Oct. 18, 1955 I. J. P. JAMES ET AL 2,721,228

COLOUR TELEVISION APPARATUS

Filed Dec. 19, 1951 2 Sheets-Sheet 1

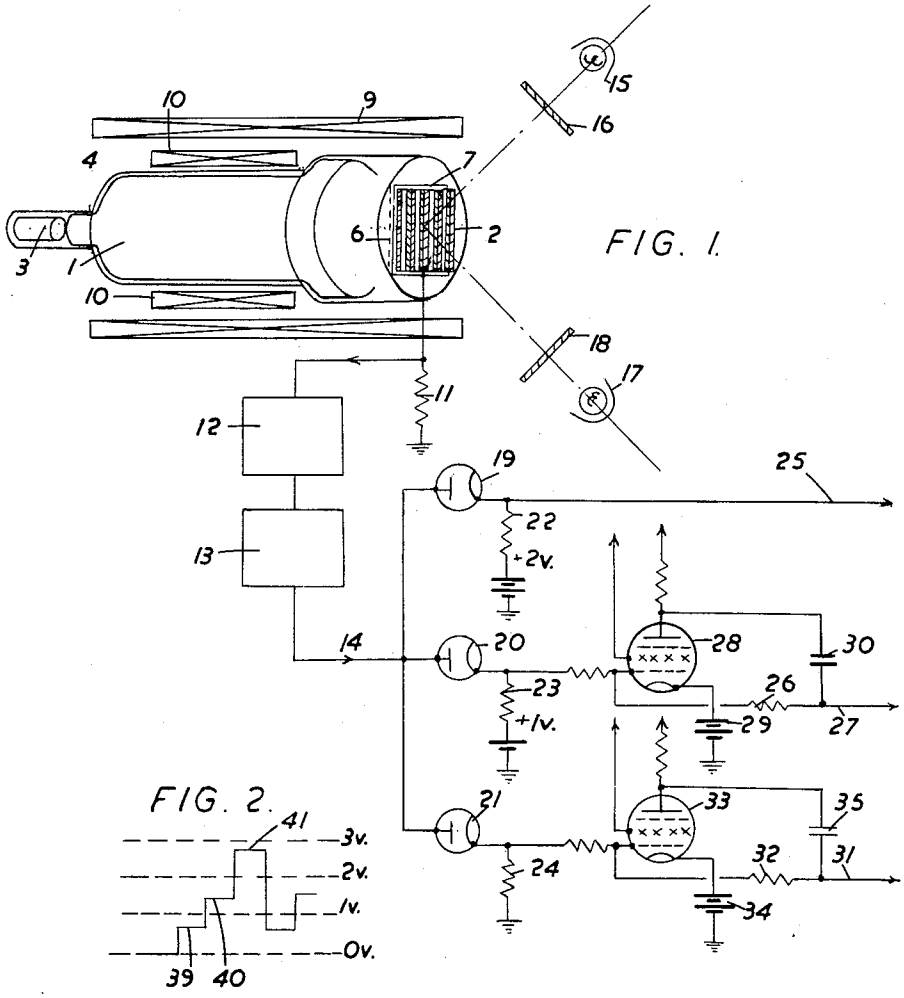


FIG. 1.

FIG. 2.

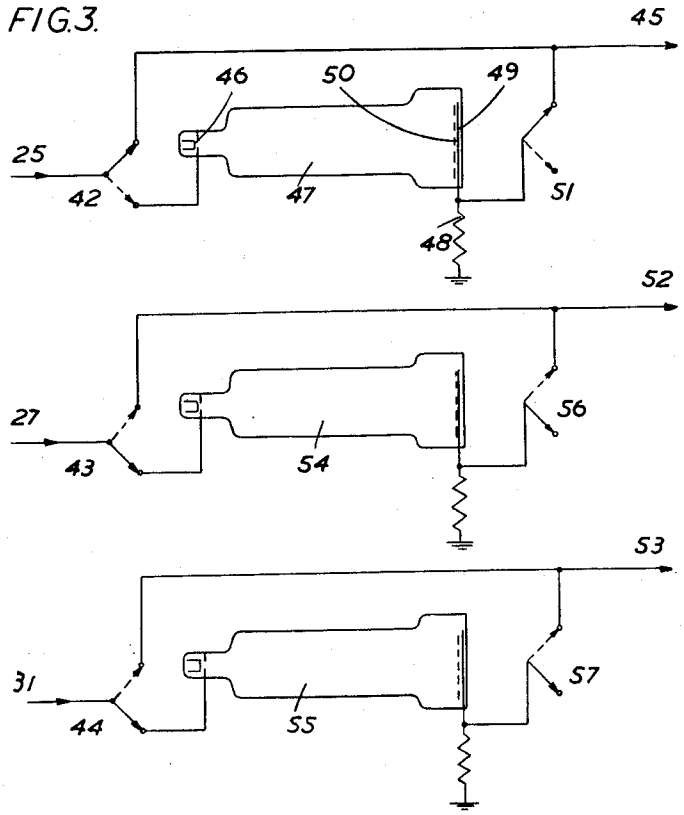
Inventors:
IVANHOE JOHN PENFOUND JAMES
JAMES ALEC LODGE
BY Ralph E. Atherton
Attorney

Oct. 18, 1955 I. J. P. JAMES ET AL 2,721,228

COLOUR TELEVISION APPARATUS

Filed Dec. 19, 1951 2 Sheets-Sheet 2

FIG.3.



Inventors:
IVANHOE JOHN PENFOUND JAMES
JAMES ALEC LODGE
BY Ralph E. Atherton
Attorney

United States Patent Office 2,721,228 Patented Oct. 18, 1955

2,721,228

COLOUR TELEVISION APPARATUS

Ivanhoe John Penfound James, South Ealing, London, and James Alec Lodge, Ickenham, Uxbridge, England, assignors to Electric & Musical Industries Limited, Hayes, England, a company of Great Britain

Application December 19, 1951, Serial No. 262,362

Claims priority, application Great Britain December 23, 1950

3 Claims. (Cl. 178—5.4)

This invention relates to colour television apparatus.

It has been proposed to generate picture signals for colour television by projecting a light image of mixed colours onto the target of a conventional television pick-up tube through a multiple section colour filter whereby the target is illuminated by different colour components of elements of the light images. The video signals generated in operating the tube then comprise intercalated signal elements representative of different colour components. In general it is desirable to separate the intercalated signal elements into different channels so that the signal elements in any one channel are representative of only a single colour. However, difficulty is experienced in doing this because, even if the sections of the colour filter are arranged according to a regularly recurrent pattern, non-linearity of the scan effected in the pick-up tube will cause aperiodicity in the recurrence of the intercalated signal elements. Therefore, to facilitate the separation of the signal elements it has been proposed to illuminate the target of the pick-up tube with biassing lights of different colours in such a way that signal elements representative of different colour components are confined to separate amplitude ranges, but problems are still encountered in effecting separation even when this expedient is adopted. For instance, it is insufficient merely to limit-off signals occupying amplitude ranges above and below a particular amplitude range in order to separate the signals in the last-mentioned range; limiting the signals of higher amplitude produces signals whose amplitude is the upper limit of the desired ranges, i. e., peak signals of the corresponding component colour whereas there should be no signal of that colour.

The object of the present invention is to reduce the problems referred to.

A further object of the present invention is to provide colour television apparatus wherein means are provided for generating signals representative of a light image of mixed colours so that signal elements representative of different colour components of elements of said image are confined to separate amplitude ranges, and wherein means are provided for separating the signal elements in a lower amplitude range from signals in a higher amplitude range by utilising signal elements in the higher range to reduce the instantaneous amplitude of the signals at least to the lower limit of said lower range. Any signals below said limit can be removed from the wanted signals in the first-mentioned range by limiting in known manner.

A further object of the present invention is to provide colour television apparatus including means for generating signal elements representative of different colour components of a light image of mixed colours during each field of the generated signals, and means for deriving signals of the field sequential type from the signal elements in such manner as to yield a good signal-to-noise ratio.

In order that the said invention may be clearly understood and readily carried into effect, the same will now be more fully described with reference to the accompanying drawings.

Figure 1 diagrammatically illustrates one example of colour television apparatus according to the present invention, and

Figure 2 is a diagram explanatory of the operation of Figure 1.

Reference will also be made to the accompanying drawing, the single figure of which is for convenience numbered Figure 3 and in which:

Figure 3 illustrates diagrammatically a feature of the invention.

Referring to the drawing, reference numeral **1** denotes a television pick-up tube of the kind adapted to operate with cathode potential stabilisation, the tube being of conventional construction (apart from a multi-section colour mosaic **2**, which will be referred to later), and comprises the usual electron gun **3**, wall anode **4**, and target structure comprising a photo-electrically sensitive mosaic screen **6** and transparent conductive signal plate **7**. The target structure is mounted on the inner surface of the end wall **8** of the tube **1** which constitutes the optical window thereof. The tube is provided with the usual focussing solenoid **9** and deflecting coils indicated diagrammatically at **10**. A high impedance load **11** is connected between the signal plate **7** and ground, as shown, and electrical signals set up across this load are applied to an amplifier **12** and thence to a D. C. establishing circuit **13** which may be of any suitable construction. The output from the D. C. inserting circuit **13** is fed to a separating circuit which is denoted in general by the reference **14** and will be described in more detail hereinafter.

The colour filter **2** is applied as close as possible to the mosaic screen and is of the same area as the latter. Alternatively a lens may be disposed between the filter and the mosaic screen in such a position as to focus an image of the filter on the mosaic screen. The filter **2** is merely indicated diagrammatically but it comprises translucent strips of green, blue and red colour arranged in a regular sequence from one edge of the filter to the other, the strips extending effectively at right angles to the lines scanned on the mosaic screen **6** by the beam in the pick-up tube **1**. Consequently if a light image of mixed colours is focussed onto the mosaic screen **6** elements of the mosaic screen are illuminated by different colour components of the elements of the light image in accordance with the pattern of the colour filter. The mosaic screen **6** is, moreover, illuminated continuously through the filter **2** with a steady blue light from the light source **15** having a blue filter **16**, and with a steady red light from a source **17** having a red filter **18**. A steady light bias is therefore applied to those elements of the mosaic screen **6** which are illuminated through the blue and red strips of the filter **2** and it is arranged that the "red" bias is of higher level than the "blue" bias to an extent which is hereinafter referred to.

The aforesaid separating circuit **14** comprises three diode valves **19**, **20** and **21** which have their anodes connected in parallel to the output of the D. C. inserting circuit **13**. The cathode of the diode **19** is biassed through a load resistance **22** to a level of +2 volts, the cathode of the diode **20** is biassed through a load resistance **23** to a level of +1 volt whilst the cathode of the diode **21** is directly grounded via a resistance **24**. The signal output from the resistance **22** is applied directly to a "red" channel **25**, that is a channel for signal elements representative of the red colour component. The signal output from the load resistance **23** is applied in parallel via a resistance **26** to a "blue" channel **27** and to the control electrode of an amplifying valve **28**. The control electrode of the valve **28** is negatively biassed by means of a bias source **29** (indicated conventionally as a battery) in the cathode lead of the valve so that the valve is cut-off if the signal in its control electrode

is less than +2 volts. The anode of the valve **28** is coupled to the output side of the resistance **26** via a condenser **30**. The signal output from the load resistance **24** is, similarly, applied in parallel to a resistance **32** and to the control electrode of an amplifying valve **33**, the resistance **32** and the valve **33** feeding in turn to a "green" channel **31**. The control electrode of the valve **33** is biassed negatively by a potential source **34**, so that the valve is cut-off if the signal in its control electrode is less than +1 volt. The anode of the valve **33** is coupled to the output side of the resistance **32** via a condenser **35**.

In operation of the apparatus, the mosaic screen **6** is scanned with a low velocity beam of electrons generated by the gun **3**, in known manner, and sets up a signal output across the output load **11**, representative of the light image focussed on the mosaic screen **6**. Due to the presence of the colour filter **2**, the strips of which extend effectively at right angles to the scanning lines, the generated signals comprise signal elements representative of the green, blue and red components of different elements or dots of the light image, the signal elements being intercalated in accordance with the pattern of the filter **2**. After suitable amplification by the amplifier **12** the D. C. component of the signals is inserted by the circuit **13** and it is arranged that the light sources **15** and **17** bias "blue" signal elements in the output of the circuit **13** so that their black level is 1 volt and bias the "red" signal elements so that their black level is 2 volts, the term "black level" being used to denote the level of the signal output corresponding to no component of the respective colour. Since no green bias is applied to the mosaic screen **6** the black level for green signal elements is zero volts. Moreover, it is arranged that the peak level of green, blue and red elements are just less than 1, 2 and 3 volts respectively. A fraction of the signal output from the circuit **13** may therefore have the form indicated in Figure 2 in which the horizontal lines represent the various voltage levels indicated. The signal levels **39**, **40** and **41** represent the light intensity of green, blue and red components of three successive elements of the light image focussed on a mosaic screen, superimposed on the light bias from the sources **15** and **17**, and if a repetitive signal of this form is applied to the circuit **14** the diode valve **19** transmits only those signal elements whose level is 2 volts or higher, that is red signal elements, to the red channel **25**. The diode valve **20** transmits all signal elements whose level is 1 volt or higher to the resistance **26** and the control electrode of the valve **28**. If the level is lower than 2 volts, the valve **28** remains non-conducting and the signal elements are passed without modification to the channel **27**. If, however, the level is 2 volts or higher the valve **28** becomes conducting and an amplified output of the signal elements is superimposed with reversed polarity, via a condenser **30**, on the signal elements which are fed directly to the resistance **26**, and the gain of the valve **28** is arranged to be such that the amplified signal elements have such amplitude that when combined with the signal elements transmitted directly via the resistance **26**, the resultant signal output is displaced to or below 1 volt, the black level for blue signal elements. Consequently red and green signal elements are suppressed and blue signal elements are fed to the channel **27**. It will therefore be appreciated that the resistance **26** provides a path to the channel **27** for signals in the amplitude range from 1 to 2 volts and that the valve **28** and its associated circuit connections provides means responsive to signals in the higher amplitude range of 2 volts and above for reducing the amplitude of signals transmitted by the resistance path **26** to or beyond the lower limit of the amplitude range from 1 to 2 volts. The diode valve **21** transmits the entire signal output from the circuit **13** and the valve **33** functions in a similar manner to the valve **28** to suppress red and blue signal elements which would otherwise be transmitted via resistance **32** to the channel **31** so that only green signal elements are fed thereto with voltages exceeding 0 volts, the black level for green signal elements. It may be possible in some cases to dispense with the diode valve **21**, but it is useful for clipping unwanted spurious signals extending to the "blacker-than-black" region.

The red, green and blue signal elements in the various channels can be employel to produce simultaneous fields of each of the colours or can be employed to produce colour television signals of the field sequential type. However, the signal elements in the various channels can also be used if desired, for the production of signals of the line-sequential or dot-sequential type.

It will be understood that the biassing and signal levels indicated in Figure 2 of the drawing are merely illustrative, and also that the order of biassing the different colour elements may be varied. For example, since green is the colour giving the greatest resolution to the eye, it may be preferable to use the middle portion of the signal output range for this colour, since a biassing light tends to reduce lag of the storage tube, especially if it employs low velocity scanning and also because the tube resolution is probably greatest in this region. The invention is not of course restricted to apparatus embodying the pick-up tubes which employ low velocity scanning.

According to a specially advantageous application of the invention to the production of signals of the field-sequential type, the signals in each channel are applied to a storage type of cathode ray tube in such manner as to produce a charge image in the target of the respective tube. This is illustrated in Figure 3, according to which the signals in the colour channels **25**, **27** and **31** respectively are applied to the input side of three switches **42**, **43** and **44** which are merely shown diagrammatically and may be high speed electronic or electro-mechanical relays of any suitable construction. The switch **42** is arranged to connect the red channel **25** alternatively to a red output channel **45** or to a modulator electrode of the electron gun **46** in a storage cathode ray tube **47**. The tube **47** may be of same construction as the tube **1** in Figure 1 and has an output load **48** connected to the signal plate **49** of the tube, the signal plate being capacitatively associated with a mosaic screen **50**. The output of signals set up across the load **48** is applied to the input side of a switch **51**, which has two positions, corresponding to the two positions of the switch **42**, in one of which the switch feeds the output from the load to the channel **45**, and in the other of which the switch is open circuited. The switches **43** and **44** are respectively associated with output channels **52** and **53**, storage tubes **54** and **55**, and switches **56** and **57** in the same manner as the switch **42**, so that these circuit connections need not be described in detail.

In operation of the arrangement, switching pulses are applied to the switches **42**, **43**, **44**, **51**, **56**, **57** such that each pair of switches assumes one codition, that indicated for the switches **43**, **56** and **44**, **57**, during two successive fields and assumes the other condition, that indicated for the switches **42** and **51**, during the next field, and so on for each series of three fields. Moreover, each switch pair is maintained in the latter condition during different fields, a red colour field being transmitted when the switches **42** and **51** are "raised," a green colour field being transmitted when the switches **43** and **56** are raised, and a blue colour field being transmitted when the switches **44** and **57**, are raised. When the switches of any pair are lowered colour signal elements in the respective channel, say **27**, are stored in the corresponding storage tube **54**. Assume, for example, that a blue colour field has just been transmitted to the output channel **53**. In the suppression interval following this field, switches **44** and **57**, having been raised, are lowered, and vice versa in the case of switches **42** and **51**. The condition of switches **43** and **56** is not changed. During the same interval, the

mosaic screen of tube 55 is uniformly illuminated to produce a uniform charge image on the mosaic screen of this tube, the illumination being, however, extinguished before the suppression interval ends. The electron beams in all the tubes 47, 54 and 55 are caused to scan the respective mosaic screens in synchronism with the scanning traversals of the beam in the pick-up tube 1, the signal elements in the channels 25, 27 and 31 having it is assumed negative polarity so as to produce negative modulation of the scanning beams in the tubes 47, 54 and 55. The desired signal polarity in the channels 25, 27 and 31 can be achieved by polarity reversing amplifiers if the polarity would otherwise be incorrect. During the next field, red signal elements in the channel 25 are fed directly to the output channel 45, and the beam in the tube 47 being unmodulated a signal output is set up across the load 48 representative of red signal elements stored in the tube 47 during the preceding two frames. This signal output is superimposed in output channel 45 in the signals fed directly thereo, so that the resultant output in channel 45 is the resultant of storage of red colour components during three fields. During the same field, moreover, blue signal elements in the channel 31 modulate the beam in the tube 55 and this beam on scanning the mosaic screen modulates the uniform charge image set up as aforesaid so that the signal elements are stored as a charge image modulation on the mosaic screen. At the end of the blue colour field the conditions of the switch pair 42, 57 and the switch pair 43, 56 are reversed, and the mosaic screen of the tube 47 is uniformly illuminated to set up a uniform charge image, all charges stored in the target of tube 47 having been wiped off by scanning with the unmodulated beam during the preceding field. During the green colour field, the signals stored in tube 54 are picked-off and fed to channel 52 to be superimposed on green signal elements fed directly from tube 1 via channel 27, while signal elements in channels 25 and 31 are stored in the respective tubes by the mechanism already described. This cycle of operation continues indefinitely. By use of the arrangement illustrated in Figure 3, substantial improvement of the signal-to-noise ratio should be obtainable more than compensating for the employment of three storage tubes. Such improvement in the signal-to-noise ratio is especially desirable in arrangements, such as described, where the maximum useful signal amplitude of each colour element is relatively small. The improvement arises from the fact that the signal elements from the three fields which contribute to a single colour field, add arithmetically whereas the resultant effect of fluctuation noise components mixed with the respective signal elements is obtained by taking the root of the sum of the squares of the amplitude of the noise components since noise is random.

The present invention can be applied to other forms of television apparatus than that illustrated. For instance it can be applied to apparatus for generating television signals by scanning of cinematograph film. In this case if the apparatus is of the kind described in United States Patent No. 2,225,033 the colour filter is placed between the film gate and the photo-electric cell. Moreover, the arrangement such as illustrated in Figure 1 hereof may be associated with a second pick-up tube as described with reference to Figure 5 in our co-pending U. S. A. application Serial No. 262,361.

What we claim is:

1. Colour television apparatus comprising an image pick-up device for generating electrical signals, comprising intercalated signal elements representative of at least two colour components of an image picked up by said device, means for biasing signal elements representative of one colour to a higher amplitude range than signal elements representative of the other colour, a signal channel corresponding to said first colour, another signal channel corresponding to said other colour, means for selectively feeding said electrical signals to said first channel including a limiter for removing signal elements in the lower amplitude range, and means for selectively feeding said electrical signals to said second channel including a path to said second channel for signals in the lower amplitude, range and means responsive to signal elements in said higher amplitude range for reducing the amplitude of signals transmitted by said path at least to the lower limit of the lower amplitude range.

2. Colour television apparatus comprising an image pick-up device including a photoelectrically sensitive surface for generating electrical signals representative of light variations on said surface, a colour filter comprising a plurality of filter elements of at least two colours for filtering light projected to said surface so that the generated signals comprise intercalated signal elements representative of at least two colour components, means for illuminating said surface through said filter with biasing light of one of said colours to bias signal elements representative of said one colour to a higher amplitude range than signal elements representative of said other colour, a signal channel corresponding to said first colour, another signal channel corresponding to said other colour, means for selectively feeding the generated electrical signal to said first channel including a limiter for removing signal elements in the lower amplitude range, and means for selectively feeding the generated signals to said second channel including a path to said second channel for signals in the lower amplitude range and a phase reversing amplifier responsive to signal elements in the higher amplitude range for reducing the amplitude of signals transmitted by said path at least to the lower limit of the lower amplitude range.

3. Colour television apparatus comprising an image pick-up device including scanning means for effecting successive field scanning traversals to generate electrical signals, comprising intercalated signal elements representative of at least two colour components of an image, a storage device corresponding to a first colour, a storage device corresponding to a second colour, means for separating signal elements representative of said first colour from signal elements representative of said second colour, means for storing signal elements representative of said first colour in said first storage device during one field scanning traversal, means for storing signal elements representative of said second colour in said second storage device during another field scanning traversal, means for deriving stored signal elements from said first storage device during a field scanning traversal subsequent to said first traversal, means for adding said derived signal elements to the signal elements representative of said first colour generated during said subsequent field scanning traversal, means for deriving stored signal elements from said second storage device during a field scanning traversal subsequent to said other field scanning traversal, and means for adding the latter derived signal elements to the signal elements representative of said second colour generated during said first scanning traversal subsequent to said other traversal.

References Cited in the file of this patent

UNITED STATES PATENTS

2,545,325	Weimer	Mar. 13, 1951
2,545,957	Kell	Mar. 20, 1951
2,552,070	Sziklai	May 8, 1951
2,579,971	Schade	Dec. 25, 1951