

You must have worked terribly hard with producing, editing the magazine and the overall planning . . .

It was really too much—but it was all the sadder when the final day came and the war closed us down.

It had a remarkable resurrection.

Yes. I was fortunate enough to be on hand to do the resurrecting. I organised the recommencement on June 7, 1946. And very exciting it has been since, starting with the Victory Parade on the very next day. After that we opened the Midland Transmitter, then the Lime Grove studios, and then we went over to Calais, at that time we did the first programme from an aeroplane. Then we started Children's Television on a daily basis, and I was lucky enough to be head of that. We opened in the North in '51. In '52 we went to Scotland and Wales and the West. The Coronation was the high spot of '53. Alexandra Palace closed in '54 and we had the first link-up with eight countries with Eurovision. In '55 we had television from a bomber and afternoon television. In '55 commercial television came and that, in a way, changed all our lives. This was because some staff went and new staff came. In '56 we opened a transmitter at Crystal Palace and also had the first television from a submarine. The Riverside Studios were opened. The following year we started television for schools and in 1960 we opened this Centre. This year the two great highspots have been the direct television from Moscow, and Royal Wedding of the Duke of Kent. And so the 25 years becomes complete with the current Radio Show.

Bernard Shaw chats to Greer Garson during the T.V. production of his play "How He Lied to Her Husband" Pictured with them is George More O'Ferral, now Producer of Drama for Anglia Television.

WHAT NEXT?

John Dickson Ph.D., Attempts a Forecast for the next 25 Years

PACE of television technological development is such that the role of Mother Shipton is no easy piece of type-casting.

This so-called prophetess is immortal because, like the famous Mrs. Harris, "there is no sich person." But had she indeed existed in 1641, as a tract of the period stated, she was at no great immediate risk in predicting the steam engine, the electric telegraph, and declaring that one day "carriages without horses shall go." Several generations, she said, would pass before such miracles were seen.

Well, it is all very different today. Prophets are apt to find their forecasts spiked and out of date almost before their prophecies are uttered.

Just think what might have been the fate of a modern Mother Shipton who, even a twelvemonth ago, dared to prophesy that 'one day' microwave TV links would cover not only Europe as well, but would link Eurovision with Moscow . . . that 'one day' TV signals would be re-radiated from space satellites, rocket-launched into space . . . that the entire scope of recorded video programming would be changed, 'one day' by the ability to stop-start edit Ampex tape.

'One day'? Already this day has dawned. Some of the prophecies are by now rather old hat, and already technicians are wondering what lies beyond the horizon.

In electronics, as in any other branch of physics and engineering, there are nevertheless certain physical limits which to some extent restrict the scope of development — as well, naturally, as the scope of romantic, prophetic imagination.

The speed of radio-wave propagation, fixed barriers such as limits of frequency-acceptance of semi-conducttors bring us to a cul-de-sac in certain avenues of development. And some latest developments which do have future potentialities prove to be less useful in television than prophets think.

For example, when Xenon (cold) lighting was developed, some said: "Well, of course in 25 years or less all TV studios will have cold lighting. With that colour-temperature of 6,500 degrees, it is obviously the coming thing. All our lighting ventilation plant can go for scrap, then . . ."

It has not worked that way. Of course there is ample scope for Xenon in television studios, but even in the Crystal Palace BBC colour tests it was decided that at the present stage of the art the disadvantages of cold lighting slightly outway the advantages Xenon, for colour studio lighting as at that time arranged by the BBC, was rather more costly than incandescent lighting, apt to be noisy when worked off AC supply, and of course demands complex starting gear compared with normal lamps.

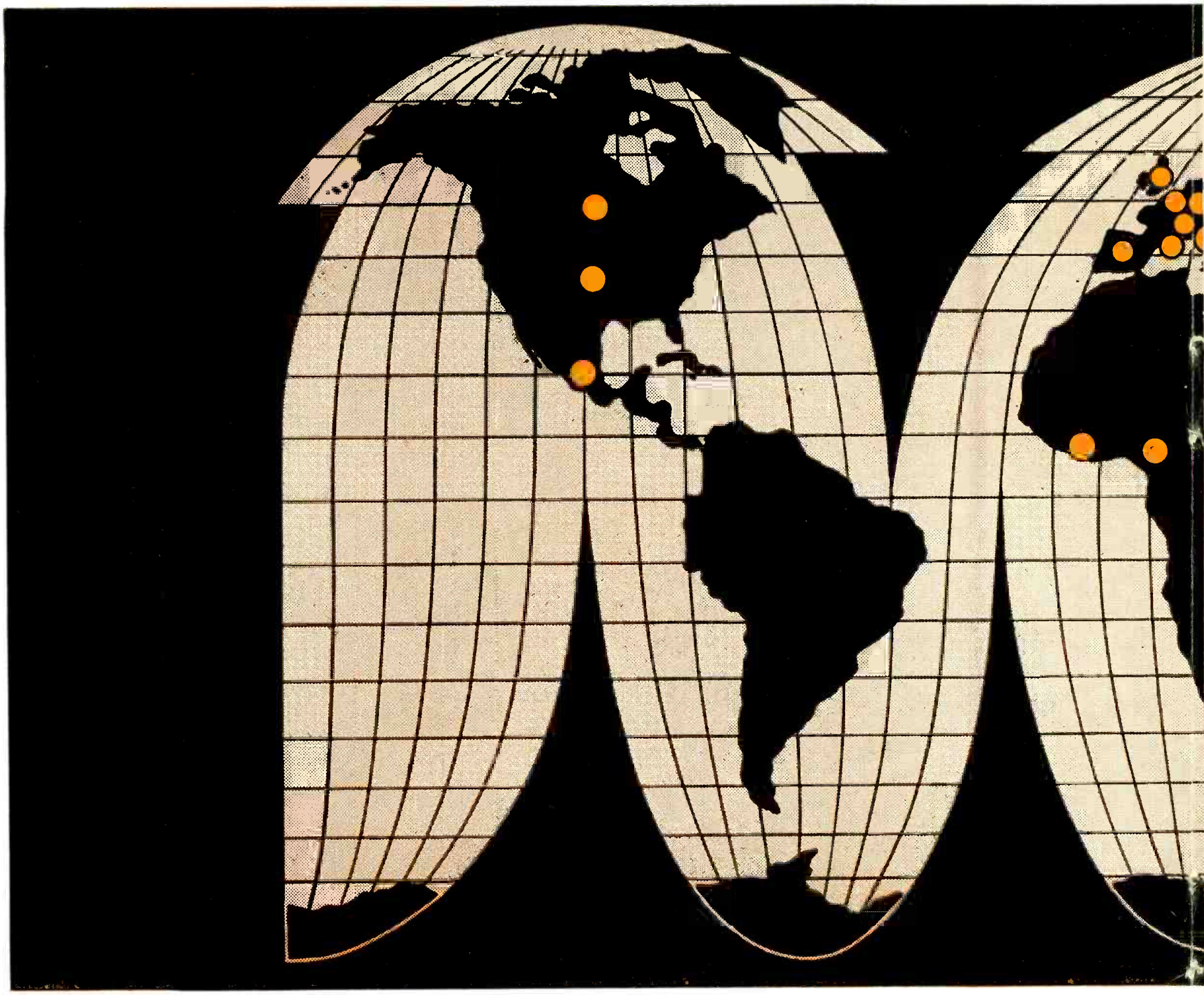
I fancy it would be a rash prophet who would say that 25 years hence incandescent lamps will be outmoded.

Rather, I think we will find higher sensitivity in cameras will bring about quite a different sort of revolution in studio lighting, reducing it possibly to living-room level.

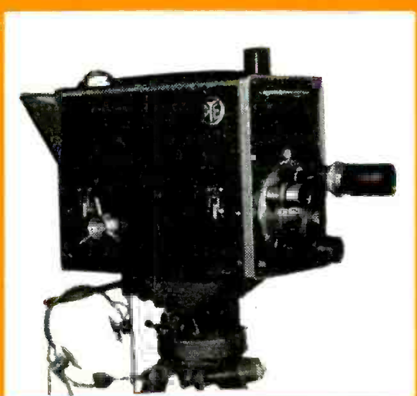
I have picked on this question of lighting rather out of context, simply to illustrate the point that the 'revolutionary' items of today will not necessarily indicate the course of progress tomorrow.

For a long-term forecast (and 25 years in television is an Age in itself), we may take a parallel industry — for example the automobile industry — to indicate the rate of progression.

Twenty-five years back, in 1936, prophets of the industry assured us, for example, that front-wheel brakes were 'the latest thing,' although Crossley, Argyll and Arrol-Johnston all had them before 1910, and the Phœnix light car used front-wheel brakes as far back as 1907. And today the advent of disc brakes, with consequent difficulties of hand-brake operation, make drum rear brakes as important a design-feature as ever. Many British cars are



STUDIO EQUIPMENT—USED A



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BULGARIA Complete Pye Installation, studios, Outside Broadcast Units, 500 watt Transmitter, etc.
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GERMANY (EAST) Five 3-Camera Outside Broadcast Units. Studio Cameras and ancillary equipment, Telecine suites, etc. Seven-stage Microwave Link Berlin Schwerin.
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HUNGARY Complete 3-Camera Outside Broadcast Unit, Telecine, etc.
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NIGERIA Complete Television Station (studios and transmitter).
NORWAY Studio Cameras, vision mixers, ancillary equipment, telecine installation.
PHILIPPINES Complete video installation (Cameras, monitors, mixers, etc.)—to be supplied through Rocke International.
POLAND Two Complete Pye 3-Camera Outside Broadcast Units, Telerecorder, telecine equipment, etc.
SIERRA LEONE Sound mixers, continuity suite equipment.
SPAIN Two Complete 3-Camera Outside Broadcast Units and telecine equipment.
SWITZERLAND Complete 3-Camera Outside Broadcast Unit, Studio Vision Mixers, etc.
THAILAND Complete Television Station for Royal Thai Army, studios, control equipment, telecine, Outside Broadcast Unit and 4KW Transmitters.
U.S.A. Approximately £300,000 worth of Cameras, Studio equipment, etc. supplied to U.S.A. Television Stations through General Precision Laboratories.
U.S.S.R. Complete 3-Camera Outside Broadcast Unit and studio equipment.

now being fitted with disc front, drum-rear layout. So the prophets would hardly have been correct. The same might have been said about yet another 'latest idea,' independent suspension.

Twentyfive years ago it seemed new, but in fact was even then old. The Bollée steam wagonette of 1873 had independently-sprung front wheels, so did the Stephens of 1898 and the Decauville, both on the original Brighton Run. Today the latest trend is for independent suspension all round. But, in main essentials, the automobile has not changed much in 25 years. Diesels have not swept the board for private cars, as Continental sections of the industry predicted. Apart from Rover's 'JET-1,' and equally experimental gas-turbine cars at General Motors, Detroit, the 'jet' car is still a dream. Like the gyro mono car, the solar-battery electric vehicle, all these one-time revolutionary ideas have been set aside by the ruthless, practical, economic demands of the present.

Instead of a revolution, the automobile industry has seen a fairly slow process of logical evolution, ham-strung unfortunately by political and labour extremes. So, despite the past rapid pace of television development, the same slower, ruthless, economic pace may soon apply to our own industry, too. I give this as a warning before indulging in prophecy, for any amateur Jules Verne or H. G. Wells can conjure up fanciful ideas.

In the immediate future, as 25 years hence, the *real* guide to coming developments will be controlled by the rule of: "*How can we explain it to the board and the shareholders?*" or, if you think nationally, "*Is this the best course to take to keep the government in at the next general election?*"

That sort of inflexible rule must be applied when we begin day-dreaming about the 25-year prospects of wired television, 'participation' (coin-in-the-slot, or other ways) programmes, big-screen colour, and so forth. Many wild-haired technical schemes and quite a few good ones will have been described to the Pilkington Committee, but State-appointed advisory and investigating committees do not make rules. They merely draw up a list for Civil Servants to read. So whether, ultimately, any of the futuristic schemes take fruit depends, as I have said, upon the boardrooms of private companies and the inner sanctums of Whitehall.

Obviously this inflexible rule mav hamper 25-year development of many things science-fiction writers take for granted.

"Sterama," an experiment in stereophonic sound by the Kansai Television Company of Japan in which a domestic sound receiver is used in conjunction with the normal TV speaker. The radio is placed behind the veiwer to carry the principal play character's voice, with a single studio camera acting as his "eyes". This arrangement is intended to create the sensation of the viewer actually taking part in the drama.

In the average super-modern house-of-the-future, you will find stainless steel furnishings, life-size, three-D, four-colour television displayed on wall panels of futuristic living-rooms. True or false? Let us face the facts.

Up to about 1950 three lone manufacturers were struggling on with projection-TV. For domestic use there was a lens system displaying the picture on a ground-glass screen. For education the picture was projected on a reflecting screen about 4-ft. wide. The trade found the public simply would not accept the slightly grey picture in the home, even though it was large. The coming of the mass-produced, slim 21-inch tube virtually killed all domestic development of the projection system, though of course it still has a big place in education, and in technical display. Will the public change its mind again, and demand even larger screens? There is no evidence that wider screens have improved the sad financial plight of the cinema industry; on the contrary.

For long, the ownership of a TV set was a status symbol, like the radiogram and the cocktail cabinet of the nineteen-thirties. Today you simply cannot give a 78-r.p.m. radiogram away, and, like the harmonium and the aspidistra, it is a sick headache, not a status symbol. There are signs the public is already regarding a cumbersome TV box in the same way. Hence the 'slimline,' and other cabinet-cum-tube developments. When this phase reaches its completion, which I predict will be long before another quarter of a century has elapsed, every TV screen will be built into the wall, just as every sink must now be a 'unit,' every bath panelled, and every toilet 'low-flush.' It needs only a couple of courageous designers to take this line by the 1962 Ideal Home Show, then ram it home for the 1962 Radio Show, and the TV cabinet will be as *passé* as the horn loudspeaker.

Participation and wired TV? Here we are on difficult political ground, for some who would see the whole programme channel truly nationalised favour State-owned wired TV, with no other liberty of choice. But "participation," no matter how politely put, means "YOU PAY." Unwisely, the TV programme industry has not been conditioning the general public to expect to pay.

Mammoth Palladium, Royal Albert

Hall and other spectacles come free; so do Cup matches, great international sporting events, opera, dynamic news coverage . . . What great series of spectacles do the Participation People hope to corner which will be worth even half-a-crown in the slot to a public conditioned to getting it all for nothing? And if a section of the public does pay, so causing a reduction in viewing figures for advertising programmes, will not the vast advertising interests counter by making an equal attraction available —free ?

Strictly this is a political and a programme problem. But it very much affects us here technically in reviewing the next 25 years, for the Participation channel will need frequencies, investment capital and technical staff. Britain. at present has little surplus of any.

It would not surprise me if one section of the British industry stole a march on Messrs. Pilkington, long before 25 years pass by, and gives the public a real treat — something which ought, I believe, to have been linked with video from the very outset. Of course I mean stereophonic sound.

All the big sections of the record industry know the commercial attraction of stereo. With many makes of disc an LP *costs no more* in stereo than in mono. Even with guinea discs, the difference is less than 8s., and of course having once sampled '3-D sound' few take mono from choice.

With the B.B.C. using so many VHF channels to give a 97 per cent. coverage of Britain, this would need readjustment for TV stereo sound. It would give a needed boost to receiver manufacturers. It would, in these bank-pressed, satiated days bring a new, exciting sensation for the viewer.

Technical problems of providing a stereo-sound channel are infinitely simpler than those of giving 3-D video ; indeed there are grounds for believing that stereo viewing is never likely to be commercially possible.

Stereo sound should have been tackled long before line-standard changes and colour were envisaged. It is not too late. I shall personally be surprised and disappointed if we do not make amends well within the next 25 years. As for high-definition colour, the BBC has already commissioned EMI Electronics to modify the Crystal Palace 10 Kw UHF transmitter for working on the 625-line standard in Band V. Experimentally the EMI Tx has been used for monochrome 625-line Band V working, and now it will include colour. It is therefore rather sneaky as a "prophecy" to write of something which is already on the verge of happening.

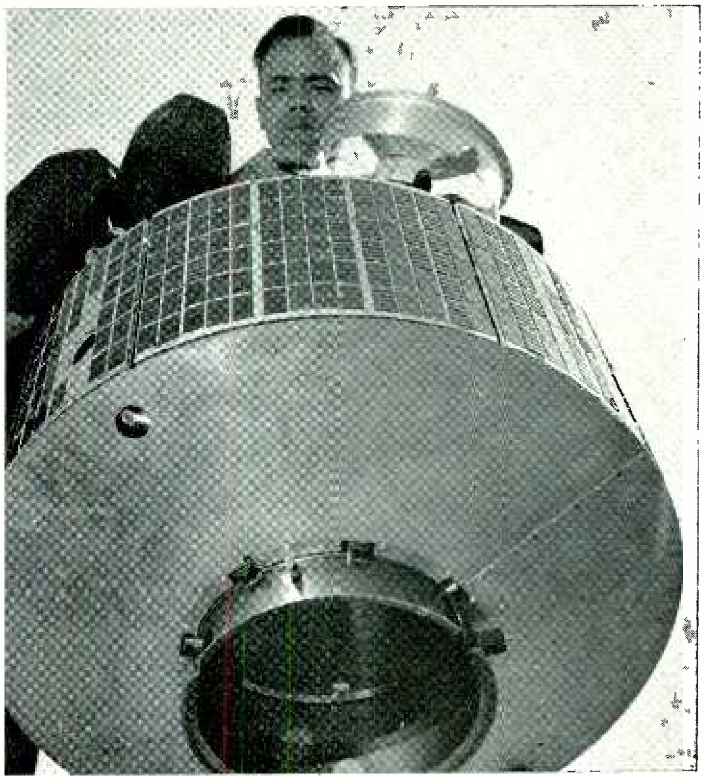
Well within 25 years, 625-line colour ? Yes, without any question.

Most of us are tired of American-bred arguments that the public doesn't like colour, and the advertiser finds it too costly. In the world of photography Agfa, Kodak and many Continental groups have got down to the cost problem, and increasing use of semi-conductors in colour receivers may well help proportionately to minimise first cost and servicing problems. As to cost of providing a colour service, this comes out of the realms of a technical survey and into the City column, for no doubt in much less than 25 years some of the wealthier contracting companies will have been forced to limit dividends by devious ways, and giving the nation a colour TV service is as good a way as any . . .

Within two years at most, Britain will have 96 per cent. service coverage for those who want a TV service at all. (A recent national-paper survey showed that already nearly half the TV audience, 11,000,000, switch on the set automatically for the evening and leave it on ; 41 per cent use it only as a background ; 6 per cent need TV on when they are reading ; surprisingly, 5 per cent like it to help them sleep !) So there is little question of needing a bigger audience, or the technical facilities for it, while only a monaural monochrome service is available. However, within 25 years we may find that the cost-per-head of programme distribution by a purely *broadcasting* system is not as cheap as it used to look, and that something like a Community system might help economically.

Last April a group of British technicians including Multisignals Ltd. started a community-TV system commercially in the Bedford area. This was always a poor area for TV reception, but an EMI aerial array was installed four miles outside the town, covering Bands I, II and III. By the end of this year the service will be available to 10,000 of Bedford's 19,000 homes. The community service gives BBC-TV, London-ITV and Anglia-ITV programmes, BBC VHF Home, Light and Third sound. Radio Luxembourg is picked up directed and redistributed on the VHF band: Signals are 30 to 60 times stronger than those obtained with a conventional aerial. Any brand of TV set can be used (unlike most other piped-TV layouts), and use of the wide-band technique means that 13 TV channels are available to subscribers.

Basically this is a system for poor areas of reception, but in coming years



The Hughes Aircraft Company satellite which will enable the United States to place a stationary communication relay station in space in the very near future. It is intended for a fixed orbit 22,000 miles above the equator, synchronised with the earth's rotation, making possible TV links between South and North America, Western Europe and Western Africa. The Hughes orbitor is 29" in diameter and weighes only 32lbs.

I see plenty of room for expansion of this novel community-TV facility, giving wide-band coverage.

To give increased services such as colour, hi-definition and stereo sound, we shall need channels. I do not necessarily say 'more' channels, for the Pilkington deliberations may actually result in some channels being sacrificed.

Radio-wave utilisation is not yet on an internationally commonsense basis. Perhaps it never will be.

VLF (below 30 Kc/s) is reserved for communication and navigation. This is the Ground or 'D-region' band, and suffers from diurnal absorption. First of the 'E-region' bands is the LF (30-300 Kc/s) used for broadcasting, as well, of course as navigation.

MF (300 Kc/s to 3 Mc/s) and HF (3-30 Mc/s) are the main broadcasting bands, but are of too lower a frequency to carry a video spectrum. Higher and lower-VHF bands (30-300 Mc/s) are the main channels for television communication.

What hope is there of extending this band to UHF, SHF or even EHF? Politically and technically there are many difficulties. Not all the UHF band, of course, is useful for more than line-of-sight communication, which means one must use a chain of repeater stations when nearing 3,000 Mc/s, and there is danger of conflict with essential radar and navigation services. SHF (3,000-30,000 Mc/s) and EHF (above 30,000 Mc/s) are both line-of-sight channels, and SHF, at least, is subject to disturbances from solar noise and rain scatter.

If we cannot extend the bands, then perhaps by international agreement other bands may be freed from existing uses to give more ether-*lebensraum* to TV services.

In Transatlantic radiotelegraphy, for example — that old warhorse of radio communication ever since Marconi's first signals pioneered the Clifden (Ireland)—Glace Bay (Canada) service —there is a coming trend to get away from HF channels (first used in 1926), and to have a chain of signal stations operating by means of ionspheric and tropospheric scatter. This seems to give significantly less interruption than the usual direct HF link.

Tropospheric scatter systems have a useful frequency range of 200-5,000 Mc/s, and usually operate with transmitters having a power of 20 kW or more. There is powerful international jostling for more communication bands, and no guarantee that even relatively local TV services could have those abandoned by communications services. But within 25 years we shall certainly see a major re-allocation of bands.

Stratovision? America has already experimented with Stratovision beamed to a DC-7 aircraft some 86 miles away, flying at a height of 23,000 feet in an orbit of a 10-mile radius. On paper it is but a short step from that to space-satellite Stratovision, such as the United States' 'Project Courier' which began when the satellite was launched back on 4th October, 1960. 'Courier' used a 1-kW ground transmitter and a 4-kW satellite transmitter, operating in the 1,700-2,400 Mc/s band.

You could write this off as just another laboratory experiment, another U.S. Army field day . . . but the stern fact remains that *eight* participating companies joined forces at the turn of the year in the British Space Development Company. (They include ATV, Pye, the Rank Organisation, A.E.I., British Insulated Callender's Cables, Decca Radar, de Havilland, and Rolls-Royce), and they obviously do not intend to waste their talents in the coming 25 years. Their initial capital was a nominal £20,000 — no indication at all of the immense potentialities of the group in television as well as in missiles and artificial satellites.

Answering back in this coming big phase of the international war, the American Telephone and Telegraph Company has obtained Federal permission to develop research for a "permanent space TV and phone system" on which the group is prepared to spend over £60,000,000. From all this you may expect all — or nothing. In less than 25 years from now you may be taking an international network of TV channels from space satellites. Or the whole show may be given over to the war of nerves. Much depends upon Moscow. Unfortunately when I turn my prophetic crystal ball in the direction of the Kremlin, it ices up. So we will leave that phase of the 25-year forecast . . .

Back home, in the studios, you want to know if there will be sensational new cameras, revolutionary lighting, breathtaking changes in pulse-generation, switching.

No, my opinion is that we have nearly reached a zenith, and the next decade at least will be in consolidation and slow development.

I believe that in the pursuit of what A-R calls this "Visual Journalism" we shall see positive development of the Peepie-Creepie and similar crystal-locked, miniaturised radio-link cameras. In Britain many editions of *Panorama* and of *This Week* would have been given more flexible coverage had it been possible for cameramen to go right in to certain news centres for on-the-spot video reportage. We all know the headaches brought in by the original French cameras, and A-R in particular did much thankless pioneering. The BBC took radio-link cameras down in submarines and up in aircraft. They became a gimmick, useful only for stunts. Within 25 years I believe we shall see a new phase of development of the light, hand-held radio-link camera.

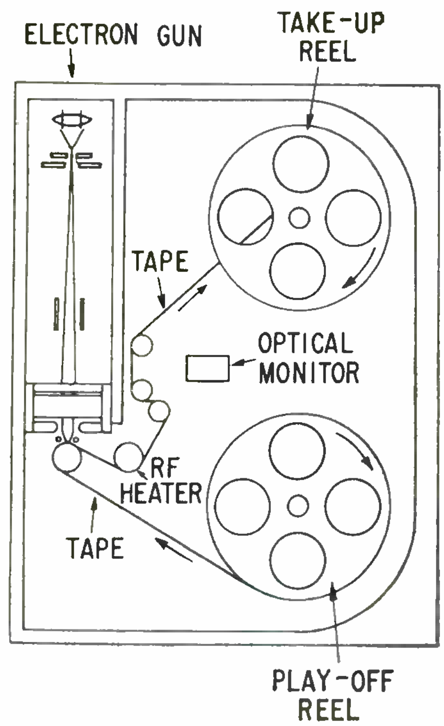
In the recording of programmes, expect big commercial development of the General Electric Thermoplastic system. I have reason to suppose they do not intend to let it develop only in the sphere where it does not come directly into open competition with Ampex and RCA; I mean, of course, the computor field. Certainly well within ten years, let alone 25, we shall see commercial rivals to stock methods of magnetic recording.

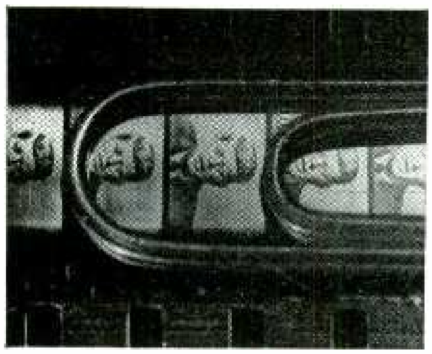
Nor am I convinced that selective editing of Ampex Videotape is the final answer. Of course it is a boon, this stop-start instant video editing of tape; it will simplify many studio problems. We might even see a gradual change in production technique, where the executive producer would insist upon seeing "rushes," and in editing from the tape, just as is done in the cinematograph world. (At present, of course, the producer or director see the show electronically, and what happens to it afterwards on the video tape is basically not their business).

I think it significant that John Silva, Paramount Television Productions' chief engineer devised what he calls a "TV-ola" (c.f. the Moviola) for precise frame-by-frame editing of Videotape recordings. This TV-ola houses four 5-in. storage monitors capable of holding a TV picture for an indefinite time. I gather that in the U.S. they are already asking: "Whatever became of the TV-ola? Did Ampex buy it off the market?"

Without wishing to enter that controversial field, I think we are going to hear much more of systems to give full, instantaneous editing. And we could certainly use such systems now, without having to wait 25 years . . .

Revolutionary cameras? I think not. The 4½-in. image orthicon, which has taken — believe it or not — *eleven years* for complete development in Britain, after the original theme was





General Electric's Thermo Plastic Recording which combines the advantages of magnetic recording together with it's low cost, with the advantages of optical recording with it's ease of editing. Left: general layout of the system. Above: Visually-recorded strip, compared for size with a paper clip.

introduced by RCA's Otto H. Schade, gives a storage target area some three times larger than most 3-in. tubes. Nobody pretends that we have reached finality in camera or tube design, but I do not think the Marconi Mk. CCM1V, or whatever it may be by 1986, will be vastly different from the present Mk. 1V.

Physicists may defy us all and produce a semi-conductor with a wider frequency-acceptance spectrum, and by the 1980's all our studio equipment will be transistorised. But this depends upon discoveries as yet unmade, and nobody likes to prophesy along such lines. In London Bernard Marsden and his ATV development team did such fine work in the transistorization of studio master-switching (now standard practice at ATV Elstree) that, again, I do not expect more than routine progression in the coming quarter of a century.

For a fuller service we shall need more TV transmitters operated in parallel, especially where Tx's are remote-controlled. I anticipate practical developments here, but it must be remembered that even the Band-1 Tx at Crystal Palace and the ITA Band-III station at Croydon were examples of the art of paralleling.

Is anyone going to bring out something entirely revolutionary in the field of television transmission — as new, for example, as the travelling wave guide, or the transistor ? Well, for the reasons indicated in the opening paragraphs of this article, 25 years is a long time — time enough for someone now a schoolboy, battling with his Eleven Plus, to become a laboratory genius, and so to give the world his masterpiece.

Can I suggest a fruitful line of development ? With pleasure. (In due course all royalties should be sent to me c/o The Editor !).

Away in the Bell Telephone Laboratories they have been experimenting with an electronic nerve cell — a basic electronic circuit that simulates some of the functions of the individual biological nerve cell, or neutron.

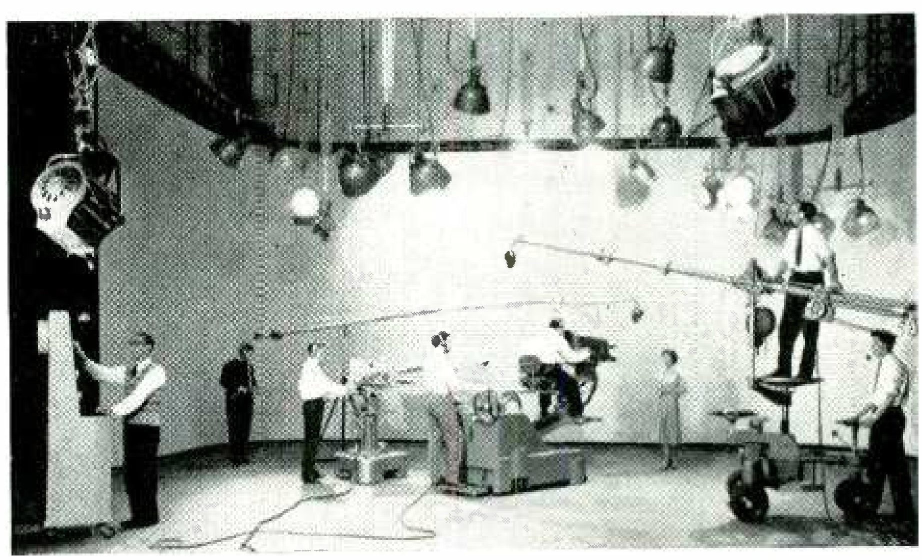
The strange little circuits used have what are called " Excitory Inputs " and " Inhibitory Inputs."

Now, with a whole quarter of a century ahead of you to plan, why not put this Electronic Nerve Cell idea in reverse ? Why not try to develop a system which the TV audience can use in the home, simply touching the Output of the nerve cell to the arm or forehead in order to impress an electronic, video image into the brain ?

This would make existing transmission channels superfluous, it would make the TV receiver itself completely unnecessary, and while it would be a nuisance to leaders of the manufacturing industry such as Mr. Thorn and Sir Joseph Lockwood, it would produce a generation of Britons able to see (or, more accurately, get the impression of) television programmes without the necessity for sitting watching the set.

TAM and other probes already seem to show that a nightly audience of 11,000,000 only look at TV with half an eye. With the Nerve Cell, they would not need to use their eyes at all. Visual impressions would be fed into the brain electronically.

Fatuous ? That was what they said to Campbell-Swinton in 1908 when he suggested the basic principle of what we now call Television. Prophecies do have a habit of coming true. Even zaney ones . . .



The privately-owned Granville Studio in London which producers of television commercials and features can hire to do thei' work with an all-eletronic system instead o, film. Videotape, although still more difficult to edit because there is no photographic image, can be viewed on a television monitor without prior processing in a laboratory and "wiped clean" for re-use.

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A close up of Paul Daneman playing the part of Richard the Third in "Traitor's Gate," produced by the Robert Stigwood Group.

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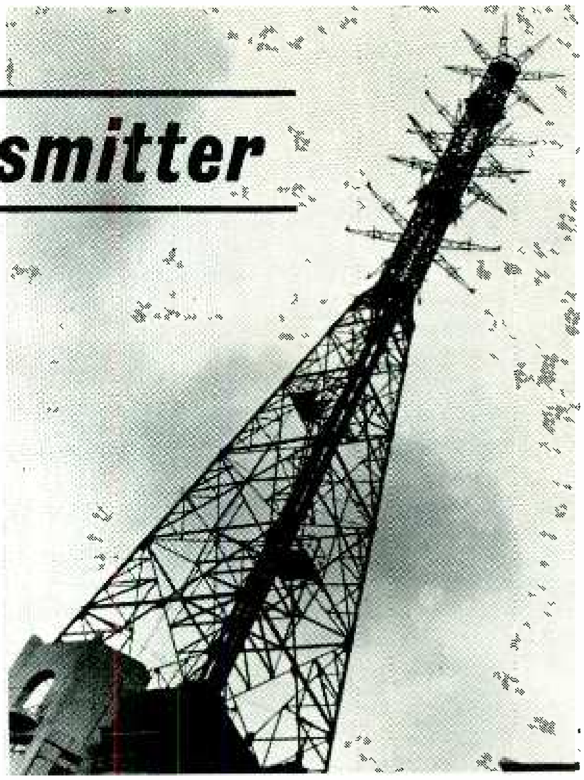


SOME DRAMATIC DEVELOPMENTS WHICH LED TO THE FIRST SERVICE POSED NEW PROBLEMS FOR MARCONI'S ENGINEERS.

TALKING to engineers who pioneered British television one realises that, although apparently the 405-line system appeared almost miraculously out of the blue, there had in fact been a large amount of steady and well directed development preceding this.

The electronic work of Zworykin in America and Shoenberg, Blumlein and their associates in this country rapidly overtook the mechanical systems of television (made famous by names like Baird) although the amount of time separating the original low definition 30 lines service and the proposed 250 lines service was quite small.

Basically, two parallel lines of development led up to the final Marconi/E.M.I. system. First, there was the all-electronic scanning system and camera development undertaken at Hayes by E.M.I. laboratories, and secondly, there was the development of the radio frequency equipment to generate the powers required and to radiate over the distances necessary these complex television signals.

The Roots

Looking, however, at the problems with which Marconi's were dealing, those on the transmission side, the roots of the whole development can be traced, first, through ever increasing keying speed using Morse and then the introduction of facsimile transmission. By this technique, instead of breaking down individual characters into morse code groups, the actual pictorial form of the letter could be transmitted. Notable experiments made by Marconi's enabled them to transmit the entire contents of a page of "The Times" newspaper in a matter of some eight minutes.

About this time, too, photographs were being transmitted from place to place by radio or by telephone line, and the speed with which a complete image could be transmitted depended almost entirely upon the pass band of the circuit, thus the wider the pass band the more quickly the information could be transmitted. Now these early facsimile experiments used transmitters with a bandwidth measured in kilocycles, but as the very high frequency transmissions became possible (as a result of the work of pioneers like Franklin) the bandwidth could be increased considerably and the speed of transmission of a particular image increased proportionately. Thus, by the time that 150 line television, using mechanical mirror drum scanners, was developed, Marconi's were ready with transmitters, modulators, aerials and feeder systems which would handle these transmissions.

The dramatic turning point came when the Television Committee, investigating on behalf of the Government the most practicable methods of introducing television, decided upon the competitive service between the Baird system and the E.M.I. system. Now, at the time immediately prior to the introduction of the service, both companies were dealing with 250 line mirror drum systems — mechanical systems basically, producing images which required a bandwidth of about one Mc/s. Both of them imposed roughly equal problems for the transmission engineer, problems which had already been solved. In fact Marconi's had already at that time provided an experimental transmitter of 4 kW, which E.M.I. were using at their Hayes Laboratories, and had under development a further transmitter of no less than 40kW power to handle this type of modulation.

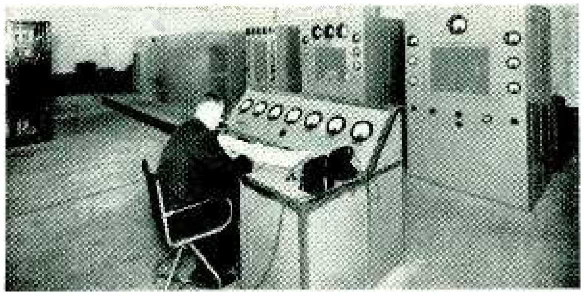
However, the all-electronic system looked so promising that the Marconi Company and Electrical and Musical Industries came together and very dramatically proposed to the Television Committee that instead of coming in with a service which was roughly the equivalent of the Baird 205 line system they would jump forward to a system giving two interlaced pictures each of 202½ lines giving the equivalent of a 405 line picture. Immediately, of course, the transmission problems were multiplied by at least two. Mr. N. E. Davis, who had been responsible for the design of the earlier transmitter was set the task of providing a transmitter capable of these new requirements. This involved new techniques never previously employed in transmitters, and reflects great credit on the designer who had only a short time in which to produce the transmitter, and

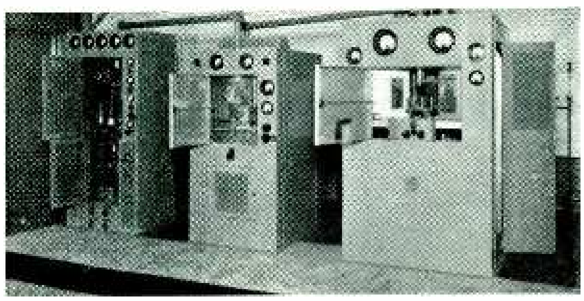
Picture at top shows the BBC mast and transmitting aerials at Alexandra Palace. The dipoles and reflectors can be seen spaced round the central lattice mast.

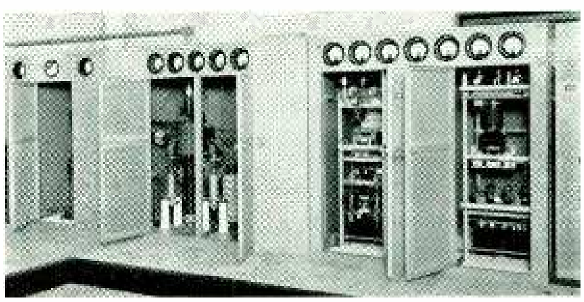
Top. The sound transmitter, supplied by Marconi's, served both the Marconi-EMI and the Baird system during the trial period until February 1937 when the all electronic system was chosen.

Centre. The vision transmitter — the radio frequency amplifier. This transmitter had a peak output power of 17 kW.

Below. The modulator for the vision transmitter.







it is interesting to note that virtually this same transmitter survived for twenty years, before being superseded by the more powerful transmitter at Crystal Palace.

The design of the transmitting valves had grown up over the course of years through a series of developments based largely upon increasing the power and reducing the wavelength of transmission.

Radical Departure in Valve Design

The problem of providing the necessary bandwidth to permit the transmission of the wide range of frequencies required, necessitated the design of special valves. Therefore, a completely radical departure had to be made in valve design and Mr. E. Green of the Marconi Company in conjunction with the designers of the Marconi-Osram Valve Company set to work to produce circuits and transmitting valves which would deal with this problem. They were very successful, and shortly afterwards it became possible to produce transmitters which had more power, more bandwidth and generally overall better performance and efficiency than had ever been achieved before.

One of the associated problems of designing transmitters to cover a large bandwidth was with their power supplies. Normally the variations of load are determined by the speed of Morse keying or by the highest and lowest speech frequencies in normal telephony. In television, however, one had to deal with variations between 50 c/s and 3 Mc/s and the DC stability had, in addition, to be extremely good if the black level were to be maintained constant.

The hard vacuum rectifiers used up to this time for transmitter power supplies had smoothing circuits of simple design, calculated to filter the ripple due to the rectifier, but these circuits were not suitable for dealing with the variations in load imposed by television transmitters; the variations ranging from the equivalent to a D.C. to one changing at a rate of 3 megacycles. Special built-out smoothing circuits were, therefore, devised which gave a sensibly constant regulation over this range of frequencies.

Problems

One of the problems which had to be faced when Mr. Franklin developed his short wave beam transmitters was that of taking the power from the transmitter to the very large and widely scattered aerial arrays. These beam aerials, consisted of a great curtain of dipoles, hung from catenary wires, spaced between towers erected broadside-on to the path of transmission. Many hundreds of aerial elements had therefore to be energised in the correct phase and with the correct power loading and all this on wavelengths which had not previously been employed. Mr. Franklin solved this problem by designing the coaxial feeder consisting very simply of an outer copper tube with an inner spaced from it by small porcelain insulator. The characteristic impedance of such coaxial assembly could be accurately determined and, of course, remained constant over a wide range of frequencies.

However, the mechanics of supporting the interior conductor involved some mechanical and electrical problems. First long lengths of cable running across fields between transmitter and aerial would be subject to expansion and contraction and therefore mechanical flexibility had to be arranged. Secondly, there would be a possibility of water being trapped in the feeder causing either a dead short or a change of capacity. Thirdly, there was the problem of branching out from the single feeder coming from the transmitter to the different sections of the aerial.

More Serious

While all these problems were solved satisfactorily for the beam transmissions using normal telegraphy they assumed tremendously more serious proportions with the bandwidths involved in the high definition television service. First, the material of the insulators had to be changed so that the losses were reduced, then the mass had to be reduced so that the capacity could be pulled down to a minimum value and throughout a very high degree of consistency had to be achieved by careful detailed attention. The aerials themselves had their own problems because instead of having a normal carrier frequency with a small diversion either side, as in telegraphy or telephony, the new aerials were expected to cover a bandwidth which was quite a considerable proportion of the radiated frequency. The normal dipole had much too sharp a cut-off and therefore more spread aerial systems had to be devised. Mr. Franklin worked on the problem of an aerial for Alexandra Palace and produced a system consisting of dipoles and reflectors spaced around a central lattice mast. The dipole elements were themselves made of a cage of three wires so that the bandwidth would be wide enough to allow for the television modulation.

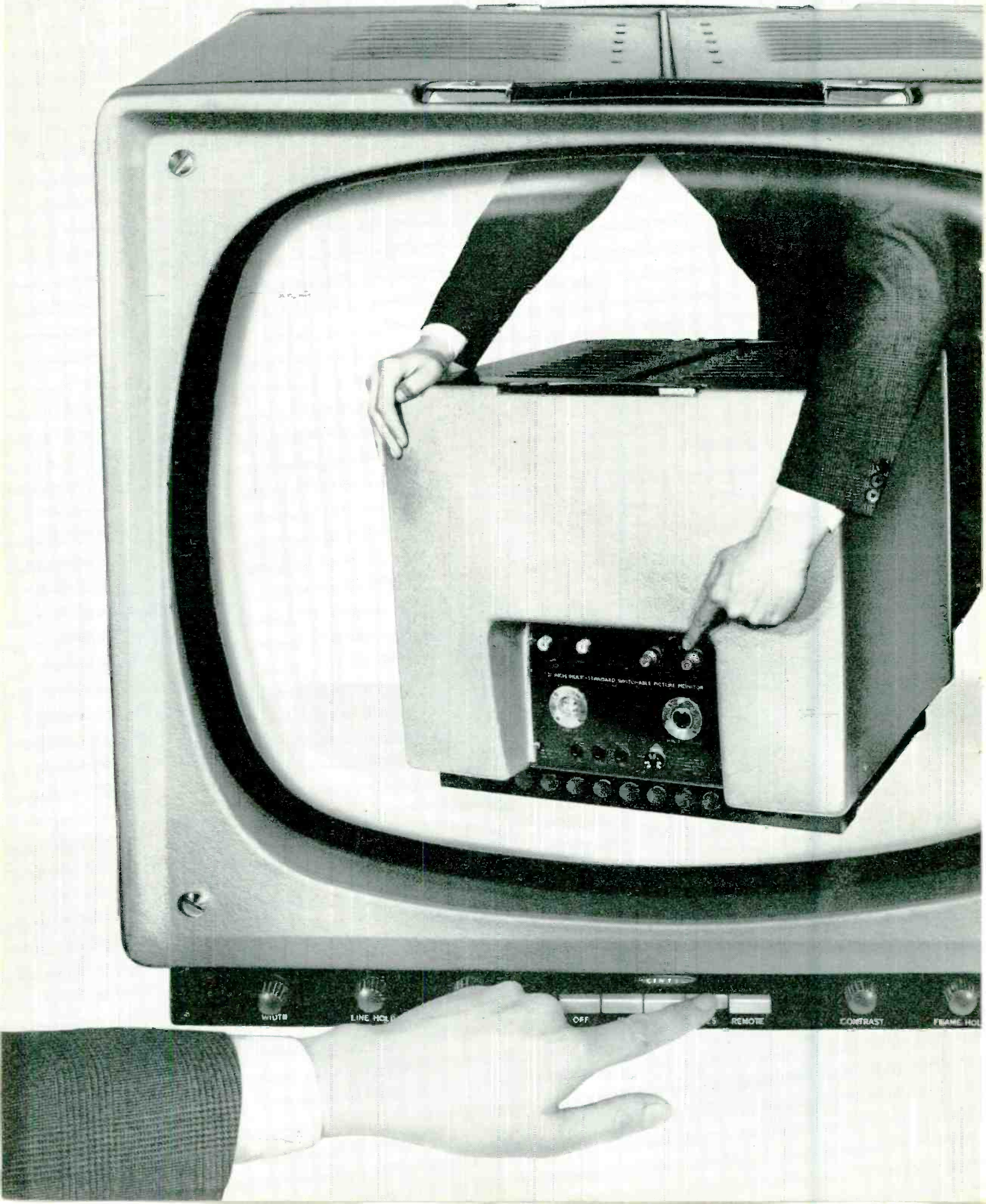
Having the transmitter and aerial immediately above the studios at Alexandra Palace produced a number of complications, in that the transmission was liable to interfere with the studio equipment. An early amusing incident was when the conductor, Hiram Greenbaum, adjusted his music stand accidentally to a half wavelength long and was astonished to discover that he could draw sparks from the top of it with his baton. He immediately rushed into the transmission control room next door, his hair literally standing on end, and demanded to know what was happening!

An interesting outcome of the introduction of television is that from normal peace-time developments of the art several far-reaching military devices had their origins. First there was the development of the Cathode Ray Tube from a purely laboratory device to a definite measuring tool, available for many different applications. The development of small portable camera tubes gave the designers of rockets a very potent tool for aerial reconnaissance and observation. So often the flow of ideas tends to be the other way — that developments carried out during the stress of war have peacetime applications — but here is a notable reversal of this system.

Talking to one of the early television engineers I asked him how he felt the medium had developed. He said that at first he found it very disappointing, it seemed that a lot of work had been put in to produce something which was only used for very light entertainment, but now with the international exchange of television programmes and the searching interviews in which one feels one knows famous people intimately, he felt that television was contributing a great deal to our understanding of the world and in particular that it was a very potent influence for peace between nations.

At this age and day when television is such an accepted commonplace it becomes very difficult to think of the problems which faced these early pioneers. Every single problem which they faced involved them in a complete new set of associated problems. No one before had used such powers at such frequencies with such large modulation bandwidth. Right from the time that the image was passed through the lens on to the camera tube to the point at which the light appeared on the receiver at home it was entire and novel technique. There had, however, been a fairly steady development which gave some guidance.

P. B. BERKELEY, AMIEE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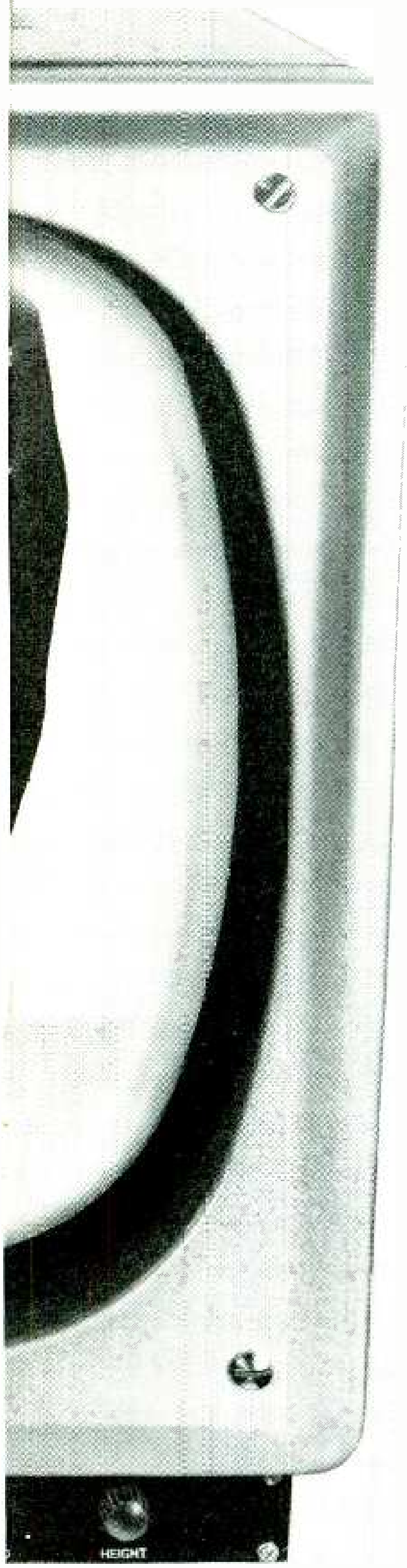

A NEW CINTEL 21-INCH MULTI-STANDARD PICTURE MONITOR

incorporating a new push-button standard change system and featuring all-recessed controls in a fibreglass/aluminium cabinet.

THIS INSTRUMENT installed by ATV in their latest studio and now being supplied to other leading programme contractors, is an all-purpose monitor which can be switched from 405 to 525 or 625 simply by pressing the appropriate button.

It also possesses a remote control system which enables a complete installation of Cintel monitors to be changed in line standard from one central point.

The interlace of the frame scan generator is better than 55/45, and linearity and geometry are such that all picture points in a circle equal to the diameter of the picture width are within 3% of their correct positions. It is designed to accept standard composite video signals in the range 0·5 to 1·5V peak-to-peak positive going video.

The syncs may be obtained either from a composite video signal or from a separate source of 0·1 to 10V peak-to-peak negative going mixed syncs. The instrument requires an input of normal 200-250V 50c/s a.c. mains, and consumes approximately 168W. The frequency response of the video amplifier is flat to within $\pm\frac{1}{2}$dB up to 6Mc/s and is less than 3dB down at 7·5Mc/s.

The size of the 21-inch model illustrated is 20″ high by $22\frac{1}{4}$″ wide, by $21\frac{1}{2}$″ long, and it weighs 86 lb. An alternative 17-inch model is obtainable. A complete technical description is available on request.

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THEORY TO FACT IN 28 YEARS

Modern Techniques Stem from an Idea Proposed in 1908

AN all electronic television system was first proposed by Campbell Swinton in a letter in "Nature" in 1908, but 15 years elapsed before John Logie Baird demonstrated his mechanical scanning system, which was the first serious attempt at television. Swinton's idea, of using cathode ray tubes at both transmitting and receiving ends of the system, was years in advance of the existing technology and even when Baird began his experiments had not really been realised. The controversy that raged around the Baird 250 line mechanical system was resolved in 1936 when the B.B.C. adopted the Marconi/E.M.I. 405 line electronic system using iconoscope tubes.

To obtain satisfactory pictures from the iconoscope necessitated particularly high illumination of the subject. Furthermore spurious signals were unavoidably generated and had to be corrected.

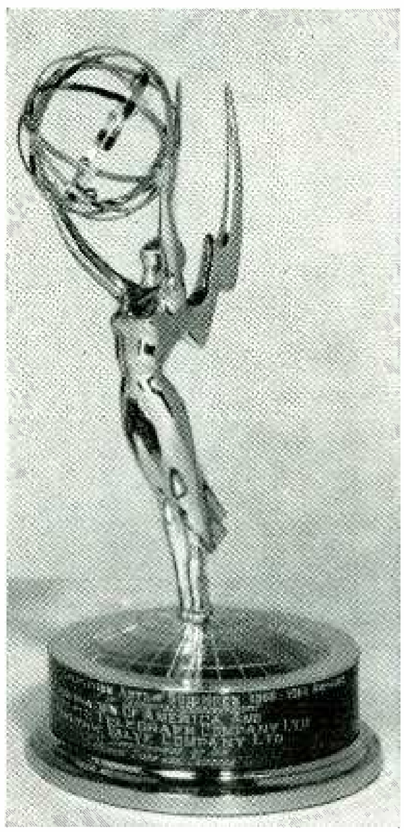
In 1937 E.M.I. added an image section to the iconoscope and the new tube had a considerable increase in sensitivity, although the problem of spurious signals still remained.

Co-incident with the image iconoscope development, the orthicon tube was being developed in the United States and so at the outbreak of war there was the iconoscope (iconoscope and emitron) and image iconoscope (super emitron) in Britain and the orthicon in America. The orthicon represented a remarkable departure from iconoscope tradition because the mosaic was scanned by a beam of low velocity electrons. Under these conditions the mosaic was driven down to approximately that of the thermal cathode and was stable at that value and so ensured a true black level.

Although spurious shading signals are almost eliminated by the use of low velocity scanning beams, the early orthicons were far from trouble free. The most serious trouble was the tendency of the mosaic to charge up positively under strong local illumination, causing loss of image, restoration of which could only be achieved by reducing the anode potential to zero for a short time, a considerable circuit inconvenience. Recent orthicons (S.C.P.C. Emitrons have overcome this defect).

The perfection of the double sided mosaic by R.C.A. during the war allowed an image section to be built on to the orthicon so increasing its sensitivity and at the same time ensuring stability.

When the television service was resumed in Britain in 1946, the iconoscope was the only working tube available but it was recognised that a considerable amount of development work would be necessary if this tube was to reach the full theoretical sensitivity possible. Theile, then of Cathodeon, indicated the direction of approach and the fruits of this development is the Riesel-iconoscope of Fernseh GMBH.



Work on the 4½″ image orthicon tube has won Marconi's and English Electric Valve a joint "Emmy" with RCA, awarded by the National Academy of Television Arts and Sciences in America.

In the United States, the end of the war saw the image orthicon firmly established and its potentialities as a high definition tube were being seriously considered in this country.

In development work on the 3″ tube The English Electric Valve Company undertook to reduce its noise, ballooning of whites, black halo around highlights, poor definition, and the inability to produce true edge transition etc.

Ballooning of whites and diffuse edges were reduced by the incorporation of a field mesh. This increased the target decelerating field of the scanning beam and prevented the displacement of the beam which gave rise to the faults. This gave considerable improvement in the picture quality. The next step was taken by Otto Schade of R.C.A. who demonstrated a 4½″ version of the 3″ tube. This allowed a larger target area, and produced considerable improvements in signal/noise ratio, resolution, true edge reproduction, black halo elimination, and grey scale reproduction.

In order to retain the optical convenience of the 3″ tube the English Electric Valve Company redesigned the electron image section which operated at higher potentials with the added advantages of higher target sensitivity and reduced picture sticking.

The used area of the photocathode in the 4½″ tube remained identical with that of the 3″ tube but also provided the possibility of using a size equal to that of the target if needed. To fill the target with the electron image from the smaller standard photocathode it was necessary to arrange in the camera a divergent magnetic field from photocathode to target in such a way that the linear photocathode dimensions were multiplied by approximately 1.5 times.

The first operational 4½″ tubes were used in Marconi Mark III cameras in the B.B.C.'s Lime Grove studio in London in 1954.

From that date the 4½″ image orthicon has been accepted in no fewer than 20 countries and is fast becoming the standard tube for quality television.

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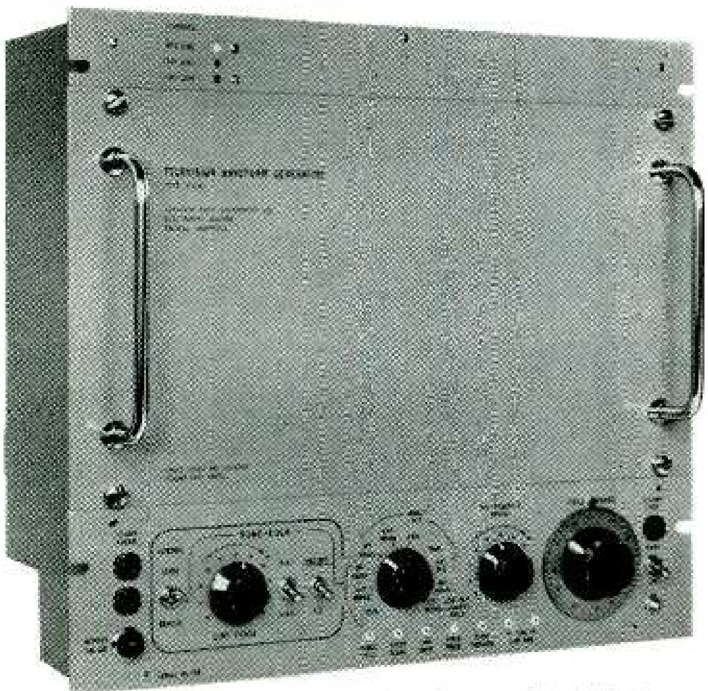
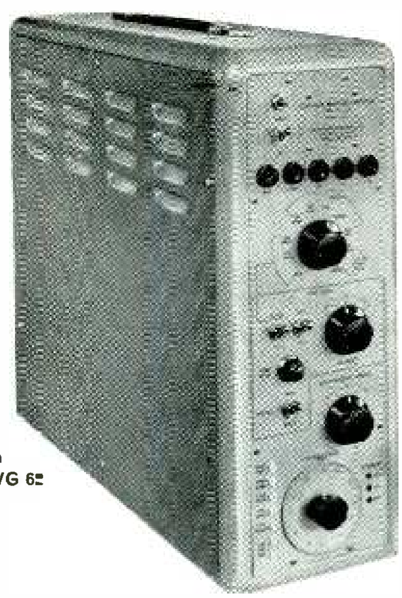


Ferguson Television Waveform Generator Type WG 61



Ferguson Portable Television Waveform Generator Type WG 62

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This equipment being fully transistorised is reliable, compact and robust.

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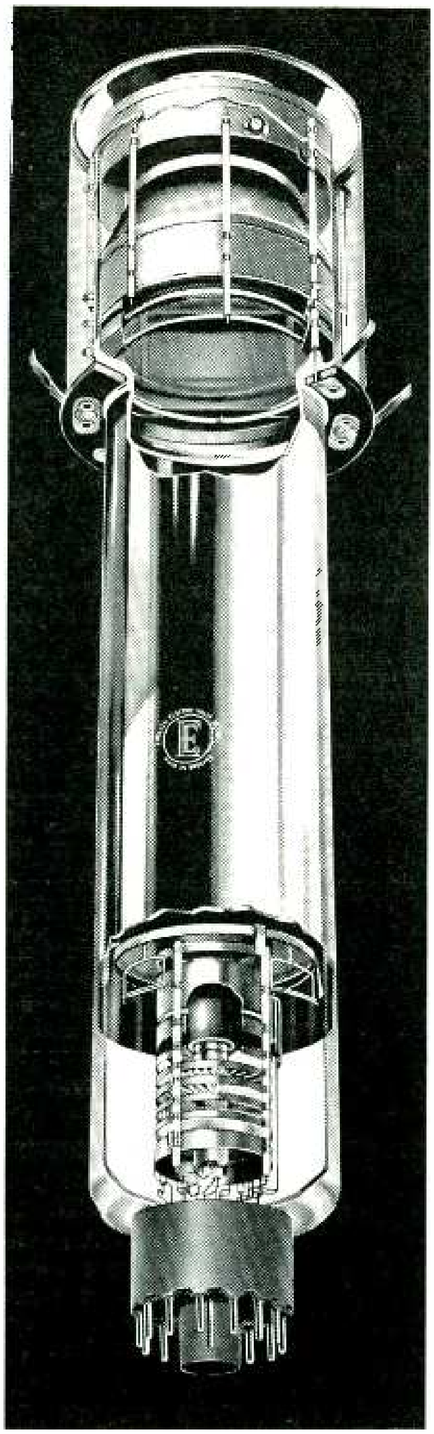
FERGUSON RADIO CORPORATION LIMITED · ELECTRONICS DIVISION

GREAT CAMBRIDGE ROAD, ENFIELD, MIDDLESEX



AROUND THE WORLD

Survey of TV Developments in the Principle Countries

IRONICALLY, television, the world's most dynamic and positive communication system, pulses a blank negative when it comes to friendly inter-communication.

Despite conventions on national level, there is little true appraisal on the part of one country of what the next is doing in the field of television broadcasting.

This is odd, because in the companion worlds of instrumentation and satellite communication there seems to be a marked, extrovert desire to brag, to 'exchange' information internationally, despite the restrictions of M.I.5, Interpol, the F.B.I. or whatever nation is concerned.

At the great 89th SMPTE Convention, held at the King Edward Sheraton, Toronto, last May, in the very full programme (which at first appeared to cover film and television techniques comprehensively) it was possible here and there to see that, so to speak, a laboratory slip was showing.

Image-forming systems, instrumentation and high-speed photography, narrow-bandwidth video tape recorders used in the Tiros satellite, optical tracking methods . . . all these subjects were dealt with scientifically. And it takes no Einstein to appreciate that these are the tools of the ballistic laboratories rather than the TV-station control room !

I stand to be corrected, but a weakness internationally of the great television chains, and of government departments controlling TV broadcasting in the different countries, is that we have too many defects in our pooling of knowledge.

We have to rely on published papers to tell us of novel video tape recording methods in Tokyo. We go through Germany and find WDR station buildings and new studio HQ going up, the very existence of which was probably unknown in many other countries. *INTERNATIONAL TV TECHNICAL REVIEW* plays its part in worldwide technical-news dissemination, and all the way from Chicago and Los Angeles to Czechoslovakia and Lima we can get the technical writers' viewpoints.

It is true that in Europe the European Broadcasting Union gives a periodic technical review of what EBU members have achieved. Many of us in the industry would like to see this extended on a world scale. There is a dearth of TV-technical information about progress in other countries.

In all modesty I have been compiling a world survey, giving an overall picture of technical progress in many countries since the War. I have relied upon personal observation (chiefly in the United States, in France, Germany and in Italy), upon the SMPTE Progress Committee, and individual probes such as the Nathan D. Golden report, the FCC Annual Report, the EBU, U.S. Office of Education, *Tekh. Kino i Televideniya*, and other sources.

The United States dwarfs the rest of the community, insofar as there are now 52,000,000 TV receivers, 88 per cent of homes have one set, and 11 per cent have more than one. TV network service is available to 488 TV broadcasting stations in 318 cities of the United States (plus hundreds of pick-up and repeater stations), and of these 14 give colour-TV services, the average colour programme time having increased to 30 hours per week by the end of last year.

It is against this truly stupendous background of technical achievement—like it or not—that the rest of the world's progress must be judged.

I will detail U.S. technical progress since the war at the conclusion of this survey, after reviewing the TV position of other nations.

AFRICA

The Federated Rhodesian territories began a TV service in November, 1960, and British groups such as Marconi's Wireless Telegraph Co. have given considerable technical aid. State approval of a TV service has not yet been given for the Union of South Africa, although big film interests such as Irene Film Studios, Pretoria, are understood to be pressure-grouping to obtain what is obviously in the public interest. Stern commercial prophets say it will be 1965 before TV comes to the Union, which will give groups such as Van Riebeeck film productions (Cape Town) ample time to develop programme channels. Technically, progress is zero.

ARGENTINE

There is a 20,000,000 public for TV in Argentina, but probably only 30 per cent could afford a receiver. A channel-7 station started working back in 1952, and through the following six years others began, all in Buenos Aires where there was the greatest density of population (more than 20 per cent of the entire nation). New stations have started operation, or are scheduled, in Mar del Plata (10,000 receivers), Rosario and Mendoza.

While there are no technical novelties from Argentina, the technical pattern is most interesting commercially. The system is 625 lines, closely following American styling, and stations work on exactly the same commercial-ad, system as in the U.S. Over 33 per cent of programmes are telecine, transmitted 25 frames p.s.

Four major TV tube and valve factories are working in Argentina, producing a total of about 500 CRT tubes per week, controlled by Sylvania, Capehart and Philips. Ampex VTR is universal at existing stations.

There are excellent film laboratories in the Argentine, notably Laboratories Alex S.A., GB Aries, and Producciones Garcia Ferre. Bulk of advertising films is handled by the mammoth Lowe Argentina S.A.I.C. There are four large sound-stages at the Sono Film studios, but most feature films used on TV are American.

AUSTRALIA

Roughly half the Australian population can now enjoy a TV service.

During the rest of 1961 and 1962, the Federal Government will be implementing Stage III of the plan first begun in Sydney and Melbourne in 1956, when Australia saw TV for the first time. The general plan has been to permit one State-operated (non-commercial) station in each State, plus two commercial stations each in Sydney, Melbourne, Brisbane and Adelaide, together with one each in Hobart and Perth. Stage III of the plan takes the service to Canberra and about a dozen remote provincial areas.

Originally Australia had reserved for herself ten VHF-TV channels. This has now been extended to 13, ranging from 45 Mc/s down to 222 Mc/s, of which some five are at present in use. Pattern of Tx and Rx design is very 'English', with 21-in. tubes, 17-in. tubes and stock British-style circuits evident. Technical novelties, nil, but Australia will be for years to come an open-air laboratory for those wishing to study service channels over remote areas, plus the added difficulty of covering such diverse country within the ether-scope of only 13 channels.

Australia has just over 10,100,000 people (much the same as Greater London) spread over 2,974,000 square miles. This is a tough TV-technical problem to solve, equally difficult economically.

CANADA

Since TV first began in Canada, it has extended through Canadian Broadcasting Corp. and other channels, so that with satellite stations and fringe coverage from U.S.-TV Tx, Canada now gets a good service. Total area to be covered is 3,851,000 sq. miles, and a population of around 18,000,000, of whom about 6,000,000 are in Ontario (Toronto), and 1.5 millions in British Columbia. There is now good TV coverage in British Columbia, as well as in Albert, Newfoundland and New Brunswick.

Programme-wise, of course Canada has a certain difficulty in that while about 6,700,000 of the population are of British races (3 million English), those of other European races number nearly as many. In fact 6,600,000 at the 1951 count. Of these, of course, nearly five million are French, and a half a million German.

Technical progress used to be guided by the Camera and Engineering Divisions of the National Film Board of Canada, and this NFB has also a technical research division which has made a number of notable contributions to the technical pool, including sound-recording techniques, magnetic recording improvements and in studio back-projection. CBC also have a TV research unit, advising the Canadian Board of Broadcast Governors. Interest technical developments also come from independent groups such as the Ecole Polytechnique de Montreal. Latest technique from the Polytechnique is Prof. Jean-Charles Bernier's device for 'reading' magnetic recording tape by entirely electronic means, without high-speed mechanisms. This is known as the Lectron, and tape at 15 in.p.s. is scanned electronically after passing it in very close proximity to a CRT.

This may open new prospects of VTR editing, for you can obtain a picture on a Lectron monitor even from a stationary tape.

FRANCE

Technicians who attended the February, 1959, International Salon of the Federation Internationale des Industries Electroniques (SDSA) at the Port de Versailles, Paris, Exhibition Park, were no doubt startled at a number of detailed French technical improvements. On the other hand it is fair to say that certain devices such as the portable CSF-TV camera were capable of further development before service use.

Progress in France is dominated to a considerable extent by the great CSF, Compagnie Générale de Télégraphie Sans Fil group. CSF equipment is in routine use with the Radiodiffusion Télévision Franchaise service. And, like the Eiffel Tower station in Paris, some 90 per cent of all French stations are equipped with transmitters and aerials built by the CSF. The CFTH (Thomson Houston) group, too, have pioneered such devices as the Vaoptron High-power Tx tube. The rival CSF group has made many technical progressions in the field of cameras and film-scanners, studio and control-room equipment, and of course the SECAM colour-TV group (financed by the Compagnie Francaise de Télévision) has also made considerable strides now that the system has been modified for FM instead of AM of the chrominance sub-carrier. As already reported in the May issue of *International TV Technical Review,* the Polonsky team developing the SECAM system have demonstrated it in Britain and the United States, and may well get French Government backing if ever the unhappy French Government can turn its attention from military politics.

It is in optics, rather than electronics, that France has been making possibly the greater contribution to our pool of knowledge, and over 90 per cent of all British TV cameras using zoom lenses get them from French laboratories.

Strangely enough, one of France's major commercial applications is in effect a rival to TV, for it is a movie-film juke box! This gadget ,the Scopitone, is developed by the CAMECA concern, and at the insertion of a coin displays one of a selection of 16-mm. continuously-running films on a sort of TV screen above this video juke box. At first I doubted if this heretic device should even be mentioned in a serious survey of technical progress!

However, as we are on the fringe of Pay-TV, who knows but that the Scopitone may soon have a TV-selection magazine instead of a choice of 16-mm. films.

France's technical difficulty is that she is at present strung to the 819-line standard. Considerable pressure has been brought to get a change to 625 lines, but a difficulty is the total of some 2,000,000 registered sets (and goodness knows how many pirates) in use, conversion of which from 819 is difficult.

BELGIUM, which for convenience can be included here, has made virtually no serious contribution to TV technical knowledge since the War. But the standard of production of high-grade equipment from such groups as Prisma, of Antwerp, is excellent. This group has done much research in connection with automatic TV receivers, monitors, TV signal generators and similar gear.

WESTERN GERMANY

Due to influx from the Soviet zone, population of Western Germany increases nightly. Basically it is some 51,000,000, and the area to be covered from the point of a TV service (including the Saarland) is approximately 95,700 sq. miles. This accounts for the present almost fantastic pace of TV construction in Western Germany, and perhaps for the comparative dearth of technical novelties. They are too busy building stations. It is fair to comment, however, that when an ABC TV (Britain) spokesman visited Germany last year, he was impressed with the fact that although some home-produced equipment was of 'Rolls-Royce' quality, production technique generally was of pre-war film pace. They were not very economical of studio-space, either, and wasted space by long run-throughs in actual studios, just as is done in film-making.

'Funktechnik' in Wetsern Germany is largely in the hands of industrial groups such as Siemens & Halske, of Munich, and the Fernseh GmbH of Darmstadt. In the past decade great progress has been made in sound reproduction, in studio accoustics and in TV-sound channel equipment generally by EMT — Elektromesstechnik Wilhelm Franz, KG, of Lahr-Schwarzwald. In fact the EMT echo machine is now becoming popular in many British TV studios, notably A-R's Wembley No. 5.

Biggest studio expansion has come, in recent years, with the stations in Stuttgart, Frankfurt and Baden-Baden. The Fernseh GmbH have done most of the electronic work here. Transistorized equipment for 625-line working is certainly up to British standards. German-designed transistor equipment is used for video distribution amplifiers and pulse generators.

True home of magnetic wire recording, Germany has in recent years been showing a lead in film telecine equipment. Fernseh developed 35-mm. suppressed-frame equipment, and also pneumatic fast pulldown equipment for 16-mm. projection. However, RCA as well as Ampex magnetic tape systems are used. Germany, by and large, has not made notable contributions to VTR techniques, but Siemens & Halske have pioneered their own standard-level generator, Wandel & Goltermann of Reutlingen designed a very precise affair for checking differential gain and phase, and the IRT, Munich group are doing new, valuable work in TV monitoring, wtih patented circuits for checking visibility of phase errors of horizontal frequency.

Several manufacturers such as Arnold & Richter and Fernseh have come together to develop the electronic system of making films, coupling an Arriflex 300 to a vidicon. This is now common practice at the Bavaria Atelier GmbH, Munich, studios, where so many German TV features and commercials are filmed.

At present there are fewer than 6,000,000 TV licences in Western Germany. The Deutsche Bundespost has a second-channel plan, which is likely to cause European international friction through the requests for more frequency channels. From Munich and Darmstadt transmitters there are experimental colour transmissions now. NTSC system was first tried in 1959, and SECAM in 1960. IRT, Munich, are pioneering their own system known as FAM, which is basically similar to SECAM, but has the colour sub-carrier modulated simultaneously in FM and AM.

Fernseh seem to have had a virtual monopoly, since 1957, of colour camera and studio equipment, and have developed a number of devices such as a colour vectorscope.

INDIA

Although an experimental transmitter has been working in Delhi, and plans are laid for another in Bombay, Indian television ought not to be dismissed as zero.

Commercially, India is ripe for exploitation in TV technicalities. Artistically, and in the production of filmed programme material, she can well hold her own. She is already one of the largest film-producing countries in the world, with some 50 studios. An enormous amount of U.S.-built equipment (notably Westrex) is going into India.

A Government agreement with the French film combine Etablissements Bauchet is helping photographic-material production. An unhappy sidelight is the relatively large number of unemployed though fully-trained electronic and film technicians in India.

ITALY

Excellent 'remotes' from Rome on the occasion of H.M. the Queen's visit to Italy and to the Pope probably startled technicians in other countries. Microwave link work was exceptionally good. The population of 51,000,000 is quite adequately covered with the Milan-Turin-Rome network, but there is a large measure of public indifference arising more from the national way of life rather than prime cost of receivers.

In studio centres there is increasing use of foreign equipment (notably Pye), and when colour TV comes to Italy the Technicolor Italiana group will be abel to cope.

All through 1959 and 1960 a long, technical legal battle was being fought out between the Italian Broadcasting Corp (RAI) and a group of would-be TV companies including Il Tempo-TV and TV Libera, which latter company had been the subject of a test-case prosecution. A constitutional court in Milan granted a monopoly to the RAI, who now has a 1962 plan to get more stations on the air, using an UHF channel. From my experience, I believe Italian TV engineers are making many detail improvements in micro-link and UHF working, but they are too busy building and working stations to write technical abstracts!

JAPAN

Niponese to the extent of 92.5-millions, crammed into islands totalling only 182,700 sq. miles, are now served —maybe you feel over-served—with no fewer than 109 TV transmitters (51 State run, 58 commercial), with eight in Tokyo and Osaka licensed to give colour-TV. NTSC system, of course, and most things based on the American outlook.

It was a shock to those who did not know of Japan's independent research when Dr. Sawazaki demonstrated his single-head video tape recording system.

And those fond of saying *"Clever devils — they can imitate anything"* had another shock when they learned that far from being a pale copy, the Sawazaki system was uniquely individual, praised in Britain, and that anyway there are *four other* magnetic video tape systems being used experimentally in Tokyo. This is perhaps no surprise to certain British electronic concerns, who regard Japan, not the U.S. nor Germany, as their most competitive rivals.

Reviewing some Japanese TV and electronic developments of the past few years, you will see that the clever devils are now originating and inspiring many avenues of development.

The Japan Broadcasting Corporation, Tokyo, runs its own research section, and a three-man team comprising physicists Mio, Kitagawa and Hiwatashi have been working on a unique slow-motion TV camera. This runs at 60 frames/sec on 16-mm. film, incorporates an automatic high-speed processing section, and transmits the slow-motion scene 1½-minutes later.

Another Tokyo TV engineer, R. S. Aha, has been working on a wideband TV switching system, capable of a bandwidth of more than 17 Mc/s. T. Ikeda has devised an ingenious technique for superimposing pulse lines on the conventional vertical scanning intervals, so that transmission characteristics of equipment can be tested during actual transmission. Harashima and H. Kojima have been doing valuable pioneer work in TV cameras illuminated by infra-red, and S. Tada has technical information which U.S. experts regarded as 'most valuable' in vertical use of vidicons.

NETHERLANDS

For religious and political reasons, the framework of TV in the Netherlands is complex, and since 1956 the NTS (Nederlandse Televisie Stichting) has a set-up comprising the various religious and political groups such as VPRO (Vrijzinnige Protestantse Radio Omroep), KRO (Kathlioeke Radio Omroep) and so on. The NTS Netherlands 12-studio centre was described in *International TV Technical Review* last September (1960) so there is no need to repeat it here; but it is odd, therefore, that SMPTE's own survey of 1960 has included no mention of Netherlands TV-technical progress. In fact this progress has been considerable.

With a total restricted time of only 22 hours' TV a week, Netherlands' discernment in choice of apparatus, and of development of it, is notable. Generally they use Pesticon (Rieselike) cameras, and flying-spot scanning is used for 35 and 16-mm. telecine. *Perforated* magnetic tape is used for film-sound, there being an interlock between the capstans driving film and tape.

For the rest of technical progress in the Netherlands, naturally this can be summed up in one word during the whole post-war period, and that one word is Philips. The Eindhoven laboratories have made valuable contributions to TC scanning systems, to wide-track sound-tape, and of course Philips have joined with the Swiss CIBA group in pioneering Eidophor projection-TV. The Philips vidicon camera chain is also widely used throughout Continental TV studios other than Germany.

NEW ZEALAND

The TV-technical progress here is quite different from that of Australia. The first public service, in Auckland, did not begin until 1959, but already a number of TV-receiver manufacturers are in operation, their output depending upon the changing import quota of CRT's, which are not yet manufactured in New Zealand. Marconi equipment is general throughout Auckland's 625-line 50-field system, and an Auckland laboratory has a 16-mm. telecine machine scheduled for manufacture, based on a New Zealand home-produced 16-mm. standard projector. Here we see no rush to work on American standards, nor to follow American technical practice, so detail improvements arising from the Auckland service and the four further Tx planned to operate by 1962, will be of importance to the British side of the industry.

SWEDEN

Gustaf VI, King of Sweden, of the Goths and the Wends—to give him his official title—recently praised the Sveridge TV system for being five years ahead of schedule, with 1-million licensed viewers out of a 7,300,000 population. The geographically-difficult country is covered by no fewer than 46 transmitters, linked with over 3,000 miles of microwave link. Although in the big-screen world the Svensk Filmindustri and the Sandrew-Ataljeerna studios have made important contributions to cinema technique, there is no major technical development in TV yet to report from Sweden, where most TV equipment is imported.

U.S.A.

During the War, the United States coined the word radar to describe the radiolocation system pioneered in Britain by Sir Robert Watson-Watt and his M.A.P. team, this British top-secret technique being given to America as part of the Tizard Mission's contribution for Reverse Lease-Lend.

At the close of the War the United States entered the Space Age without a pause, and all the big research and industrial groups, from RCA, GEC, Ampex, Eastman Kodak to Fairchild and DuMont, Photo-Sonics and dozens more have been enlisting and training technicians in instrumentation, photo-optics and space technology for new generations of Samos, Midas and Tiros missile launchings.

It is therefore all the more remarkable that the United States has reached the TV pitch outlined at the beginning of this survey, with colour-TV programmes now going out for more than 30 hours a week, and TV networking now available to 488 stations by the end of 1960.

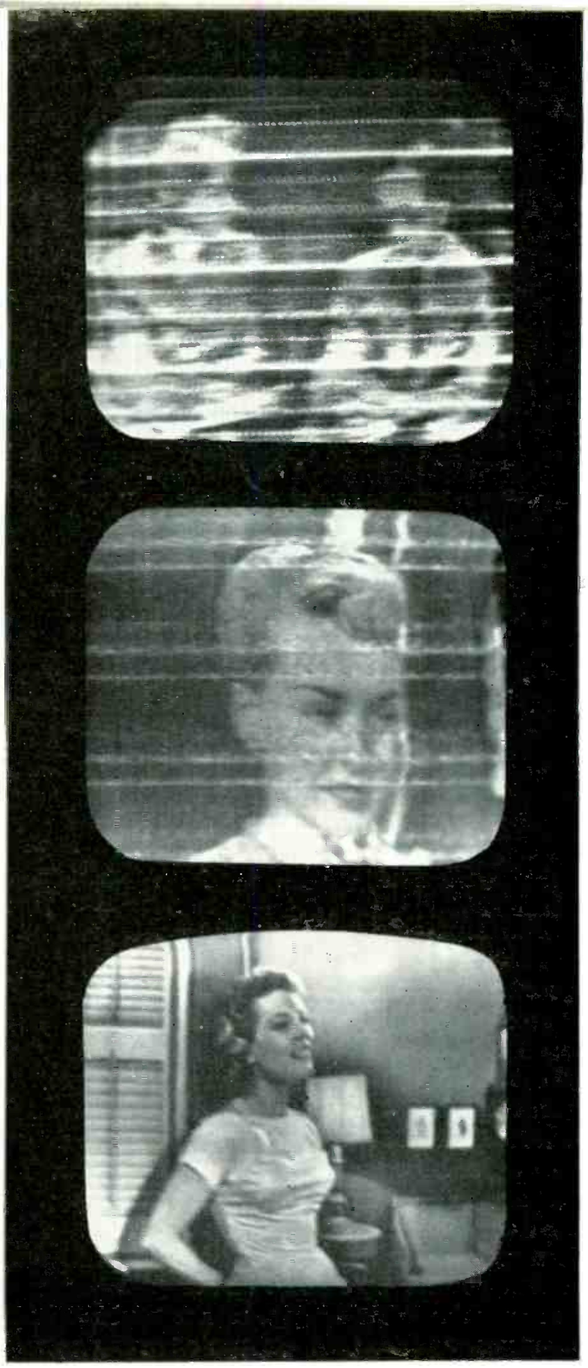
Major technical developments since the War for which the United States must take full credit are the development of colour television along NTSC, the Ampex system of Videotaping, processes for editing Video magnetic tape, such as the TV-ola and Conrac, and a battery of electronic techniques for Pay-TV, ranging from the International Telemeter Co. system, Zenith closed-circuit, Skiatron Electronics to Charge-a-Vision and Key TV, recently developed by TelePrompTer Corporation.

U.S.S.R.

Russia is, of course, the third country with a public colour-TV service, although it is limited, and the U.S.S.R. has its own version of the "Eurovision" link with other East European countries. However, knowledge in the West of Russian work in the television field is scant. But we do know there are over 100,000 cinema-theatres in the U.S.S.R., 11,000 more than last year, and well-informed technicians believe that in addition to developing the ultra-new 70-mm. wide-screen movies, bigger State-run groups like Mosfilm are able to start a plan for big-screen TV immediately the Kremlin decides this is the social order to pursue. Most Russians prefer mass-entertainment, and are conditioned to it, so there is a large potential for big-screen TV in public places.

Moreover, the Iron Curtain sometimes lifts a little between Asia, more than it does across Europe, and from technical abstracts in **Tekh. Kino i Televideniya** it is from time to time possible to glean valuable hints.

Electronic recording of a picture comes into sight. Pictures show (1) Very early videotape pictures made with the first working systems. (2) An example of the first pictures made with transverse scanning heads. (3) A typical picture made with prototype VR-1000X and FM modulation system.



PROJECT VIDEOTAPE

By Joseph Roizen
Ampex Corporation

The announcement, "This has been a Videotape Recording," is repeated several times a day in television studios from Tokyo to Helsinki. Behind this factual statement is the story of a group of men in a small company who started and completed Project Videotape.

IN 1944 Alexander M. Poniatoff founded Ampex Electric Corporation. Ampex had six employees and one small building in San Carlos, California. Its products were permanent magnet motors and solenoids for the United States armed forces. When the war ended, the company shifted their research and manufacturing to products for the peacetime boom.

Mr. Poniatoff decided that their experience and background would be a natural for the magnetic recording field. Their first new product was an audio recorder for radio stations. This unit (the model 200) proved to be of such professional quality that it had its successors (model 300, 350, 351, etc.) became the standard of the broadcast industry, used by the major networks and recording companies throughout the world.

By 1951, Ampex (whose name comes from the initials of Alexander M. Poniatoff's name and the letters ex for excellence) was well established in the manufacture of audio tape recorders and looking for other applications for magnetic tape technology. A discussion between Mr. Poniatoff and his top technical staff produced the decision to investigate the possibility of recording television signals on tape.

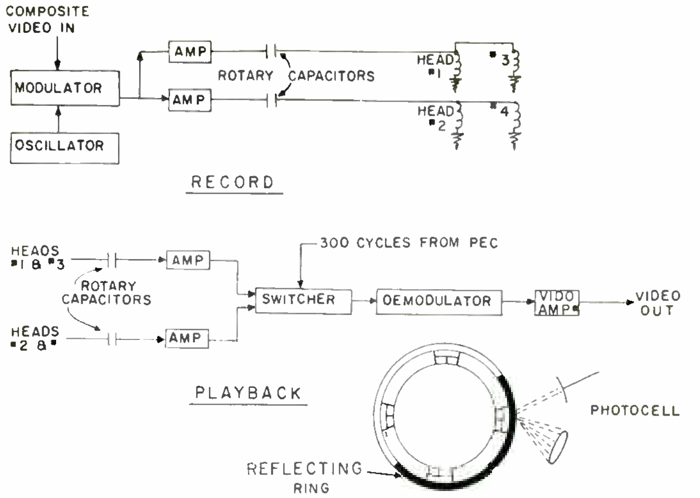
Project Videotape was authorized in December of 1951 and Charles Ginsburg joined the company to undertake it. Earlier consultations by Ampex research director, Walter Selstead, and Marvin Camras of the Armour Federation (of which Ampex was a licensee) had centred around the rotating head method, rather than high tape speed techniques and time division multiplexing systems, and Ginsburg began work on this method.

During the course of the project, the Ampex engineers were aware of other work in the area of recording television pictures on tape. RCA was able to show colour television recording on tape transports utilizing fantastic speeds. Crosby Enterprises had shown recognizable pictures in monochrome using one inch tape and multiple longitudinal tracks. In England the VERA project under Dr. Peter Axon, (now Managing Director, Ampex Great Britain Ltd. and Ampex Electronics Ltd.) used still another technique for recording and reproducing visual signals. The Japanese were working on a system known as DESSAN which employed fast tape speed and longitudinal recording tracks.

Ampex's first approach to a working system was brute force with rotating heads. In keeping with basic formula of gap width and writing speed, a few general parameters were established.

To achieve a 2½ megacycle recording the tape was to move at 30 inches per second while the head-to-tape speed would be in the neighbourhood of 2500 ips. Since there are several methods of scanning (variations of transverse, arcuate, or helical) one had to be selected. The first seemingly logical choice was the arcuate method. This consisted of three heads mounted on the flat surface of the drum scanning a two inch width of tape.

An almost recognizable picture was shown in October of 1952 and enough management enthusiasm was generated



The photograph shows five of the original group working with an arcuate head scanning system which was eventually abandoned in favour of the transverse scan arrangement. Block diagram on the right was the first of a complete system using transverse heads, modulation-demodulation and sequential switching. Unlike present machines, heads were ganged in nandem, and 300 rps used as the drum speed.

to permit the design and construction of a second system which was in operation by March of 1953. In this second system a change had been made from three to four heads in order to make use of a two-way switching system by which the output during playback of either of the two sets of diametrically opposed heads could be selected. The radius of the arc described was about 1¼ inches, giving 105 degrees of arc on the tape. An amplitude modulation system was used; the capstan motor was driven directly from the power line while the high speed drum motor was driven from the fifth harmonic line frequency (300 cps).

In this new system the pictures were now discernable, but, unfortunately, so were the flaws . . . which were later to absorb so much engineering time to eliminate. The term "venetion blind" first came into being at this stage.

At this point the project was officially shelved with the understanding that it be revived when additional study proved it advisable. Progress continued to be made with some minor time and money allotments and a few "bootleg" experiments, and in 1954 the project was again formally reactivated. Present on the project at this stage were the six people who would soon develop a prototype recorder: Charles Ginsburg, project leader, Charles Anderson, Ray Dolby, Shelby Henderson, Alex Maxey, and Fred Pfost.

First Technical Change

The first major technical changes in the project consisted of a departure from arcuate sweep to transverse scanning and the development of an AGC system to compensate for amplitude fluctuations. The departure from arcuate sweep was brought about because of two basic limitations in that method. As the arc is scanned across a moving tape, velocity components in the tape due to capstan variations have an uneven effect, producing non-linear flutter errors across the scan, maximizing at the edges of the tape. The second important consideration has to do with the geometry of successive arcs. To provide an adequate guard band between tracks at these same tape edges produces a substantially larger guard band at the centre of the track. Tape packing density is then reduced by this characteristic. To record the same amount of information that is presently recorded with transverse scan at 15 ips would require 22½ ips with arcuate scan.

The desired system called for providing at least a one-half hour continuous programme in a reasonably sized package. At 30 ips a 12½ reel of two inch wide tape provided sufficient video track density at 1 kc per inch packing to achieve this. At this stage, no modulation method was being used.

In December of 1954 the first pictures utilizing the new geometry were made. Although the results were gratifying in terms of improved stability, it took a great deal of faith and understanding to be optimistic in the face of some of the gross shortcoming in the reproduced picture.

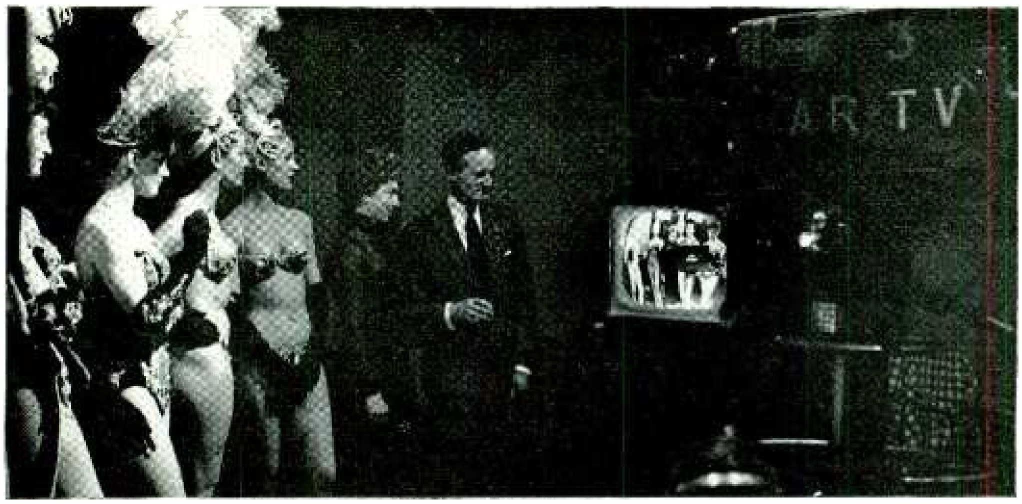
Now, to follow the path of final development of Project Videotape, it becomes necessary to divide the subsequent work into individual regions.

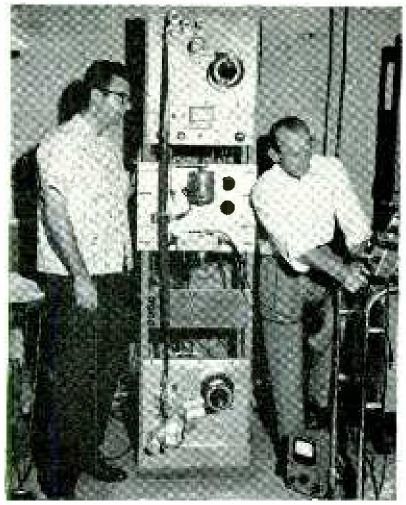
When it became apparent that an AGC system would have a difficult time with the rapidly fluctuating head signals, Charles Anderson proposed the use of a vestigal sideband FM system rather than the prevalent amplitude modulation. He had seen a reference in Fink's Television Engineering Manual to some work done by the U.S. Federal Communications Commission in conjunction with tests on vestigal sideband transmission of frequency modulated television carriers. The big question centred around the very unusual relations among carrier, deviation and modulating frequencies.

Anderson began work on the new system on January 2, 1955, and early in February the first FM picture off tape was reproduced. The method used was a conventional reactance tube technique, heterodyning the sidebands from the 50 mc region down to frequencies suitable for reproduction from tape and subsequently moving the information on playback up to about 50 mc for limiting and detection.

The circuit complexity of this system at that time led to the development by Ray Dolby of a much simpler, free-running multivibrator, the frequency of which could be modulated by the composite video signal. It is ironic that further progress in the signal system has been hampered by the limitation of the multi-vibrator modulator, which has caused a return to the heterodyne method in present day machines.

On March 2, 1955, a very convincing demonstration





Left: The first closed circuit demonstration of a VR-1000A recorder abroad being given in May 1958, at Associated-Rediffusion Limited in London. Right: Alex Maxey and Kurt Machein are shown with the first one-headed "hoo ha". The tape is four inches wide and is shaped into an overlapping tube. The single scanning head inside the female guide is belt driven by an external motor.

was given for the Ampex Board of Directors. Picture resolution was extremely low as the system was somewhat less than 1.5 mc wide. The monitor had to be operated with a short time constant in the horizontal AFC because of velocity variations in the head drum, which was, at that time, belt driven.

On February 4, 1952, two days after his last final examination at the University of California, Fred Pfost had joined Ampex as an electronics engineer. By 1954 he had become very interested in head design and, feeling that he had some new ideas on head design, began work on construction of the first video head assemblies.

There were many problems with heads at this time even though there was no attempt at duplicating heads. It was assumed that some simple jigs, ferrite, mu metal, epoxy, and elbow grease comprised the full complement of ingredients needed. However, it was found that new heads would simply not stay together when subjected to high centrifugal force, and new methods and designs had to be evolved to meet the electrical and mechanical requirements of this critical item.

Fred Pfost's ceaseless experimenting and high creativity produced the original design for the four-headed assembly now in universal use. Early transverse heads had consisted of a drum composed of two halves. One half contained the four ferrite cores and their windings, while the other half was slotted to accept the alphenol tips which projected beyond the drum periphery and formed the writing gap. When the two halves were bolted together, the alphenol tips lay over the ferrite core and, in effect, were extensions of the magnetic field produced by the core windings.

These heads were originally operated by belt-drive from stationary motors. Further experimental work showed the advisibility of combining the motor with the head drum assembly and the head drum itself was altered to a single piece of brass with machined cavities into which the "dime assembly" of the ferrite core and the alphenol tips were epoxied.

Important Discovery

In February of 1955, Alex Maxey had some after hours experimenting and had discovered some very significant phenomena connected with the characteristics of pictures reproduced by tape. He discovered that the amount of information read out during playback by each of the heads per unit of arc sweep could definitely be controlled by varying the tape tension. There are three ways of doing this, and the final one selected resulted in the female vacuum guide approach.

The tape is held in an arc concentric with the periphery of the drum by guide assembly with two grooves connected to a vacuum. At the point of head contact with the tape a third groove behind the tape provides sufficient clearance so that the head can penetrate the tape adequately.

Alex Maxey, who had started on the programme in August of 1954, was primarily concerned with the mechanics of the top plate and some ideas on servo mechanisms. Although he first tried running the tape with a vacuum male guide near the head assembly, he quickly realized the advantage of a moveable female guide . . . and this technique of varying tape tension proved to be one of the major breakthroughs in the programme. It proved an excellent solution of the problem of information rate changing if the heads wore down to a smaller radius and it gave an answer to a great part of the question of ultimate interchangeability of recorded tape.

Key Figure

In 1952, Ray Dolby, who was then a 19-year-old student engineer with no formal training, became involved in some of the electronic development on the project. His technical understanding and ingenuity made him a key figure and he was responsible for some of the specialized electronics which were developed as the project progressed. The multivibrator modulator, the processing amplifier, and parts of the servo system were the products of his fertile imagination.

The 1955 demonstration to the Board of Directors convinced the then General Manager of the Audio Division, Phillip L. Gundy, that the project should be given greater priority. He moved it to isolated quarters with five times as much space as before and kept it behind locked doors. The objective for the project was assigned. It was to have a system suitable for public demonstration ready within one year.

The various problems were being attached in a more orderly fashion. Each element of the final machine was evaluated and improved. An entirely new head development programme was carried out by Fred Pfost. Improvements were made in resolution, in signal-to-noise, and in time base stability. The unit was removed from its crude wooden cabinet and placed in the now familiar console and rack arrangement.

By 1956, the project was ready for demonstration. Some 30 people, including Ampex management group were invited to view the unit. The machine first played back a previously recorded tape. It was then announced that a recording would be made and played back immediately. After two minutes of recording, the tape was rewound and the play button depressed. As the picture appeared on the monitor, the group who were completely silent up to this point, rose and gave a standing ovation to the assembled engineers.

The next few weeks saw a procession of distinguished visitors, including William Lodge of CBS, Frank Marks of ABC, and Sir Harold Bishop of the BBC. Visitors were sworn to secrecy and brought in separately so they would not encounter each other. Plans were made to produce a Mark IV machine which would be shown at the National Association of Broadcasters show in Chicago that year.

Several technical improvements were made in this unit. These included the blanking switcher, which had the head switching transients in the horizontal blanking interval, and an automatic degaussing system for the rotary heads. As is customary with the crash programmes involved in getting equipment ready for exhibition, there were weeks of extended working hours and seemingly insurmountable technical bugs.

The machine was finally assembled and shown in Chicago. Ampex was flooded with orders for some four-and-a-half million dollars. Included among the units were sixteen units to be hand-built for broadcasters who had an immediate on-the-air requirement. Work started on these units at the same time that full-scale production of a standard unit was begun. A prototype VRX-1000 went on the air for the first time on November 30th, 1956, from CBS Television City in Los Angeles; NBC and ABC followed suit in early 1957.

Problem had to be solved

These early hand-built prototypes were unique in that tapes recorded on one could not be played back on another without using the same set of heads. It was necessary to store or ship individual heads with a tape. Although this was not a serious problem for the early use of the recorders . . . time delay for the different U.S. time zones . . . it was obvious that the interchangeability problem must be solved in a production recorder.

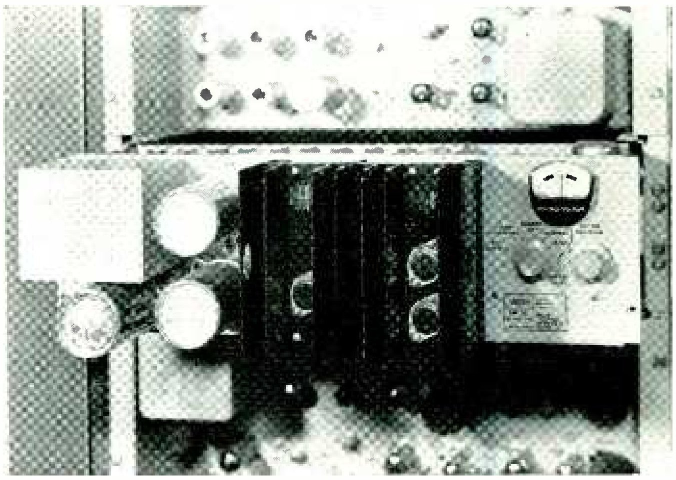
Kurt Machein was assigned as project engineer for the production VR-1000. His group was faced with the major problem of turning what was essentially a hand-built prototype into a practical, simple-to-operate device. During the interim period between the hand-built building of the VRXs and the first production unit, there were several new contributions made by his team. Two of the major contributions were in the area of splicing and electronic correction of skewing.

These two problems were arousing considerable discussion. It was claimed that the likelihood of being able to splice an invisible image with a track-to-track spacing of only .005 inch seemed quite remote. It was also claimed that the required manual correction for skewing, the most common geometric error, would require the constant supervision of the machine by an operator.

The splicing problem was solved by the development of a system which put magnetic impulses on the edge of the tape which could be used for visual alignment of the frame ends so that a mechanical splice could be made. The first splicer given with each machine consisted of a simple metal block in which the tape ends could be aligned for cutting with a straight edge and a razor blade. In this fashion adequate, if tedious, splices could be made. Eventually a mechanical device was designed which utilized these visualized magnetic marks to simultaneously cut both tapes and hold them in position while the splicing patch was applied.

The second problem that of non-manual correction of skewing was overcome by a unusual electronic device. This unit measured the time displacement in relation to an average of the start of each horizontal television line and controlled a servo mechanism which positioned the female guide until error was minimized. This system was capable of detecting and correcting for errors in the order of .05 microseconds.

Although the rotating head unit had been accepted by



Amtex, one of the newest developments from Ampex, has just been introduced in Britain. By sampling timing accuracy once in every hoizontal interval it accomplishes line-by-line compensation of timing errors in composite video signals. In this way it eliminates geometric distortion of recorded television pictures such as skewing quadrature and phase modulation.

the industry and the plant was gearing itself for production of that unit, there was by no means total agreement among the engineers on the project that the best possible system had evolved. Alex Maxey had begun work on a totally different system utilizing four-inch-wide tape in which the width of the tape was formed into an overlapping tube in a female guide and scanned by a single belt-driven head. This unit was given the title of "the one-headed hoo-ha". It was followed by at least six versions of single-headed helical scan machines that eventually resulted in the VR-8000 recorder, introduced by Ampex early in 1961.

The major engineering effort, however, was concerned with the refinement and production of the four-headed recorder.

Kurt Machein took responsibility for two main objectives in the production programme. The first was to complete the engineering programme for the production unit; the second was to ensure that a cadre of well-trained engineers was available when the television recorders began operation.

With characteristic thoroughness, attention to technical details, and accurate assessment of auxiliary needs, Kurt Machein directed the engineering programme to its optimistic time schedule. The first production VR-1000 was delivered to KING-TV in Seattle, Oregon, in November 1957.

Ready along with the first video recorder, was a well-trained group of engineers available to tackle the service problems that were anticipated for this new unit. Kurt Machein had realized that the video recorder was unlike standard television broadcast equipment in that it combines in one package both electronic and mechanical devices involving some extremely complicated servo mechanisms. He had begun the recruiting of television engineers from the broadcast industry to be specially trained in the new systems. He had also developed training courses for competent technicians within the company.

These new service engineers were ready for problems and they found them. Ampex was soon involved in some highly interesting and sometimes humorous field engineering.

A new technical slang came into being, fostered by the geometric distortions that a "nervous" television recorder was inserting into the pipe line between the picture source and the home viewer. Along with the more common terms used such as skewing, scalloping, and quadrature, there appeared such non-Websterian words as maidenhair, sunflower effect, head hunting, waterfall, and jitter. Ampex engineers well remember the plaintive cry for help by a CBS executive with the pointed telegram saying, "the natives are restless tonight." All knew that he meant that head-hunting had become severe. This term described a side-to-side oscillation of the picture on the receiver screen brought about by pendulum action in an improperly damped head assembly.

Great Debates

Great technical debates raged throughout the industry over methods of measurement which would either prove or disprove the rotating mechanism's adherence to FCC stability standards which had been established for electrically generated signals. The introduction of a mechanically driven transducer into the television system complicated the interpretation of these standards. It was necessary for the Ampex device to meet these standards and, after some work, it did.

Slowly, through field trials and customer reports, the deficiencies of the system became apparent and corrective steps to improve manufacturing methods were taken. The precision required in the mechanical assembly of the head structure was especially stringent, and great precautions in the handling of bearings and other strategic components proved to be the solution to many problems.

The VR-1000 was becoming the work horse of delayed programming and with this as an established fact, its entrance into the television programme production field became obvious.

The author gratefully acknowledges the assistance of Charles Ginsburg in making available his files, his memory, and his experience towards the preparation of this article.

Special thanks are also given to Harold Lindsay, Charles Anderson, Alex Maxey, Fred Pfost, and Kurt Machein for their generous help.

To all others who were instrumental in the development and operational use of the Videotape Television Recorder, the author offers his thanks, and hopes that they have enjoyed their participation in the area of television recording as much as he has.

NEW ADVANCES IN OPTICS REVIEWED BY G. R. COOK

Taylor, Taylor and Hobson's Varotal 3 zoom lens, the only one of its kind in the world with a focal range of 4 inches 40 inches, was recently shown to the Russians at the British Trade Fair in Moscow. Picture shows a stage during the assembly; the magnified eye belongs to a technician at the company's Leicester works, who is scrutinising part of the mechanism on assembly.

GIANT STRIDES IN DEVELOPMENT OF THE TELEVISION ZOOM LENS

Electronic computers have speeded progress in the design of highly-complex lenses with variable focal length enabling the many situations exactly the right picture area to be captured without movement of the camera. The significance of this development can be seen in most TV outside broadcasts and zoom lenses also increases the flexibility of studio production.

THE latest television camera lenses in use illustrate some of the progress in optical science that has taken place in recent years. Extrapolation from previous history certainly indicates that significant improvements should have been achieved but the present rate of advancement has been greatly accelerated by a number of new factors affecting both the design and manufacture of optical systems.

One of the most important new factors is the availability of electronic computers for optical design and research. The development of a finished lens design requires an enormous amount of calculation. When this had to be done by hand, using tables of logarithms or desk calculating machines, it was not always possible to explore the full capabilities of a design concept because of the large amount of calculation that was needed. With electronic computers the computational processes can be made with greater ease and at a considerably increased speed. For example, it would take about ten minutes to trace a single ray of light through one of the surfaces of a complex lens system by the old methods, whereas the same process takes about one second using an electronic computer.

The extent of the evaluation that is now possible permits an adequate assessment of performance to be made at the design stage thus avoiding delays and cost of making prototype lenses for test purposes. The increased speed of operation also enables the lens designer to develop a number of alternative constructions before choosing the best for his particular purpose.

Electronic computers also have features which can be used to provide a degree of automatic design at some stages of development thus leaving the lens designer more time to devote to more fundamental aspects of lens research.

In this way the general standard of lens performance is being raised and lenses based on fairly old types of constructions now yield results which would have been considered quite impossible at the time that they were first introduced. Entirely new constructions have also been produced to meet the demands for more extreme specifications.

Another new factor has been the introduction of new types of glass having unusual optical properties. These offered an immediate opportunity to improve the capabilities of existing types of lens constructions and a considerable amount of useful work took place extending the scope of these older lens forms.

This difference between the use of a new material or a new technique for the improvement of an existing lens and its eventual use in a more fundamental and more useful way is also illustrated by the advantages to be gained from the surface treatment or coating of polished glass surfaces. This is the so-called "blooming" of lenses which reduces the amount of light reflected from each surface in a lens thus

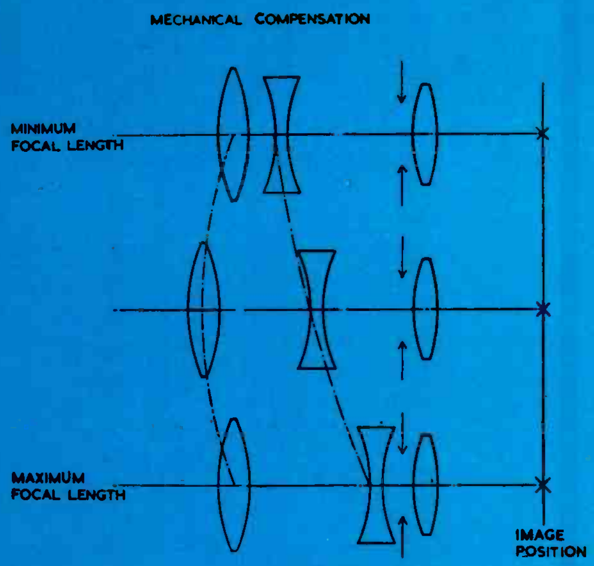


FIGURE 1.

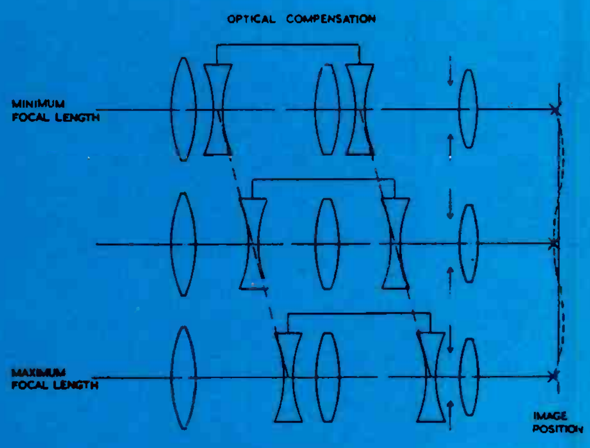


FIGURE 2.

improving the contrast of the image and increasing light transmission.

The first applications of this technique were to improve existing lenses. At this stage it had little or no effect on the type of lenses that were being designed. In later years, however, it was recognized that it was no longer necessary to pay so much regard to the shape and the number of surfaces within a lens with the result that the designer had a very welcome increased freedom of action which helped to ease the problems of aberration correction. Many of the modern lens constructions now in use are only practicable through the advantages to be gained by this technique.

More recently these improved design techniques and the development of new manufacturing processes have been directed towards the use of polished glass surfaces which are not spherical in shape. The polished surfaces within a photographic lens system have to be made extremely accurately. The departures from the shape of surface specified by optical design have to be held to very small tolerances which are often measured in terms of a few millionths of an inch. Conventional manufacturing techniques are only capable of this order of accuracy when the surface is part of a sphere because such surfaces tend to be self-generating when one spherical surface slides in all directions on another.

It has been known for many years that this restriction to spherical surfaces sets a severe limitation to the designer's freedom of action. Although optical aberrations can be brought under closer control as the number of constructional variables is increased, there is a practical limitation to the number of components that can be incorporated.

Non-spherical surfaces not only give the designer the extra variables that he needs, but also permit the achievement of results which otherwise are impossible or impracticable.

Although highly specialised optical systems containing such surfaces have been made in the past, their manufacture has been based on empirical methods not suited to mass production at economic costs.

In an attempt to overcome these limitations, research commenced immediately after the war, to find methods which would enable varying types of non-spherical surface to be made under production conditions to the required precision. With the company concerned this has involved a capital expenditure of nearly £200,000 and some of the processes developed have only just been brought to a production level.

These surfaces can now be made at the required degree of accuracy and at a cost which has a negligible effect on purchase price.

The use of electronic computers solved many of the design problems which previously tended to slow down progress on these lines and this ability to both design and manufacture such surfaces almost as easily as spherical surfaces has already produced some outstanding results and will continue to be an important factor in future developments. It offers particularly useful advantages in camera objectives covering very wide angular fields of view and in zoom lenses.

The advantages obtained from the use of zoom camera lenses are by now well recognised and this type of lens has become an essential requirement for television where continuity of presentation to the viewer sets operational demands which differ from those experienced in cinematography.

At the present time zoom lenses are required to give a high standard of performance and television has progressed beyond the point where novelty of zoom specification is the only feature of importance. They are now expected to reach standards of definition which compare favourably with those of the normal fixed lenses that they are intended to replace.

The successful design of a higher quality zoom lens involves the solution of optical and mechanical problems which are considerably more difficult and more numerous than those arising in connection with normal types of lenses. The correction of all the optical abehations must be well maintained throughout variation of focal length over a wide range and the plane of best image definition must remain in a fixed position relative to the camera.

Although the optical construction of zoom lenses varies to a considerable extent, they may be classified into two distinct types. In the first category the relationship between the movements of lens components is non-linear, and this demands the use of complicated cam mechanisms or their equivalents. There are at least one non-linear and at least two moving components. Lenses based on these principles may be classified broadly as relying on mechanical compensation for image shift. A typical example of this first type is shown in Figure 1. Movement of the middle component

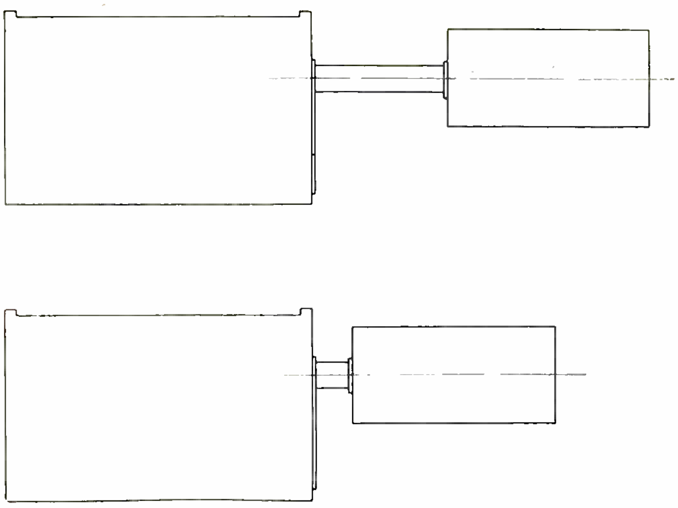


FIGURE 3.

can be considered as producing change of focal length, whilst the movement of the front component maintains the image plane in a fixed position relative to the stationary rear component. If the non-linear cam mechanism is well made, there is no image shift in mechanically compensated systems.

In the second category the relationship between the movements of components is a very simple one, and no non-linear mechanism is required. By adopting a sequence of alternate stationary and moveable components, a degree of optical compensation for image shift can be achieved, and this type of system is classified broadly as relying on optical compensation. Figure 2 shows a simple example of optical compensation in which the powers and positions of the components are chosen in such a way that the two movements can be identical and they may then be linked together mechanically as a single linear movement.

All systems of this second type provide exact compensation for image shift at only a number of points in the range of focal lengths, leaving small, but sometimes very significant, errors of focus at intermediate points. The magnitude of these errors of focus is dependent on the number of points in the focal range at which the image position is constant, and the number of such points can only be increased by adding extra moving components to the system. The residual errors of focus are proportional to focal length, and although it may be argued that they can be held within the depth of focus of small and short focal length zoom lenses covering small picture formats, the errors become very significant in the large zoom lenses which cover the Image Orthicon format, and which have the ranges of long focal length required for outside television broadcasts.

Both types have been used successfully in American and European television during the last few years and the failure of one to supersede the other confirms the opinion that mechanical compensation offers attractive optical advantages provided they are not offset by the presence of errors of movement arising from inefficient mechanical construction. Extensive use of mechanically compensated zoom lenses in outside broadcasting has established the fact that, in their range of focal lengths, they can yield at full aperture an optical performance which compares favourably with that of any normal lens. The most important characteristics which differ from those of optically compensating systems arise from the fact that the fundamental arrangement of individual components is more simple and occupies less space. This permits the use of complex optical constructions for each member while the overall complexity and size of the complete system is maintained at a practical level. The more complex components allow all aberations to be held within unusually small tolerances under varying conditions of use. Efficient design and manufacture overcome mechanical difficulties which, it is alleged, have hitherto limited the performance and usefulness of this type of zoom system.

Present-day techniques are such that the ideal specification for a zoom lens to be used in the studio can be defined quite clearly, and the full requirement can often be met by a single zoom lens having the desired range of focal lengths.

For outside broadcasting, however, an extremely wide range of focal lengths is required, and at the present stage of optical knowledge there is no possibility of providing this with a single zoom lens. The best possible solution has been to provide a basic optical system having a fixed ratio between maximum and minimum focal length and to change the numerical value of the range by the interchange of one of its optical components with another.

Figure 3 shows the type of operational difficulty that arises in this procedure. The arrangement at the top of the figure shows a lens and camera combination where the lens has its minimum numerical range of focal lengths. The diagram at the bottom shows the effects of an interchange of component to yield a range of longer focal lengths.

The main body of the lens now occupies a different position relative to the camera and a new set-up procedure has been necessary to find the one position of the Image Orthicon tube to suit the single focal plane position of the lens at which true zoom characteristics are maintained.

It must be remembered that zoom lenses suitable for outside broadcasts are necessarily large and heavy, and this interchange of components takes some apperciable time. It is therefore rarely attempted within the duration of a televised event.

A minimum limit to size and weight is set by specification alone. If a lens is to hold its relative aperture of about f/4.0 up to a maximum focal length of 500 m/m's. or an aperture of f/8.0 up to 1,000 m/m's. focal length, the diameter of the front component cannot be less than 125 m/m. and the overall length of the system will be in proportion.

The zoom lens whose description follows and the optical construction of which is shown in Figure 4, has been designed to meet, as far as possible, the specialised requirements of outside broadcasts. It has been named Varotal III and is intended for Image Orthicon Cameras with a 40 m/m. picture format diagonal.

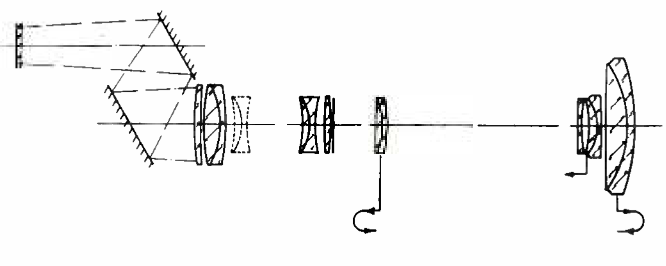


FIGURE 4.

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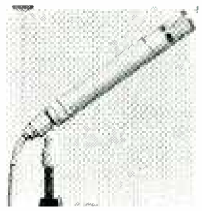

C 28 A

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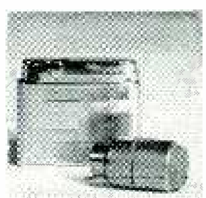

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In order to take full advantage of the higher standards of definition which are now possible, the principle of mechanical compensation for image shift has been adopted and the position of the focal plane is constant throughout the focal range.

The optical construction chosen is the one which permits the most compact arrangement for the zoom section, and by utilizing three moving components in this part of the lens, a number of further advantages are gained. These are:

1. The large movement of the second component can be made linear while fulfilling the ideal operational requirement that change of focal length should be logarithmic with respect to linear movement of the zoom control lever.
2. The non-linear movement of the first and third components can be equal and opposite in direction. This enables one component to act as a counterweight to the other so that the force required to drive the lens is no greater when it is inclined at a steep angle than when it is horizontal.
3. The use of three moving components gives a much better control over the correction of optical aberrations at all positions in the focal range and so gives improved standards of performance.

For a considerable period of time, resolving power was assumed to be a useful criterion for lens performance but this is not the only factor limiting the information-carrying capacity of an optical system. In some circumstances higher resolving power, that is the ability to record very fine detail, may certainly be required. In other conditions, however, high resolution may not be present in the structure of the object being viewed or it may not fall within the information-carrying capacity of the complete system comprising camera, processing and viewing means. In such cases definition or the sharpness of single boundaries in the image becomes of greater importance than resolution.

In the absence of knowledge regarding the magnitude of the optical aberrations present in a lens, the user often assumes that the departures from perfection are small and that a high merit rating for resolution implies a high rating for sharpness. With most camera lenses this is not a valid assumption and resolution and sharpness must be considered as two distinctly different aspects of lens performance.

In cases where the existing level of resolving power is considered to be adequate it is held at about this level whilst the new techniques are concentrated on improving image quality with respect to definition and contrast, colour correction and the provision of a more uniform illumination throughout the picture format. These are significant improvements which are seen subjectively as better picture quality but which are not always revealed by test procedures based solely on the resolving power criterion.

This is particularly the case in television where the limited information-carrying capacity of the transmission channel sets such a severe limit to the resolution transmitted that almost any lens judged by its resolving power alone might appear perfectly adequate for the purpose.

New design and evaluation techniques have been adopted for the special and well-defined conditions arising in television and these show quite clearly that the requirements for definition, sharpness and contrast are quite as high as those in any application of photography.

Many workers in the field of television optics have contributed to this clearer understanding of television lens requirements and arguments that any lens is good enough for television are now discredited.

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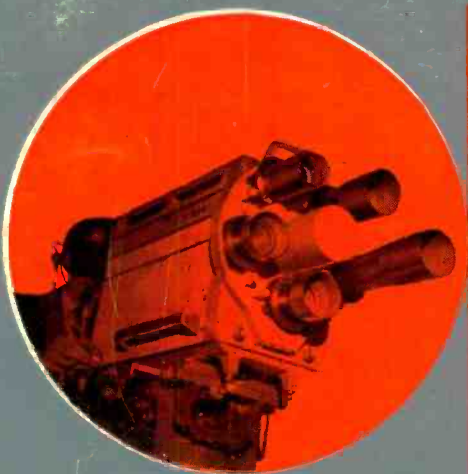

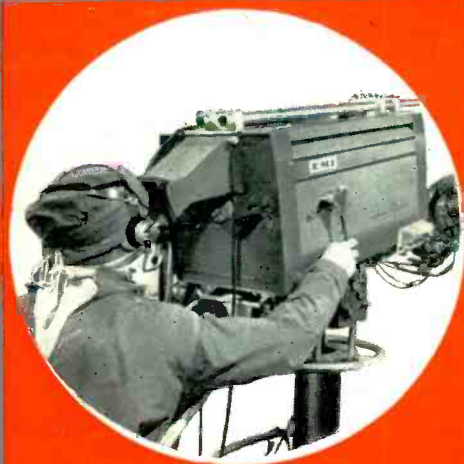

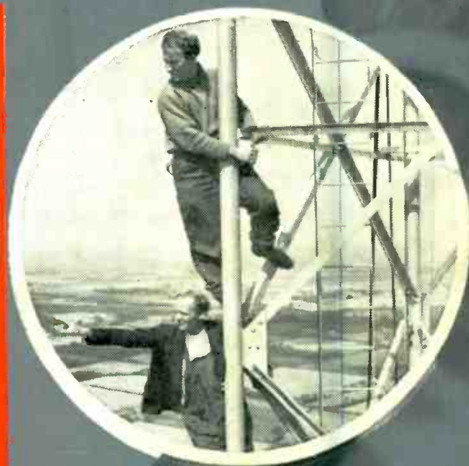

1. 1,000 ft up on the Mendlesham TV Aerial Mast, tallest in the Commonwealth, supplied to ITA by EMI Electronics.

2. EMI Type 204 Colour TV Camera Channel, in use at Hammersmith Hospital.

3. EMI Type 203 4½" Image Orthicon Camera, as supplied to BBC, Commercial TV and overseas authorities.

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