ENGINEERING TRAINING SUPPLEMENT

No. 2

1. FUNDAMENTALS OF TELEVISION

BY

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

2. GLOSSARY OF TELEVISION TERMS

BRITISH BROADCASTING CORPORATION

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PREFACE

This supplement is divided into two sections ; the first is an introduction to Television principles specially written for those with no previous knowledge of the subject, and the second is a Glossary of Television terms used in the BBC Television Service.

Section I is an extract from the Television Instruction Book prepared by D. C. Birkinshaw, Superintendent Engineer (Television), and a copy of this book, which contains a full description of the London Television Station, is available for reference at every transmitting station or studio centre.

The Glossary (Section 2) contains a number of definitions extracted from British Standard 204 : 1943, *Glossary of Terms used in Telecommunication.** Reference has also been made to Chambers's Technical Dictionary, 1944.

*Obtainable from British Standards Institution, 28, Victoria Street, London, S. W.1. Price 3s. 6d. post free.

1. THE FUNDAMENTALS OF TELEVISION

The moving finger writes, and having writ moves on,
Nor all thy piety nor wit
Shall lure it back to cancel half a line
Nor all thy tears wash out a word of it.
Omar Khayyám.

General

Television is the art of seeing from a distance, almost instantaneously, a scene which is so situated, by virtue of its remoteness or position, that it cannot be viewed by optical means.

It is essential at the outset to determine what is implied by the term 'Scene' from a technical standpoint. Fundamentally, a scene may be described as an area from which light is travelling to the eye. It may be regarded as being composed of a very large number of infinitely small subareas known as elements. If each element is sending the same amount of light to the eye, the scene is said to be blank and has no pictorial interest, but if there is considerable variation between the amount of light proceeding from the various elements, then the scene possesses detail, and conveys intelligence to the eye of the observer. It is the function of a television system to transmit this intelligence to a distant point, and reconstitute there an image or picture which will send to the eye of an observer substantially the same intelligence as he would receive if he were standing in front of the original scene.

Some connecting link is required between the sending point and the receiving point, and two types of such connecting links are known, both electrical in their operation, these being radio transmission and cable transmission. In each case the intelligence is represented during the course of transmission by an electric current; we can now say, therefore, that we must provide at the sending end transmitting apparatus to transform the intelligence contained in the radiation of light by the numerous elements of the scene into electrical intelligence: the connecting radio or cable link will then reproduce that electrical intelligence at the receiving point, where we must provide further apparatus to transform it back into a luminous picture.

It is in this process of transformation at each end that a fundamental difficulty arises. The electric current in the connecting link can be completely specified by stating its amplitude at any instant of time. In other words, we only need to employ two dimensions, time and amplitude, in order to describe the current completely.

On the other hand, two dimensions are insufficient to describe a picture. They are sufficient to describe a blank scene, because we can specify it

completely by saying that it has a certain degree of brightness at a certain time. It follows, therefore, that a normal communication channel can be used with the simplest of transformation apparatus at each end to transmit the intelligence contained in a blank scene whose brightness is varying, because obviously, we can arrange that variations in brightness will be represented in the communication channel by variations in the amplitude of the current.

A picture, however, is more elaborate than a blank scene because it contains detail, and in order to describe a picture completely we need three dimensions: time, amplitude and position, the additional dimension of position being necessary in order that our description may cover the various items of detail located in various parts of the picture. The communication channel is unable to transmit such a picture directly, since owing to the absence of a third dimension or variable there is no property of the communication channel which we can utilise to convey information as regards the detail. The most the channel can do is to average out the brightness of all details in the picture, and reproduce it as a blank scene having a certain value of brightness. This difficulty may be made clear by employing an analogy.

Suppose that the scene to be transmitted is the page of a book, and that the communication channel is a telephone: imagine that a man A at the sending end wishes to represent the page to a man B at the receiving end, so that the latter can reproduce the page on a sheet of paper in exactly the same form as the original page. We know that the man A cannot send the whole of the intelligence contained in the page to B instantaneously, because the natural properties of the communication channel, consisting of the two men and their telephone system, are insufficient; but, if A reads out the words in order line by line, he can eventually transmit to B the whole of the intelligence in the page. In fundamental terms, what A is doing is to reduce the three dimensions which describe the intelligence of the page to two, in order that they may suit the communication channel.

The television system operates in a manner precisely similar to the above analogy. It examines the picture element by element, and in fact "reads it out" to the receiver, which then assembles the received intelligence in the correct order and reconstitutes the picture. The process by which the picture is examined is known as scanning.

Scanning

In practice the scanning of the original scene is very similar to the process of reading a book, since the scene is scanned in horizontal lines beginning at the top left-hand corner and ending with the bottom right-hand corner. The total assembly of lines employed to scan the full area of the scene is known as a field, and in order that transmission may be continuous, the scanning of the scene is regularly repeated, an agreed number of fields per second being successively transmitted. If the number of fields per second is more than a certain minimum figure, the eye of the observer at

the receiving end, assisted by its natural property of persistence of vision, receives the impression of continuous transmission, and the reproduction of action and movement in the original scene becomes possible.

Synchronising Signals

Returning to our analogy of the two men on the telephone, if A reads out the page of the book to B, then unless B is told how to arrange the words, he will not necessarily reproduce the page in the same form as A sees it. He may arrange the words in too few lines, or too many lines, or he might even write them out in a single but very long line. To get over this difficulty, A must clearly insert additional information at intervals to enable B to arrange his words properly. At the end of each line he must say " Begin a new line," and if more than one page is to be read, at the end of each page he must say " Begin a new page." He must, in fact, synchronise the writing of B with his own reading. We may, in fact, describe the standard phrase " Begin a new line," which is spoken at the end of each line, as the line synchronising signal, and the phrase " Begin a new page " as the page synchronising signal.

An exactly similar state of affairs exists in a television system. At the end of the scanning of each line, the scanning process is momentarily interrupted and a line synchronising signal is sent to the receiver to tell it to begin a new line, and at the end of each field or picture which corresponds, of course, to the end of a page in our analogy, a picture synchronising signal, differing in character from the line synchronising signal, is sent to the receiver to tell it to begin a new picture.

We have now established that it is necessary in a television system to transmit two sets of signals from the sending to the receiving end : the vision signals, which will carry the intelligence corresponding to the brightness and detail of the picture, and the synchronising signals, which will tell the receiver how to reconstitute the picture so that all the various details take up their correct position. Now since these two sets of signals have separate functions to perform at the receiver, they must be effectively transmitted as separate entities, each signal retaining its own individuality. Fundamentally, this calls for two separate transmission channels, but this is an uneconomic solution to the problem, and it would be preferable to transmit both signals on one channel. Since the vision and synchronising signals have characteristics in common, they cannot be mixed in a straightforward way but must be combined in a manner which will allow their separation in the receiver. We shall see later how this can be achieved.

D.C. Waveform

If we consider for a moment the nature of the waveform of the electrical signals which in a sound-communication channel represent the sound to be transmitted, we find that it is a mixture of alternating currents or voltages having any frequency from about 40 to approximately 10,000 c/s. The important point is that all these signals consist of alternating current (A.C.),

i.e., a current which consists of alternate positive and negative half-cycles operating about a central position known as a datum line, and the area under the curves on each side of the datum line being equal.

In television, however, neither the vision signals nor the synchronising signals are represented naturally by an alternating current but by a direct or unidirectional current (D.C.). This does not here imply a steady supply such as that generated by a battery or a system of D.C. mains, but a current which operates on one side only of an initial datum line, and not on both sides as in the case of A.C. The difference between the two is

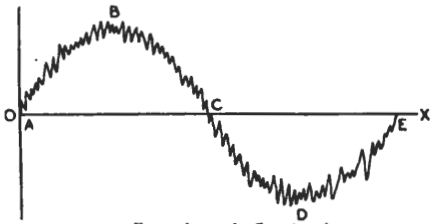

Fig. 1. A.C. Cycle.

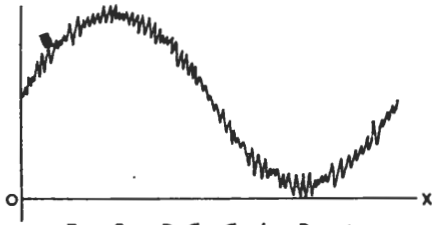

Fig. 2. D.C. Cycle, Positive.

illustrated in Figs. 1 and 2. Fig. 1 shows one cycle of an alternating current having a positive half-cycle *ABC* which is positive with respect to the datum line *OX*, and a negative half-cycle *CDE* which is negative with respect to the datum line, the latter, of course, representing the zero of voltage or current. Fig. 2 shows the same cycle of amplitude variation in the form of a unidirectional current. In this case, the whole of the waveform *ABCDE* is in the positive sense with respect to the datum line *OX*, which again represents a zero of current or voltage.

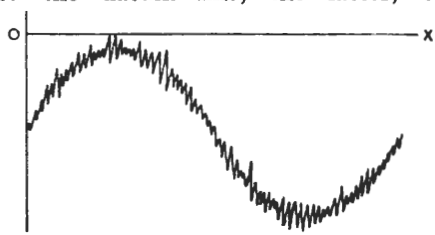

Fig. 3. D.C. Cycle, Negative.

A third variation is possible, represented by Fig. 3, which again represents a unidirectional current, but having a negative sense with respect to the datum line *OX*.

It is evident that the currents which represent sound in the sound-broadcasting system have the form of Fig. 1, since the original sound wave is an oscillation about a central datum line, and the current which represents it must have the same form.

In a vision system, however, the vision signal represents the light and shade of the picture at any moment, and such light and shade is obviously positive at all times with respect to the datum line representing zero brightness or black, since we can conceive of no such thing as negative brightness. The vision signal, therefore, must have the form of Fig. 2. In other words, it is a unidirectional current. Its amplitude may and will vary from moment to moment, but it will always be positive with respect to zero.

The synchronising signals also are represented most naturally by a

unidirectional current, and in this case it is immaterial whether the sense of the representative current is positive or negative, as all that is required is a burst of energy at the right moment which can be adapted to say to the receiver " Begin a new line," or " Begin a new picture," as the case may be. By arranging that the sense of the synchronising signals is opposite to that of the vision signals, i.e., negative, then a solution to the problem of maintaining the individuality of the two sets of signals in the transmission presents itself, for if we mix the signals in such a manner that the two datum lines coincide, we have formed one composite signal or waveform in which all excursions on the positive side of the datum line represent vision signals and convey information as to the brightness of picture detail, while those on the negative side of the datum line are concerned with synchronising alone. Thus the picture and synchronising signals may be separated from each other at the receiver by methods of discrimination based on " sense," which is for many reasons more satisfactory than other methods which have been tried.

A typical composite waveform of this sort is illustrated in Fig. 4. *OX* is the datum line, and the portion of the waveform *ABC* is a representation of a vision current during the time of one scanning line. It is confined entirely to the upper or positive side of the datum line *OX*. The other part of the waveform *CD* is the line synchronising signal, taking the form of a simple burst of energy in the negative sense, and this is similar in general characteristics to the simple negative unidirectional sine wave of Fig. 3, but differs in that it is a square pulse. The datum line *OX* thus forms an impenetrable barrier between the two types of signal. It will be evident that the complete waveform of Fig. 4 may be transmitted by one communication channel, but that the two components of it, viz., the vision and synchronising signals, though in effect mixed because they are passing through the same channel together, are still retaining their individuality, since they differ in the important characteristic of sense, and may be separated at the receiver by some device which responds only to signals in one sense or the other.

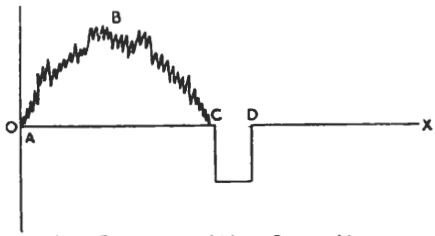

Fig. 4. Composite Waveform, Vision and Synchronising Signals

We have seen that the datum line *OX* represents the transmission of zero picture brightness, or black, and now that it has been made to coincide with the datum line from which the synchronising signals operate in the negative direction, it also represents the state when no synchronising signals are being transmitted. It therefore represents the transmission of no intelligence whatever, and is known as the **black level**. It is possibly the **most important characteristic** of a television system.

Picture/Sync Ratio

Referring to Fig. 5, which shows Fig. 4 redrawn with the addition of one or two explanatory details, if *BB* is the black level, then there will be another level on the positive side of the datum line, and shown as *WW*, which will represent the current corresponding to the whitest part of the line. This is termed the white level. There is yet another level on the negative side of the datum line, shown as *SS*, which will be the amplitude when the synchronising signals are being transmitted. This is known as the sync level. The ratio p/s of Fig. 5, i.e., the ratio of the amplitudes of the picture and synchronising signals, is an important value, and is known as the picture/sync ratio.

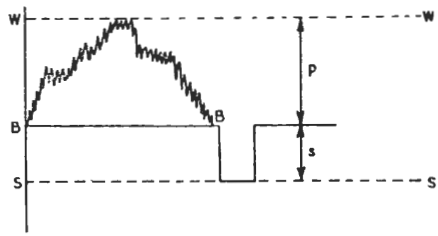

Fig. 5. Composite Waveform, showing p/s ratio.

Two different values of picture/sync ratio are in use in the Marconi-EMI system: a ratio of 1 : 1 in most of the vision frequency circuits and a radiated ratio of 7 : 3, to which further reference is made in Item 1.1. The point of this difference is as follows:

It is unnecessary to radiate a synchronising amplitude as great as the picture amplitude corresponding to a picture/sync ratio of 1 : 1, as it has been found by experiment that with such a ratio and at such receiving situations where interference ruins the picture, the synchronising still remains perfectly steady, which is an obviously unnecessarily high standard of excellence of synchronising. It is far better to arrange that the synchronising of the receiver just fails when interference on the picture itself is of such a degree as to spoil its entertainment value. A radiated picture/sync ratio of 7 : 3 is therefore employed. To obtain such a radiated value the radio frequency circuits of the transmitter must be supplied with a picture/sync ratio of 1 : 1, i.e., more synchronising amplitude than is finally needed. This is because the synchronising signals fall upon the bottom bend of the modulation range of the transmitter and the process of modulation automatically reduces their amplitude relative to that of the vision signal. This matter is further developed in Item 1.1.

Vision Frequency Range

We have seen, then, that a television system operates by repeatedly scanning a scene and so generating an electric current, which at any moment represents the brightness of elemental areas in the scene taken in a prescribed order, and, by means of radio transmission, reproducing this current, together with synchronising signals, at the receiver. We have now to determine, more intimately, the nature of this current and, in particular, the frequency band which it occupies. This frequency band will depend upon the number of lines "*L*" into which each picture is divided, and the number of pictures "*P*" which are sent per second, and also the shape of the picture. The

product of the number of lines per picture and the number of pictures per second, viz. LP, is the number of lines transmitted per second and is known as the line frequency : P is known as the picture frequency.

If we analyse the vision frequency waveform we shall find that it is composed of a pure direct current, which we will designate f_o, and a large number of A.C. frequencies consisting of the picture frequency P and a great many of its harmonics, together with the line frequency L and a great many of its harmonics. In theory, for perfect reproduction we need an infinite band of frequencies, but in practice, an upper limit must be set, the lower limit being, of course, zero frequency, i.e., D.C. The highest frequency which it is necessary to preserve in the practical vision frequency waveform may be obtained from the following formula :—

$f = (L^2RP)/2$ where L and P have the meanings already specified and R is the ratio of width to height of the picture ; R is known as the aspect ratio. For example, for a system of 405 lines per picture, 25 pictures per second, and $R = 5 : 4$, the value of f, the highest frequency needed, is 2.56 Mc/s.

This formula is derived as follows :—

Imagining a square picture divided into L lines both horizontally and vertically, then we shall have produced a grille, containing L^2 small squares. If each alternate square is black and white respectively, corresponding to the presence of detail in the picture, then a rise in current will represent a white square and a fall in current the adjoining black square, and since one rise and one fall in current constitutes one cycle, whether in pure A.C. or variable D.C., then $L^2/2$ ripples of current will be created by scanning the grille. If the grille be scanned P times per second there will be $(L^2P)/2$ ripples per second, and if the picture is wider than its height in the ratio R there will be L^2R (instead of L^2) elemental areas, and the final number of ripples per second, corresponding to the finest detail, becomes $(L^2RP)/2$. Strictly speaking, the value of R to be used in the above formula should be somewhat greater than the actual aspect ratio of the picture because of a feature of the system known as suppressed scanning. This has the effect of increasing f by some 8 per cent., so that in the above example the value becomes 2.76 Mc/s.

It is an important feature of television that not only must all these frequencies be reproduced at their correct amplitude but they must all take the same time to get to the receiving screen. To achieve this there must be no phase distortion within the system and this usually means that the band width of all circuits must be considerably greater than the value of f given by the above equation.

Interlacing

We must now turn to one aspect in which television scanning differs from the action of a man in reading a book. The band width of all circuits is directly proportional to P, but the value of P also determines the amount of flicker in the system, the flicker decreasing with the increase of P. The flicker also depends upon the picture brightness, increasing with brightness. It

follows that an absence of flicker can only be secured by the use of great band width in circuits, which brings in its train technical difficulty and expense.

Fundamentally, P, the number of pictures per second, is also equal to the number of vertical motions carried out by the scanning per second. This must be so if the lines are scanned sequentially, i.e., in their natural order, but we are not obliged to scan the picture in the natural order of the lines, provided the receiver faithfully follows the scanner. We can, for example, scan all the odd lines, missing the even lines, and then let the scanner return and scan the even lines. There will thus be two vertical motions of the scanning for every picture transmitted. The semi-picture containing either odd or even lines and resulting from such a process is called a frame, and the number of frames per second is known as the frame frequency, the process as a whole being termed interlaced scanning. The frame frequency, of course, is always greater than the picture frequency, and it is found that the eye responds to the frame frequency rather than to the picture frequency as regards flicker and is, as it were, deceived into thinking that $2P$ pictures per second are being transmitted. This affects the nature of the transmitted signals in a manner dealt with in Item 1.1.

Summary

We see, therefore, that the fundamentals of television involve the translation of the scene into an electric current by the process of scanning, which may be interlaced to reduce flicker in relation to a given band width, and that the process is constantly repetitive, to ensure the reproduction of a steady picture capable of displaying moving objects in the scene. (The repetitive nature of television signals allows of the extensive use of cathode ray tubes for monitoring the performance of circuits throughout the system.) In addition, synchronising signals linking the operation of transmitter and receiver must be transmitted in a manner ensuring their eventual separation. Since there are obviously a great many ways in which the picture can be scanned, it is necessary for an authoritative body to lay down, for the time being, standards which shall be observed in transmission and which are equally applicable to the transmitter and to the receiver. At present these standards are as follows :

No. of lines per picture .. 405
No. of pictures per second .. 25
Twin interlacing giving a frame frequency of 50

The remaining standards covering the synchronising signals and details of modulation are covered in the next section.

2. GLOSSARY OF TELEVISION TERMS

Accelerator. An electrode in a cathode-ray tube which is normally positive with respect to cathode. Its primary function is to control the axial velocity and the configuration of the electron beam. Where more than one accelerator is used, numbering is normally taken outwards from the cathode.

Angle of View. The angle in the horizontal plane sub-tended at a camera lens by the extremes of the viewed scene. Similarly, the angle of view in the horizontal plane sub-tended at the eye of the observer by the vertical edges of the viewed picture.

Angle Shot. A camera technique in which a subject or scene is shot from an unusual or extreme angle, such as an abnormal side view, looking down from a high level, or looking up from a low level.

Aperture Distortion. The reduction of definition due to the finite size of the scanning spot or aperture in the direction of scanning.

Aperture (Photographic). The effective diameter of a lens from the point of view of its acceptance of light. See 'f' number.

Art Bars. A test waveform produced by an electronic circuit for injecting into the picture channel a signal which will produce a standard geometrical design to be used as a basis for measurements. The signal produces a large black cross on a white background which permits the examination in detail of general performance.

Aspect Ratio. Ratio of width to height of a picture.

Audio Frequency. Any frequency lying within the range of normal hearing. Usually the range includes all frequencies between 16 c/s. and 15,000 c/s.

Background. In sound : Noises incidental to but not forming part of the main broadcast.

In vision : The brightness values of the darkest portions of the picture.

In stage setting : The drapes or background scenery forming the walls of the set.

Back Lighting. Spot-lighting from the back, designed to bring individual subjects out of the background by virtue of their brightness.

Back Projection. Pictures produced by projecting pictures on a translucent screen.

Beam Current.	The magnitude of the current projected by an electron gun on a target.
Black Level.	The datum line of the television signal from which picture signals start in a positive sense and synchronising signals in a negative sense, i.e., the signal level at which no intelligence whatsoever is transmitted.
Black-out.	In video technique: A pulse used to extinguish the return sweep of a scanning system. In theatre parlance: A blacking-out of all lighting to produce a finale effect in a sketch.
Blooming.	A modern process by means of which internal reflections of light at the various surfaces of the components of a lens may be minimised so as to prevent loss of light transmitted and reduction of contrast from light ordinarily indiscriminately scattered over the image from the contact surfaces.
Boom.	A mobile microphone carrier used in a television studio.
Broad.	A form of illuminator giving an unconcentrated beam without the aid of a diffusing screen.
Camera Tube.	The electronic tube used in a television camera.
Cathode-ray Tube.	A device in which a fluorescent surface can be excited into luminescence by impinging upon it a beam of electrons generated by an electron gun and capable of deflection to any part of the screen.
Chickens.	Description of a vision waveform in which the majority of the signals during a line are in the grey to white region, only descending to black at the beginning of the scan.
Close-up.	The transmission of a point of interest in a scene so that it occupies a high percentage of the area of the transmitted picture. The reverse of a long shot.
Co-axial Cable.	Two conductors so arranged that the central conductor, formed by a wire or tube, is surrounded by another tube forming the second conductor. The insulating medium is mainly air. Such a pair has low loss over a wide frequency band, including that required for video frequencies.
Colour Chart.	A special type of test card used for examining the performance of television cameras. Various colours are displayed on the card, and adjacent to them the monochromatic tones in which these colours should ideally be reproduced.

Composition. The art of so orientating a camera that the objects of interest are disposed in the most artistic relationship to the boundaries of the picture.

Conditioning. The preparation of any electronic tube before use by operation under non-standard conditions.

Contrast. The ratio of the dark to the light portions of a television picture. Pictures having high contrast have very deep black and brilliant whites, while a picture with low contrast has an over-all grey appearance.

Cut (Vision). Abrupt change from one camera to another.
(Sound). Abrupt cessation of sound such as would be produced by a very fast fade-out.

D.C. Component. That component of the video waveform which represents the average brightness of the picture as a whole.

Definition. Degree of fineness of detail of a televised picture when compared with the original scene. Generally defined by assessing the finest detail which can be reproduced in terms of the corresponding fundamental video frequency.

Deflection. The movement of the electron beam in a picture or camera tube by means of electrostatic or magnetic fields.

Deflectional Sensitivity. In a cathode-ray tube, the degree of spot displacement resulting from a potential difference of one volt between a pair of deflector plates or a current of one ampere in the deflector coils.

Deflection Yoke. The combination of electrical coils used to direct an electron beam up-and-down and right-to-left to scan an area. (In the camera tube it is the mosaic that is scanned; in the picture or receiver tube, it is the fluorescent screen.)

Deflector Coil. In a cathode-ray tube, a coil which deflects the beam over the surface of the screen by virtue of the magnetic field produced by the current flowing through the coil.

Deflector Plates. In a cathode-ray tube, the electrodes which deflect the beam over the surface of the screen by virtue of the potentials existing between the plates. Those plates arranged for horizontal deflection are designated X and those for vertical deflection, Y.

Depth of Focus. Limits of distances along the optic axis between which everything in a scene appears in sharp focus.

Dipole Aerial.	An aerial consisting of two conductors of equal length in the same straight line, with a pair of lead wires connected at the inner ends. Each conductor is somewhat less than a quarter of a wavelength long.
Disc Anode.	In a cathode-ray tube, an anode consisting of a metal disc with an aperture to permit the passage of an electron beam.
Dissector Multiplier.	See Image Dissector.
Dissector Tube.	See Image Dissector.
Distortion.	Any departure from ideal reproduction of vision or sound.
Dolly.	The movable platform on which equipment, usually a camera, can be mounted or transported.
Dolly Shot.	A camera picture which involves the moving of the camera while the picture is on the air, such as dollying-up from a long shot to a close-up.
Double Image.	See Ghost.
Down Stage.	Towards the camera.
Edge Flare.	A rim of illumination around the edge of the picture on the receiver tube.
Electron Camera.	General term used for apparatus which produces video frequencies by means of electrical scanning of a scene, and in which the storage principle is not used.
Electron Gun.	A system of electrodes which produce an electron beam.
Electron Lens.	A device involving a system of electric or magnetic fields capable of focusing a beam of electrons.
Electrostatic Focusing.	In a cathode-ray tube, the action of causing the beam to converge into a sharply defined area on the surface of the screen by means of electrostatic fields between two or more deflecting plates.
Emitron.	Trade name for the specific electron camera used with the E.M.I. television system.
Field.	Total assembly of lines employed to scan the full area of the scene being televised.
Field of View.	That part of a scene at any instant included in the view of a camera.
Flat Light.	Lighting a scene with over-all brightness without modelling or highlights.
Flyback.	The rapid return of the spot from the end of a line to the commencement of the next. Also the return of the spot from one end of a frame to the beginning of the next, in a similar manner.

'f' Number. The focal length of a lens divided by its effective diameter as set by the aperture stop or diaphragm. As the diameter is reduced so does the 'f' number increase. The light transmitted is inversely proportional to the square of the aperture number.

Focal Length. That distance behind a lens at which a sharp image is produced of an object lying infinitely far in front of it.

Focus. In optics: (n) The point at which reflected or refracted rays converge to form a pencil of minimum diameter.
(v.t.) To cause light rays to converge on a given point.

In cathode-ray tubes:
(n) The point at which an electron beam converges to a pencil of minimum diameter.
(v.t.) To cause an electron beam to converge on a given point by electrostatic or electromagnetic means.

Focus (hard or soft). The action of an optical or electronic focusing system to produce a well-defined or poorly-defined image.

Foot-candle. A unit of illumination. The illumination on a surface of one square foot in area on which there is a uniformly distributed flux of one lumen, or the illumination produced at a surface, all points of which are at a distance of one foot from a uniform source of one standard candle.

Foundation Lighting. Non-characteristic light, producing sufficient illumination to register a basic but inartistic picture on the camera tube.

Frame. The semi-picture formed by scanning alternate lines of a picture or scene.

Frame-bend Waveform. A paraboloidal waveform injected to correct picture illumination in the frame direction.

Frame Divider. Apparatus for generating the master frame frequency from the master frequency by electronic division.

Frame Frequency. The number of frames per second.

Framing. The process of centring a picture already in synchronism by adjustment of the frame shift control. Also, in a film projector or telecine apparatus, the operation of centring the frame in the gate of the projector.

Frame Keystone Waveform. Waveform which increases in amplitude after the manner of a saw-toothed wave but flattens out more and more as the amplitude increases, and used in scanning tubes where the gun is not perpendicular to the target.

Frame Suppression Pulse. A pulse injected to suppress spurious signals, create black datum line and provide black periods between frames.

Frame Synchronising Pulse. A pulse injected into the vision circuits at the end of each frame.

Frame-tilt Waveform. A saw-toothed waveform injected for the correction of picture illumination in the frame direction.

Fuzz. The appearance of stray light at the bottom of a televised picture.

Gamma. A constant which expresses the *degree of linearity* between the contrast in a scene and the contrast in the televised or photographic reproduction of that scene. It is not just the simple ratio between the contrast of the scene and the contrast of the reproduction. In detail, if P_1 and P_2 are two points in the original scene and I_1 and I_2 are their light intensities, then their contrast ratio is $\frac{I_1}{I_2}$. These same two points as reproduced will have new intensities I'_1 and I'_2 and their contrast ratio will be $\frac{I'_1}{I'_2}$. The gamma is the quotient of the logarithms of these contrast ratios.

$$\text{Therefore } \gamma = \frac{\log \frac{I'_1}{I'_2}}{\log \frac{I_1}{I_2}}$$

Ghost. A secondary image or picture formed on a television receiver screen by a signal from the transmitter which reaches the aerial by more than one path. Ghosts are usually caused by the reflection of the signal by large buildings, hills, etc., near the receiving aerial.

Gradation. The division of a monochrome picture into a number of tones of separate intensity. In fine gradation there are many such tones; in coarse gradation only a few.

Grey Scale.	The achromatic colour scale or table, from white through greys to black, the intermediate greys differing from each other only through a proportional admixture of white and black. For practical printing and photographic purposes, it is a ten-step transition from white, through greys, to black.
Gun.	See Electron Gun.
Gun Current.	Total current produced by the electron stream emitted from the cathode of the cathode-ray tube.
Hard Light.	Light directed on to a scene, having great concentration and such location as to produce strong shadows.
High Light.	The element of a picture distinguished pictorially by the brightness of its tone and very often appearing to stand out in the background.
Iconoscope.	See Storage Camera.
Image Dissector.	A form of electron camera in which the optical image is focused upon a photo-emissive surface, the emitted electrons from which are electronically swept across a point anode in such a manner as effectively to scan the whole electron image.
Intensity Modulation.	Modulation of the radio-frequency carrier of a television system by means of a current proportional to the luminous intensity of the successively scanned elements of the original scene.
Interlaced Scanning.	A form of line scanning in which the image is scanned in alternate lines, the lines of one frame falling midway between those of the next.
Lateral Inversion.	The effect produced when the sides of a televised scene appear in reverse on the reproducing screen. It can be caused by reversed connections on the line-scanning apparatus.
Lens Spot.	The name given to a type of illuminator used for the illumination of television scenes in which concentration of the beam is accomplished by a lens.
Light Flare.	A white spot on the television picture caused by a badly placed floor or spot light.
Light Meter.	A meter to measure the light levels reflected by stage sets and performers' faces.
Line Bend Waveform.	Parabolic waveform at line frequency, injected in anti-phase to correct picture illumination in the line sense.
Line Divider.	Apparatus which provides the master line frequency by electronic division from the master frequency.

Line Frequency.	Number of lines scanned per second.
Line Keystone Waveform.	A saw-toothed waveform at line frequency which is modulated in amplitude at frame frequency by the Frame Keystone Waveform (q.v.). Used for scanning in a tube in which the gun is not perpendicular to the target.
Line Scan.	(i) A scanning system in which the spot traverses the image in a series of straight lines. (ii) The system which produces such scanning. (iii) The line field displayed on a tube by such a system.
Line Suppression Pulse.	Period of black starting immediately before, and continuing after the synchronising signal. Introduced to eliminate spurious signals which would otherwise interfere with synchronising signals.
Line Synchronising Waveform.	A waveform consisting of square pulses at line frequency which is transmitted along with the picture waveform so as to hold receiver scanning mechanisms in step with the transmitter scanning system.
Line Tilt Waveform.	Saw-toothed waveform at line frequency injected in antiphase to correct illumination of the picture in the line sense.
Long Shot.	The transmission of a scene in such a manner that a considerable physical area is shown in the generated picture. The reverse of a close-up.
Lumen.	Unit of light intensity. One lumen per square foot of surface equals one foot-candle. The standard candle emits 4π lumens.
Lux.	An illumination of one lumen per square metre.
Magnetic Deflection.	See Deflection.
Mid Shot.	A scene transmitted so as to have characteristics lying roughly midway between those of a close-up and those of a long shot.
Milli-Phot.	Roughly equals one foot-candle. (See Phot.)
Mirror Spot.	The name given to a type of illuminator used for the illumination of television scenes in which concentration of the beam is accomplished by a mirror.
Mix (Vision).	A control technique by which a picture on a second camera is made to merge with a picture on the air and is gradually brought into full view while the other picture is gradually faded out.
Modulation.	(i) Control of illumination intensity by variation of beam current, scanning velocity or voltage, in a cathode-ray tube.

(ii) Control of the radio frequency output generated by a vision transmitter, by means of the video frequency input.

Monochrome. A picture which is reproduced solely in tones varying from black, through grey to white, i.e. in which no true colours appear.

Montage. A series of pictures transmitted either successively or simultaneously in some geometrical layout, or otherwise presented, so as collectively to convey an idea.

Mosaic. A mica plate on one side of which is deposited a number of photo-electric nodules, each insulated from the other. These are so minute that the small area occupied on the mosaic by a single picture element contains a very large number of nodules. More generally, the scanned target in a television pick-up tube of the storage type.

Multiple Scanning. The consecutive scanning of a scene by two or more electron beams.

Mush. Interference in finely divided form occurring all over the screen of a television picture reproducing tube.

Negative Image. The effect produced on a reproducing screen when the whites and blacks of the televised scene appear to be reversed.

Negative Video Signal. A video waveform in which an increase of voltage in the positive sense represents a white-to-black change in picture detail.

Pan (or Panorama). A camera movement showing fresh portions of the scene by turning the camera in a horizontal or vertical plane.

Parallax. Difference between geometrical position of objects in a scene in relation to the scene boundaries as viewed by two separate lenses placed closely side by side.

Peak White. The steady level of R.F. output from a television transmitter, uninterrupted by synchronising or other pulses, and equal to the normal level attained during the transmission of full white in the original scene.

Penumbrascope. Apparatus for projecting shadow effects on to screen as scenery.

Perspective. The degree of perfection of reproduction in a photograph or televised picture, of geometrical relationships in the original three-dimensional scene. Alternatively, the relation between the angle of view of the camera and the angle of view of the observer of the transmitted picture.

Phase Swinging.	The effect produced on the reproduced picture when the frame frequency of the receiver is out of synchronism with that of the transmitter. The picture appears to wander on either side of a mean position.
Phot.	One lumen per square centimetre.
Photo-electric Current.	The current produced when a photo-electric cell is subjected to incident light rays.
Photometer.	Instrument used in the measurement of light intensities.
Picture Element.	Small sub-area of a scene to be televised, the picture being composed of a large number of such elements.
Picture Frequency.	The number of complete pictures (as distinct from frames) televised in one second.
Picture Monitor.	A cathode-ray tube for reproducing the televised picture at various points in the transmitting system.
Picture Point.	See Picture Element.
Picture Ratio.	See Aspect Ratio.
Picture Signal.	That component of a television signal which conveys the picture intelligence, the remaining components being related to synchronising.
Picture/Sync Ratio.	The ratio of amplitudes of the picture and synchronising signals.
Plastic Effect.	The introduction of an appearance of relief into a reproduced scene, as a result of phase distortion in the picture signal.
Positive Video Signal.	A video waveform in which an increase of voltage in the positive sense represents a black-to-white change in picture detail.
Pre-view.	The act of inspecting a television picture before it is radiated, usually on duplicate apparatus.
Projection Receiver.	A large-screen receiver where the picture is reproduced on a projection screen, rather than on the face of a cathode-ray tube, the principle being optical projection, as distinct from direct viewing.
Rain.	Finely divided vertical interference patterns in a television picture.
Raster.	See Field.
Red-sensitive.	The term applied when a camera is unduly sensitive to the red components of a scene being televised. Such a camera causes the red-component areas to produce over-emphasised brightness in the relative areas of the reproducing screen.

Relaxation Oscillation.	An oscillation in which the alternating current or voltage changes slowly over part of the cycle and rapidly over the remainder. It is produced by storing energy in a reactive element, followed by a period of relaxation, during which the energy is discharged at a different rate.
Return Line.	A thin line appearing on the screen of a cathode-ray tube, caused by the return of the spot during the flyback intervals.
Return Trace.	See Return Line.
Ringing.	The appearance of marked white edges to dark picture elements or vice versa, caused by phase distortion and if exaggerated tending to introduce plastic effect.
Scanning.	The examination of a picture, element by element, in horizontal or vertical lines, by means of a beam of electrons or light, for the purpose of transmitting or receiving the picture intelligence.
Scanning Aperture.	(i) A hole in a scanning disc through which the scanning beam passes. (ii) The effective size of the spot from an electron gun at its point of impact with the scanned area.
Scanning Beam.	The electron beam used in scanning a scene or picture.
Scanning Coils.	The coils used for causing magnetic deflection of the electron beam during the scanning process.
Scanning Line.	The excursion of the spot on a cathode-ray tube screen whilst scanning a single line.
Scanning Spot.	(i) The light spot produced on the cathode-ray tube screen by the scanning beam. (ii) The equivalent spot on a television pick-up tube.
Screen.	(i) In a cathode-ray tube, the broadest area of the tube, the specially prepared surface of which becomes luminescent when bombarded by an electron beam. (ii) Generic term applied to any form of screen on which televised scenes are reproduced.
Screen Burning.	Discoloration of a fluorescent screen caused by a departure from normal operating characteristics.
Semi-picture.	The resultant part-picture obtained by scanning alternate lines of a picture. (See Frame.)
Sequential Scanning.	Scanning in which the lines are scanned in numerical order in the same direction.

Shading.	The process of correcting the light distribution in the image produced by the television camera. The process of introducing externally generated wave-shapes into a television picture to compensate for the discrepancies created by uncontrolled electron distribution in the camera tube. See Line Tilt, Line Bend, Frame Tilt, Frame Bend.
Shift.	Term applied to the movement of the scanning field, either vertically or horizontally, across the screen of a cathode-ray tube. " X " shift implies horizontal and " Y " shift vertical deflection.
Shot.	The limits of scenic area included in the view presented by a television or film camera.
Signal Plate.	The electrode which, with the mosaic nodules, forms a number of separate capacitors, the electrode acting as a common back plate.
Slipping.	Failure of one, or both, of the synchronising circuits to hold, which causes the received picture to slip vertically or horizontally.
Snoot.	Fitting applied to an illuminator to control the area of the emergent beam.
Soft Light.	Light directed on to a scene, having no concentration and such location as to illuminate the scene without creating shadows.
Sound Mixer.	The title of the operator who controls the fading, mixing, and volume from microphones and other sound sources in a television system.
Spill Ring.	Series of concentric bands of non-reflecting surface fitted to an illuminator to eliminate rays other than those parallel to the optic axis.
Standing D.C.	The presence in a video waveform of a D.C. voltage or current bearing no relation whatever to the intelligence conveyed by the waveform.
Storage Camera.	A form of electron camera containing a mosaic electrode upon which the image to be televised is focused and which is scanned by an electron beam.
Streaking.	A spurious image in a television picture, normally of reversed tone, which appears to the right of a picture detail.
Superimposition.	Overlapping or blending the image produced by one camera with the image from another.
Suppressed Scanning.	The injection of suppression between lines and frames : (a) to suppress spurious signals between lines and between frames.

(b) to establish the correct black-level datum line.
(c) to hold the transmitted signal at black level for a time sufficient to allow the flyback of the spot on the receiver to be completed during the black-level interval.

Suppression. (i) Elimination of spurious signals from the picture signal in the flyback period.
(ii) Adjustment of the over-all brightness of the transmitted picture by electronic means in the camera circuits.

Sweep. A term used to describe the motion of the electronic beam in a waveform monitor.

Sweep Circuit. The circuit in a cathode-ray waveform monitor which provides voltages to the deflecting plates of the cathode-ray tube. Cf. Time Base.

Synchronising. In an oscilloscope : The adjustment of the time-base frequency so that it bears an integral relationship to the frequency of the signal under investigation.
In a television system : The adjustment of the line and frame frequencies so that these frequencies are coincident at transmitter and receiver.

Synchronising Modulation. That portion of the total modulation which forms the synchronising impulses as distinct from the picture signal.

Tearing. Breaking up of a section of a television image because of maloperation of the line synchronising system in the receiver.

Telegenic. Having good pictorial qualities when seen by television.

Telephoto. A lens of exceptionally long focus designed to obtain a close-up shot of a scene with the camera some considerable distance away.

Test Pattern. A drawing containing a group of lines, circles, etc., transmitted for receiver adjustment and transmitter test purposes.

Tilt-and-bend. The injection into the video-frequency channel of an auxiliary waveform, usually of saw-toothed and parabolic character, to correct for departures from correct illumination values, which would otherwise exist from the action of the iconoscope.

Time Base (line or frame). Apparatus which generates the potentials required to deflect the spot across the screen of a cathode-ray tube.

Tone.	(i) In sound, a pure sinusoidal frequency generated and radiated for adjustment of the sound system. (ii) In vision, the degree of brightness of an individual area in a monochrome picture.
Trapezium Distortion.	Geometrical distortion in a television image, due to inter-modulation between the line and frame scanning currents or voltages.
Track (up or back).	To move a mobile camera towards or from the scene.
Track Shot.	A picture produced by moving a camera to or from a scene on its mobile mounting while in operation.
Vertical Scanning.	A form of scanning in which lines are scanned in a vertical direction, as opposed to the more normal system of horizontal scanning.
Video Frequency.	The term describing any individual sinusoidal frequency contained in the band occupied by picture or sync signals.
Video Signal.	The complete waveform after the picture signals from the camera have been added to the synchronising signals from the electronic synchronising generators.
Vision Mixer.	The title of the operator who controls the fading, mixing, and cutting of cameras in a television system.
Waveform Monitor.	A cathode-ray tube arranged to display the waveforms produced by the various electronic circuits of a television system.
White Level	That voltage in the video frequency waveform which corresponds to the transmission of full white in the original scene.
X-plates.	The pair of deflecting plates in a cathode-ray tube to which the horizontal deflecting potentials are normally applied.
Y-plates.	The pair of deflecting plates in a cathode-ray tube to which the vertical deflecting potentials are normally applied.