EMITRON TELEVISION

EMITRON

COLOUR

TELEVISION

Foreword

For many years E.M.I. Research Laboratories have been closely investigating the technical problems associated with colour television, and the wide experience gained by research into the highest standard monochcrome television equipment has enabled the Company to make a major contribution to the advancement of colour television technique. This is well illustrated in the application of the modern Emitron camera tube to the conversion of colour television signals. The unique merits of the Emitron in this respect have led the General Electric Company of America to incorporate the tube in the design of the latest " Chromacoder," and the Columbia Broadcasting System has adopted it in a similar equipment at present employed by the C.B.S. colour television service in the United States. Again, in the case of colour film transmission, the well known E.M.I. Flying Spot Film Scanner has been considerably modified and with the addition of a specially developed colour analyser has been shown capable of producing the finest quality colour television pictures.

Although the prototype models of these colour television channels are in an advanced stage of development, it will be appreciated that it may well be some time before such equipment will be sufficiently standardised to be made generally available in a form suitable for use by broadcasting authorities.

SIMULTANEOUS COLOUR TELEVISION using a FIELD SEQUENTIAL CAMERA

One of the most important, and incidentally controversial, units in a colour television system is the colour camera. A considerable amount of research and development effort has in the past been directed towards producing a compact and yet efficient colour camera. While no generally accepted decision has yet been reached on the most satisfactory type of camera, some comment on the factors involved may at this stage be of interest.

Of all the modern types of colour camera available today there is little doubt that the field-sequential colour television camera is the simplest. Only a single pick-up tube is required, which may be of the standard type used for monochrome television. Unfortunately, the field-sequential system as a whole is non-compatible, so it is therefore necessary to look into the question of the most practical form of camera which may be used for the generation of simultaneous compatible signals.

One form of simultaneous camera employs three pick-up tubes which are associated with beam-splitting colour filters. This camera has a number of serious disadvantages which make it difficult to handle operationally. For example, it is large, is usually over 300 lbs. in weight, and involves a complex optical system which makes turret changes difficult and introduces a considerable loss in light efficiency. Furthermore, it is essential that every camera contains three matched pick-up tubes, which are difficult and costly to produce. Another objection is that the camera requires separate amplifiers for red, green and blue signals. Each of the amplifiers has three parameters which affect picture quality, namely: gain, picture black-level, and gamma characteristic. In a studio with three cameras, ignoring the question of matching the colour filters and registration, there are altogether twenty-seven possible variables involved in matching the pictures from the three cameras.

It is also the practice when transmitting colour signals by this system to associate a colourplexer with each individual camera channel in order to simplify camera switching. This in itself necessitates a further considerable investment in equipment.

An alternative approach to the camera problem is to use a simple field-sequential camera and to convert the field-sequential signals into simultaneous signals by storage techniques. There are quite a number of possible arrangements for effecting the conversion.

The method indicated in the diagram uses three cathode ray display tubes and three Emitron pick-up tubes. In the present E.M.I. equipment the field-sequential signals are derived from a camera operating with 405 lines, interlaced 2:1, with 150 fields per second and a bandwidth of 9 Mc/s. These signals are then fed into gating circuits arranged so that the red signals are displayed on one cathode ray tube, the green signals on the second cathode ray tube, and the blue signals on the third. In other words, each cathode ray tube is operative for 1/150th of a second during each 1/50th of a second in order to display a particular colour component picture on the photo-sensitive surface of a storage type pick-up tube. All three pick-up tubes are scanned simultaneously with 625 lines, interlaced 2:1, and at the rate of 50 fields per second. Their outputs consist of simultaneous red, green and blue colour component signals produced according to the C.C.I.R. scanning standards.

It will be seen that a component field which takes 1/150th of a second to " write on " the display cathode ray tube, is " read off " in 1/50th of a second within its associated pick-up tube. This means that the converter is acting as a frequency divider. Thus, for example, a 9 Mc/s signal in the original field-sequential signal is converted into a 4.6 Mc/s output signal.

The equipment for the conversion of field-sequential signals into simultaneous signals has been developed by E.M.I. Research Laboratories in this country, and by the Columbia Broadcasting System and General Electric Company in the United States, who have called the converter " The Chromacoder ". The American companies are at present successfully using Emitron tubes in their colour television broadcasting equipment.

Research in the E.M.I. laboratories on the Emitron Pick-Up Tube Type 5956 has shown that not only has the tube excellent properties for use in field-sequential colour cameras, but also that its storage characteristics render it entirely suitable for the colour conversion system.

It is clear that no leakage of the electron image stored in the pick-up tube must occur if accurate reproduction of colours is to be achieved in the final picture. In addition, there must be no unwanted effects, such as secondary emission shading or haloes, if colour distortions are to be avoided. The Emitron pick-up tube used in the converter fulfils these requirements completely.

It should be noted that while in the present equipment two different line scanning standards, *viz.*, 405 and 625, are used, there is no reason why identical or other line scanning standards should not be employed.

Line-beating patterns caused by interference between the scanning raster on the pick-up tube and the scanning raster on the display tube are reduced by the use of " spot wobbling " and " spot broadening " techniques.

Phase-compensated aperture correction circuits render negligible any loss of definition due to the scanning apertures. This is largely because the signal/noise ratio of the converter is good and adds little noise to the output signal. Specially designed pre-amplifiers, using the E.M.I. Low-noise Triode Type 5559 in a " coiled-input " cascode circuit, help to maintain the high signal/noise ratio.

Since the display cathode ray tube has a power-law characteristic and the converting Emitron tube has a linear characteristic, it is necessary to alter the gamma characteristic of the signals in the converter. The " true-black level " feature of the Emitron contributes to the successful operation of the gamma-correction circuit.

Certain types of pick-up tube suffer from a defect known as " burn in ". The image of an object which has remained stationary for some time tends to be retained by the tube and can be seen superimposed as a ghost image on the picture long after the scene has changed. Such a defect is naturally more serious in colour television than in monochrome, as the retained image may be of quite different colour from its altered background. No " burn in " effects occur with the Emitron, making this an outstanding advantage in a converter where long life is essential.

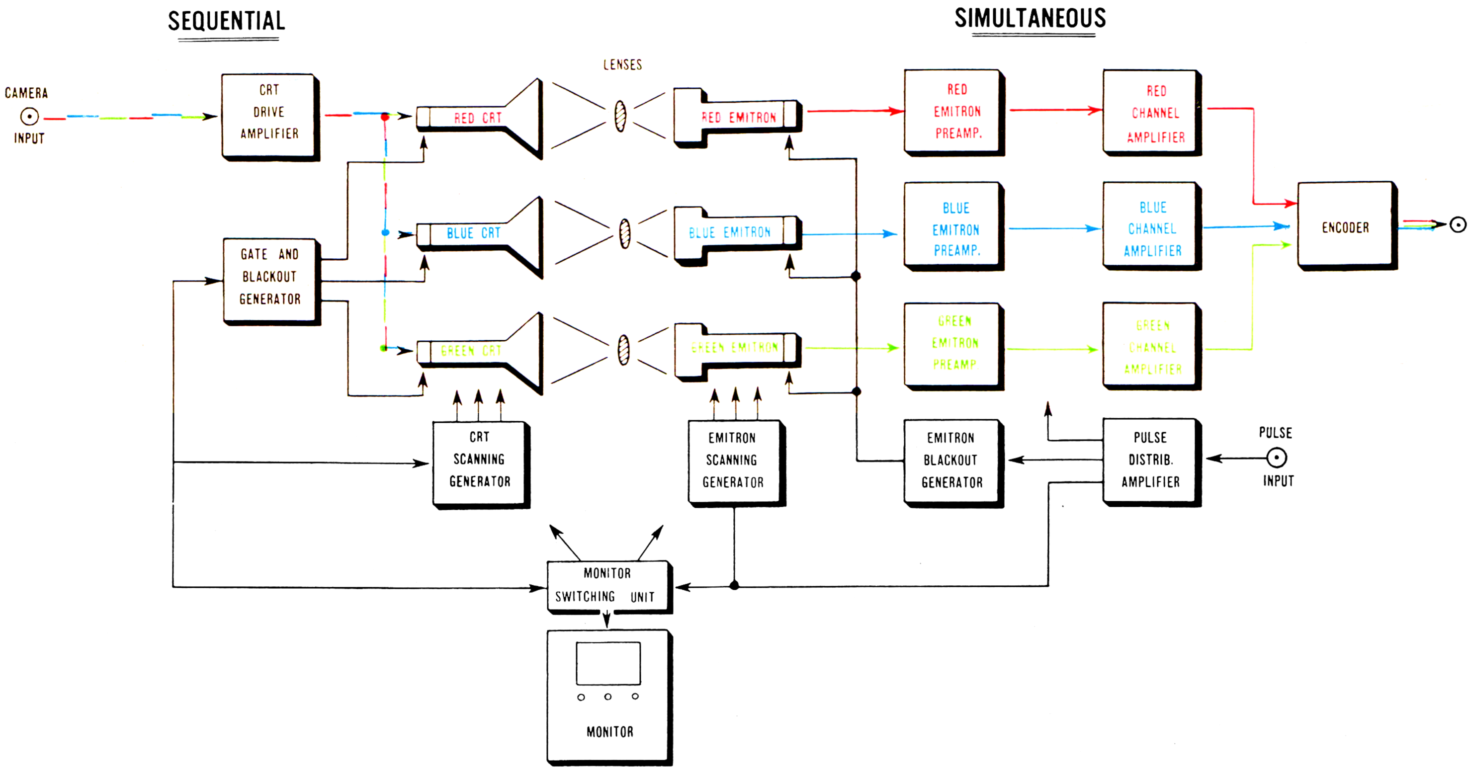
One operational feature of the Emitron, which is important to studio operators, is that the tube requires no long warming-up period. Furthermore, as the three tube equipment is essentially static, registration problems in the converters, although similar to those in the three pick-up tube camera, are reduced because there is more space for incorporating circuit refinements.

Colour break-up, which is one of the drawbacks of the field-sequential system, is eliminated because the converter produces a simultaneous picture. Colour fringing due to movement remains, but this is not a serious disadvantage with most subjects.

One converter can accept signals from any number of separate field-sequential cameras. Thus, in the case of a studio having three field-sequential cameras and one converter, only one set of simultaneous equipment is necessary. The number of possible parameters affecting picture fidelity is therefore very much reduced in comparison with the number involved when a studio has three cameras of the three pick-up tube type.

Finally, the sensitivity of the field-sequential camera employing the Emitron tube is such that excellent pictures are obtainable at f/4 with 400 foot/candles of incident illumination.

From these considerations, it will be realised that the converter or " Chromacoder " system represents a major step forward in the development of colour television.

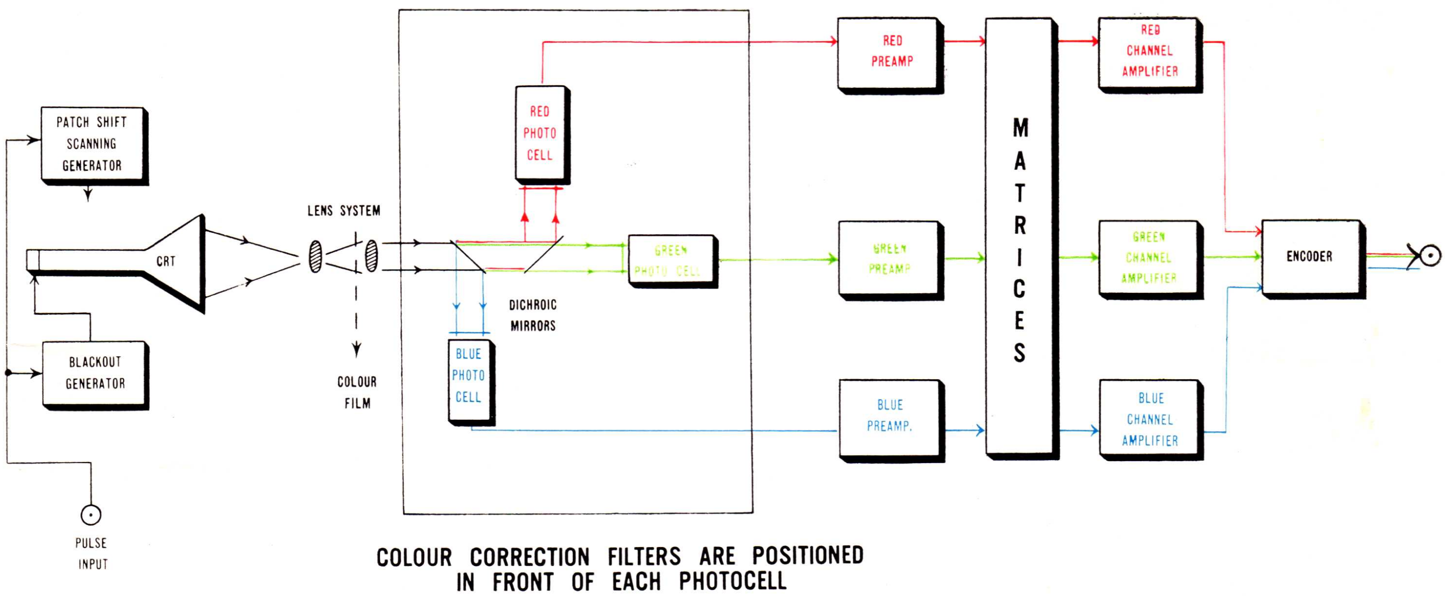


SIMPLIFIED BLOCK DIAGRAM OF A CHROMACODER

THE COLOUR TELEVISION FILM SCANNER

The flying spot technique is here applied to the problem of analysing colour film in terms of three primary colours.
The colour film is first of all scanned by a flying spot of light. The spectral characteristic of the spot of light is modified by the transmission at every point on the film. The resultant light is then divided into three colour components by a dichroic mirror assembly. Three photocells collect these light components and convert them to electrical signals, which are then passed on to suitable amplifier chains. In addition to the electronic circuits, the amplifier channels include fixed gamma stages and linear matrices for colour correction and balance. Three video signals—red, green and blue—are available at the output terminals for encoding into a standard colour waveform.
A continuous motion projector is used to transport the film at 25 frames per second. There are 50 television fields per second, each film frame being scanned twice. The conventional flying spot method of film scanning is to provide an interlaced raster on the scanning tube, two optical paths, and a simple shutter, so that each film frame is scanned in two positions of the film. One important disadvantage of this method is the low efficiency of light collection.
A new method is introduced in this film scanner for following the moving film. A single lens with a large aperture used in

SIMPLIFIED BLOCK DIAGRAM OF A COLOUR FILM SCANNER



COLOUR CORRECTION FILTERS ARE POSITIONED IN FRONT OF EACH PHOTOCELL

conjunction with a shifting patch on the face of the scanning tube achieves the same result as previously, but enables a much more efficient optical system to be employed. The film is followed by moving alternate fields to one or other of two patch positions on the scanning tube by means of a specially generated shift waveform applied to the field scanning coils.
The method may also be applied to the American standards of 60 television fields and 24 picture frames per second. In this case, alternate film frames are scanned by two television fields and three television fields respectively. Altogether five patch positions on the tube face are required for these particular standards.
It may be seen that with suitable modification the equipment may be adapted for use with any of the recognised television standards in monochrome or colour.

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